MADERA SUBBASIN

Sustainable Groundwater Management Act (SGMA)

Joint Groundwater Sustainability Plan

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

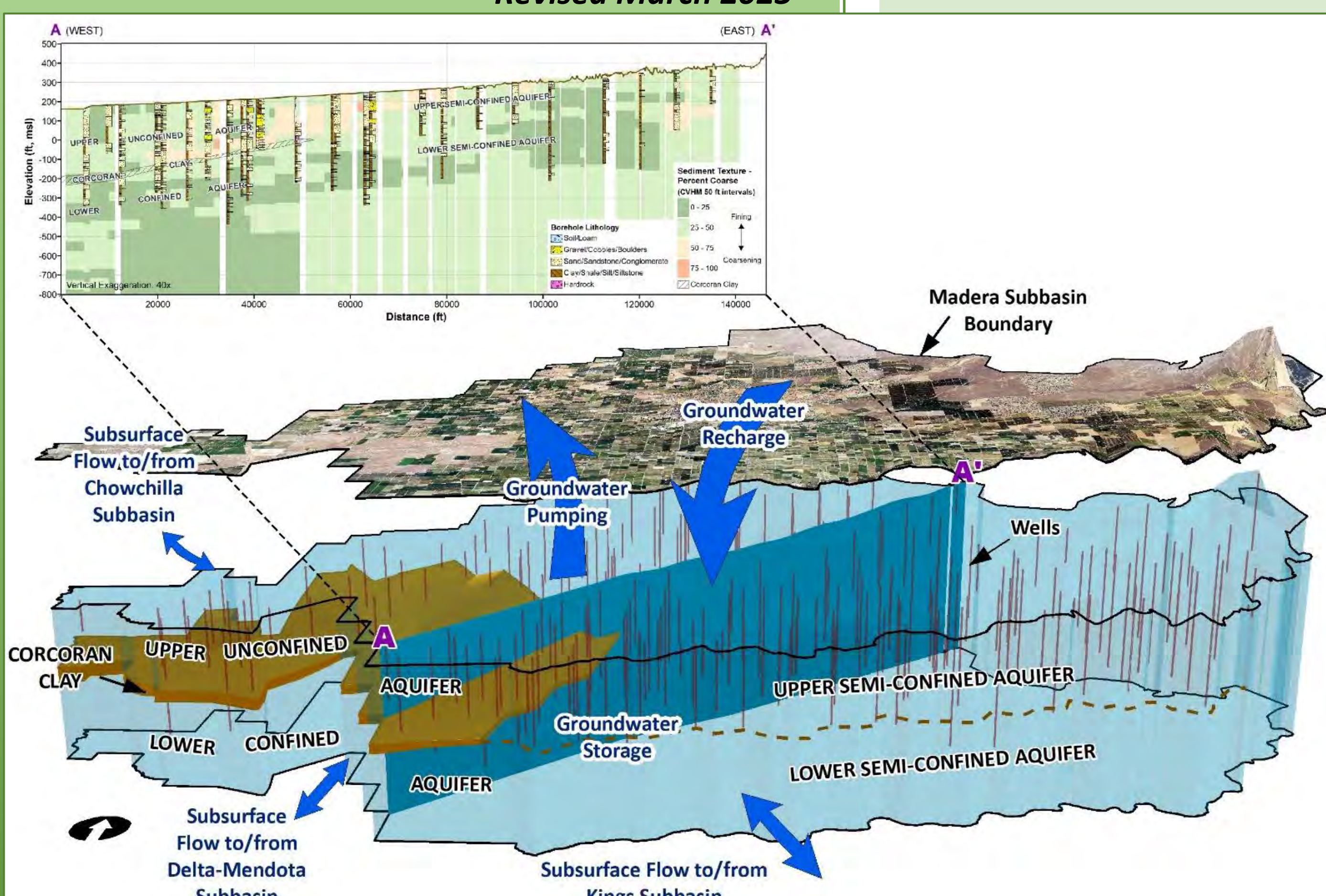
APPENDIX 2. PLAN AREA AND BASIN SETTING

Technical Appendices 2.A. through 2.G.

January 2020
Revised March 2023

Prepared by

Davids Engineering, Inc. (Revised GSP)
Luhdorff & Scalmanini (Revised GSP)
ERA Economics
Stillwater Sciences and
California State University, Sacramento



Madera Subbasin

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APPENDIX 2. PLAN AREA AND BASIN SETTING

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APPENDIX 2.A. MADERA SUBBASIN ANNUAL SPATIAL LAND USE

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

GSP Team:

Davids Engineering, Inc
Luhdorff & Scalmanini
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To support GSP development, land use areas in the Madera Subbasin were identified from available data in Madera County, which includes the entire Madera Subbasin.

Annual land use estimates were primarily based on spatially distributed land use information from DWR Land Use surveys in 1995, 2001 and 2011 and Land IQ[1] remote sensing-based land use identification for 2014. County Agriculture Commission land use areas were used to interpolate between years with available spatial land use information. Lands in the District were assigned to one of 17 land use classes.

The following five steps were used to develop the Madera County-wide annual, spatial land use dataset.

1.) Developed spatial land use coverages for 1995, 2001, 2011, and 2014. Made adjustments to the spatial coverage, including:

    a) Filled missing area from LandIQ coverage with 2011 DWR coverage (native, semi-agricultural, urban, and water account for 86% of the missing area)

    b) Used the water area from 2001 for the 1995 DWR survey (water surfaces were not included in the 1995 DWR survey).

2.) Calculated agricultural area:

    a) Assumed county data does not include idle land (county data has idle equal to zero for all years)

    b) Excluded idle land from DWR agricultural totals to be consistent with county totals

    c) Calculated the ratio of the DWR agricultural total area (not including idle lands) to county agricultural production area for years with DWR (or Land IQ) land use data

    d) Estimated agricultural area for missing years between the first and last available county data by interpolating the ratio calculated in step (c)

    e) Estimated agricultural area for missing years outside the available county data by extending the annual trend or estimating as equal to the nearest available county data

3.) Multiplied county agricultural acres for each crop by the ratio calculated in in step 2 (c) to adjust county agricultural areas for each crop scaling each crop area in each year by an estimate of the difference between the areas in the DWR land use surveys and County Commissioner reports. This procedure assumes DWR areas are the most accurate.

    a) Interpolated native, semi-agricultural, urban, and water land uses between DWR years.

    b) Calculated idle area as the remaining area (total DWR land use minus total cropped area)

4.) Reviewed calculated idle and crop area graphs and adjusted individual annual cropped areas with abnormal crop area shifts based on professional judgement to eliminate calculated negative idle areas

    a) 1996 adjustments--replaced high miscellaneous truck areas with interpolated values between 1995 and 1997

    b) 2002, 2003, 2004 and 2005 adjustments--replaced high areas for mixed pasture and alfalfa between 2001 and 2011 DWR areas by interpolating areas between 2001 and 2011.

[1] Land IQ is a firm that was contracted by DWR to use remote sensing methodologies to identify crops in fields.

c) 2012 adjustments--replaced high miscellaneous deciduous, field and truck with interpolated value between 2011 and 2013

5.) Implemented the DWR Land Use interpolation tool to create annual spatial cropping data sets.

Table A2.A-1 summarizes the land use sector and average acreage of each land use class in the Madera Subbasin based on the above land use analysis.

Table A2.A-1. Average Land Use Acreages in Madera Subbasin, 1989 to 2014.

Land Use Sector	Land Use Class	Acres
Agricultural	Alfalfa	9,060
	Almonds	36,888
	Citrus and Subtropical	6,613
	Corn (double crop)	7,422
	Grain and Hay Crops	7,831
	Grapes	79,707
	Idle	11,998
	Miscellaneous Deciduous	11,091
	Miscellaneous Field Crops	10,296
	Miscellaneous Truck Crops	2,531
	Mixed Pasture	7,204
	Pistachios	21,709
	Walnuts	1,013
Native Vegetation	Native	98,634
	Water	3,445
Urban	Urban	27,842
	Semi-agricultural	4,289
Total		347,572

References

DWR. 2011. “Madera County land use survey data.” State of California, Department of Water Resources. Available online: https://water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Land-Use-Surveys. Also published in 1995 and 2001.

Land IQ. 2014. “Statewide Crop Mapping 2014.” Land IQ, LLC, and State of California, Department of Water Resources. Available online: https://gis.water.ca.gov/app/CADWRLandUseViewer/.

Madera County. 2018. “Madera County Crop & Livestock Report.” Madera County Department of Agricultural Weights and Measures. Available Online: https://www.maderacounty.com/government/agricultural-commissioner-weights-and-measures/annual-crop-reports. Published annually.

APPENDIX 2.B. ASSESSMENT OF GROUNDWATER DEPENDENT ECOSYSTEMS FOR THE MADERA SUBBASIN GSP

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

GSP Team:

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Assessment of Groundwater Dependent Ecosystems for the Madera Subbasin Groundwater Sustainability Plan

PREPARED FOR

Madera Subbasin Coordination Committee

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1 GDE IDENTIFICATION

Groundwater dependent ecosystems (GDEs) are defined in California's Sustainable Groundwater Management Act (SGMA) as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)). As described in The Nature Conservancy's guidance for GDE analysis (Rohde et al. 2018), a GDE's dependence on groundwater refers to reliance of GDE species and/or communities on groundwater for all or a portion of their water needs. In this section, we detail the information sources used, new information gathered, and methods applied to make determinations and to describe the conditions of GDEs identified in the Madera Subbasin. We used Rohde et al. (2018) as well as the text of SGMA itself as primary guides.

1.1 GDE Mapping and Methods

We began the process of identifying the GDE units in the Madera Subbasin using the California Department of Water Resources' (DWR) iGDE (GDE indicators) database, published online and referred to as the Natural Communities Commonly Associated with Groundwater dataset (Klausmeyer et al. 2018). We augmented these data with other relevant spatial vegetation data, aerial imagery, information on vegetation types, depth to groundwater, plant and animal species distributions in the area, plant species rooting depths, and field observations. Data analysis was conducted through a series of steps to augment, filter, classify and aggregate the GDE polygons within the Madera Subbasin.

1.1.1 Data sources

This section includes brief descriptions of the data and other information sources used to identify and aggregate potential GDE polygons into GDE units.

Our starting point for GDE identification and analysis was the iGDE database (Klausmeyer et al. 2018). We downloaded the iGDE geodatabase from the DWR website (https://gis.water.ca.gov/app/NCDatasetViewer/#) and incorporated it into the project geographic information system (GIS) to create a preliminary map to serve as the primary basis for initial identification of potential GDEs. This data set is a combination of the best available data obtained from multiple publicly available sources:

- VegCAMP – Vegetation Classification and Mapping Program, California Department of Fish and Wildlife (CDFW 2019) – Areas mapped to the alliance level and with a minimum mapping unit (MMU) of 1.0 and 0.25 acres for natural uplands and wetlands/ riparian areas, respectively; mapped using 2012 imagery from the National Agriculture Imagery Program (NAIP) for the Southern San Joaquin Valley.
- NWI v2.0. – National Wetlands Inventory (Version 2.0), U.S. Fish and Wildlife Service (USFWS 2018); MMU = 0.5 acres.
- CalVeg – Landsat-based classification and assessment of visible ecological groupings, USDA Forest Service (March 2007) – vegetation mapping to the alliance level that is cross-walked to VegCAMP; MMU = 2.5 acres.

In addition, we added a more recent vegetation mapping source for the San Joaquin River riparian corridor, developed by Stillwater Sciences under contract with the Bureau of Reclamation for the San Joaquin River Restoration Program (Bureau of Reclamation 2014). This dataset represents an update to the Geographic Information Center's 2009 vegetation map, prepared for DWR's

Central Valley Flood Protection Program; this update used 2012 NAIP imagery and 2013 field observations. Vegetation was mapped to the alliance level with an MMU of 0.25 acres (Bureau of Reclamation 2014).

Klausmeyer et al. (2018) created the iGDE dataset as a starting point to identify potential GDEs across the state. Per the authors, this dataset requires careful review and refinement with local information since it was created at the state scale and broad decisions were made without consideration of local conditions. Thus, we reviewed all areas included in the iGDE dataset and scanned the full area of the Madera Subbasin, using aerial imagery and existing vegetation mapping, to check for potential GDEs that might have been omitted or mischaracterized during creation of the statewide iGDE dataset.

To inform the assessment of GDE condition and potential effects (Sections 2 and 3), we obtained mapped plant community and wetland types detailed in the original VegCAMP, NWI, and CalVeg datasets as well as the San Joaquin River Riparian Vegetation dataset, the latter of which was available in-house. We evaluated and incorporated information on depth to groundwater and plant species rooting depth into this analysis to help inform subsequent assessment of potential sensitivity of vegetated GDEs to changes in groundwater. Published information on depth of rooting for riparian and wetland plant species was obtained in the form of a database (spreadsheet) collated and made publicly available online by TNC at The Nature Conservancy's Groundwater Resource Hub (https://groundwaterresourcehub.org/gde-tools/gde-rooting-depths-database-for-gdes/). Where data were missing, Stillwater's vegetation ecologists conducted literature searches to update this database for phreatophyte[1] species occurring within the Madera Subbasin. Depth to groundwater in the regional aquifer was estimated and mapped by LSCE based on existing well data, as described in Section 2.2.2 of this Groundwater Sustainability Plan (GSP) and provided as a geodatabase. Information on hydrogeology was used to better understand the distribution of other perched/mounded groundwater in the subbasin (Davids Engineering and LSCE 2017).

1.1.2 Procedure

In general, we followed the steps for defining and mapping GDEs outlined in Rohde et al. (2018). Throughout this process, we applied a decision tree to determine when species or biological communities were considered groundwater dependent based on definitions found in SGMA and Rohde et al. (2018). This decision tree, created to systematically and consistently address the range of conditions encountered, is summarized below, where the term 'unit' refers to an area with consistent vegetation and hydrology:

The unit is a GDE if groundwater is:

1. An important hydrologic input to the unit during some time of the year, AND
2. Important to survival and/or natural history of inhabiting species, AND
3. Associated with:
    a. A perched/mounded[2] unconfined aquifer, OR

[1] A phreatophyte is a deep-rooted plant that obtains its water from the phreatic zone (zone of saturation) or the capillary fringe above the phreatic zone (Rohde et al. 2018). Phreatophytes grow where precipitation is insufficient for their persistence and groundwater is therefore required for long-term survival (Naumberg et al. 2005). Phreatophytes are often, but not always, found in riparian areas and wetlands.

[2] The degree to which the shallow groundwater is perched or mounded atop shallow clay layers. Mounding is often pronounced underneath rivers which are often the source of the mounded water.

b. A regional aquifer used as a regionally important source of groundwater.

The unit is not a GDE if it is an open water feature (e.g., stream, pond, wetland) whose hydrologic regime is primarily controlled by:

1. Surface discharge or drainage from an upslope human-made structure(s), such as irrigation canal, irrigated field, reservoir, cattle pond, water treatment pond/facility; or
2. Precipitation inputs directly to the unit surface. This excludes vernal pools from being GDEs where units are hydrologically supplied by direct precipitation and very local shallow subsurface flows from the immediately surrounding area.

In the Madera Subbasin, groundwater occurs as a perched/mounded unconfined aquifer under the San Joaquin River along the southern border of the subbasin and as a regional aquifer throughout much of the western and central portions of the subbasin. In the extreme eastern portion of the subbasin, groundwater occurs in relatively thin alluvium overlying shallow bedrock. Because of the thin alluvium (and hence limited groundwater availability), there is little well data or other information in the eastern part of the subbasin to quantify groundwater depth.

Specifics on the above decision steps, as applied to the Madera Subbasin, are provided below.

1.1.2.1 Identify Communities supporting phreatophytic vegetation

After obtaining the relevant spatial data described above, we overlaid and evaluated these data in GIS to select the most recent and highest quality vegetation and water body mapping information. In this case, consistent with Klausmeyer et al. (2018), we prioritized the most recent and highest resolution mapping over earlier and coarser scale mapping information. Thus, the order of priority, from first to last, was: San Joaquin River Riparian (Bureau of Reclamation 2014), VegCAMP, NWI v2.0, CalVeg. The highest priority mapped vegetation type polygons that overlapped with the iGDE polygons were summarized by vegetation type and total acreage. These vegetation types were reviewed by one of our experienced wetland and riparian ecologists to remove vegetation types adapted to well drained, upland conditions (i.e., those not considered phreatophytes) from the working GIS layer, such as blue oak woodland (*Quercus douglasii*).

1.1.2.2 Identify potential GDEs based on potential hydrologic connection to groundwater

We removed iGDEs without a potential hydrological connection to groundwater from the original dataset using spatially extrapolated or interpolated empirical measurements of depth to groundwater (DTW) for winter/spring of water years 2014 and 2016. DTW mapping for 2015 was not used due to limitations resulting from few available water level measurements. The 2014 and 2016 DTW data were the most accurate and recent DTW data available for the Chowchilla Subbasin. While the 2016 data represent conditions after the 2015 SGMA baseline, the use of shallow groundwater data from both years was deemed appropriate because it provided a more conservative (i.e., more inclusive) indicator of potential GDEs than the use of a data from a single year.

A DTW of 30 feet was used as one of the primary criteria in the initial screening of potential GDEs. The use of a 30-foot DTW criterion to screen potential GDEs corresponds to the maximum rooting depth of valley oak, *Quercus lobata* (Lewis and Burgy 1964), one of the species that compose iGDEs in the subbasin and is consistent with guidance provided by The Nature Conservancy (Rohde et al. 2018) for identifying GDEs. Potential GDEs were retained for further analysis if the underlying DTW in either winter/spring 2014 or winter/spring 2016 was equal to or shallower than 30 feet. In addition, we evaluated DTW under the San Joaquin and Fresno rivers during 2014 and 2016 in relation to river flow, and evaluated available surface flow characteristics in other streams and sloughs in the subbbasin to assess the potential connection between surface flow and groundwater levels. If there was evidence that the surface water was connected to groundwater (i.e., a gaining stream), that reach would be eligible for inclusion as a potential GDE. Because the vast majority of rivers and streams in the subbasin are not perennial and all are in a net-losing hydrological condition (i.e., losing water to the groundwater system), this criterion excluded most of the smaller river channels and associated terrestrial vegetation from consideration as GDEs. Thus, we generated a draft map of the potential GDEs that occur in areas where DTW was less than or equal to 30 feet in either water year 2014 or 2016. We used 2012 geospatial vernal pool mapping data (Witham et al. 2014) in combination with aerial photographic analysis to identify vernal pools mapped in the iGDE data set and remove them from the working GIS layer and draft map. Other surface water features such as stock ponds that we determined were not connected to groundwater were removed based on review of aerial photographs and other available information.

1.1.2.3 Refine potential GDE map

We reviewed for accuracy the mapped vegetation cover in remaining polygons identified as potential GDEs using visual analysis of Google Earth and NAIP imagery. These potential GDE polygons were primarily those dominated by terrestrial vegetation (i.e., vegetated potential GDEs). We removed from the potential GDE map those areas that had, since vegetation mapping occurred, changed land use from natural vegetation to developed uses (urban, roads, or agriculture). During this heads-up review of the potential GDEs, areas supporting riparian or wetland vegetation that were not in the original iGDE geodatabase, but were included in other high-quality datasets (e.g., VegCAMP or San Joaquin River Riparian mapping [Bureau of Reclamation 2014]) and have the potential to be hydrologically linked to groundwater (i.e., located in an area where the depth to water is less than or equal to 30 feet or along a gaining river or stream reach), were added to the potential GDE geodatabase and map. Polygons on the potential GDE map were labeled and color-coded as “kept,” “added,” or “removed” from the original iGDE data set according to the above described criteria (Figure A2.B-1).

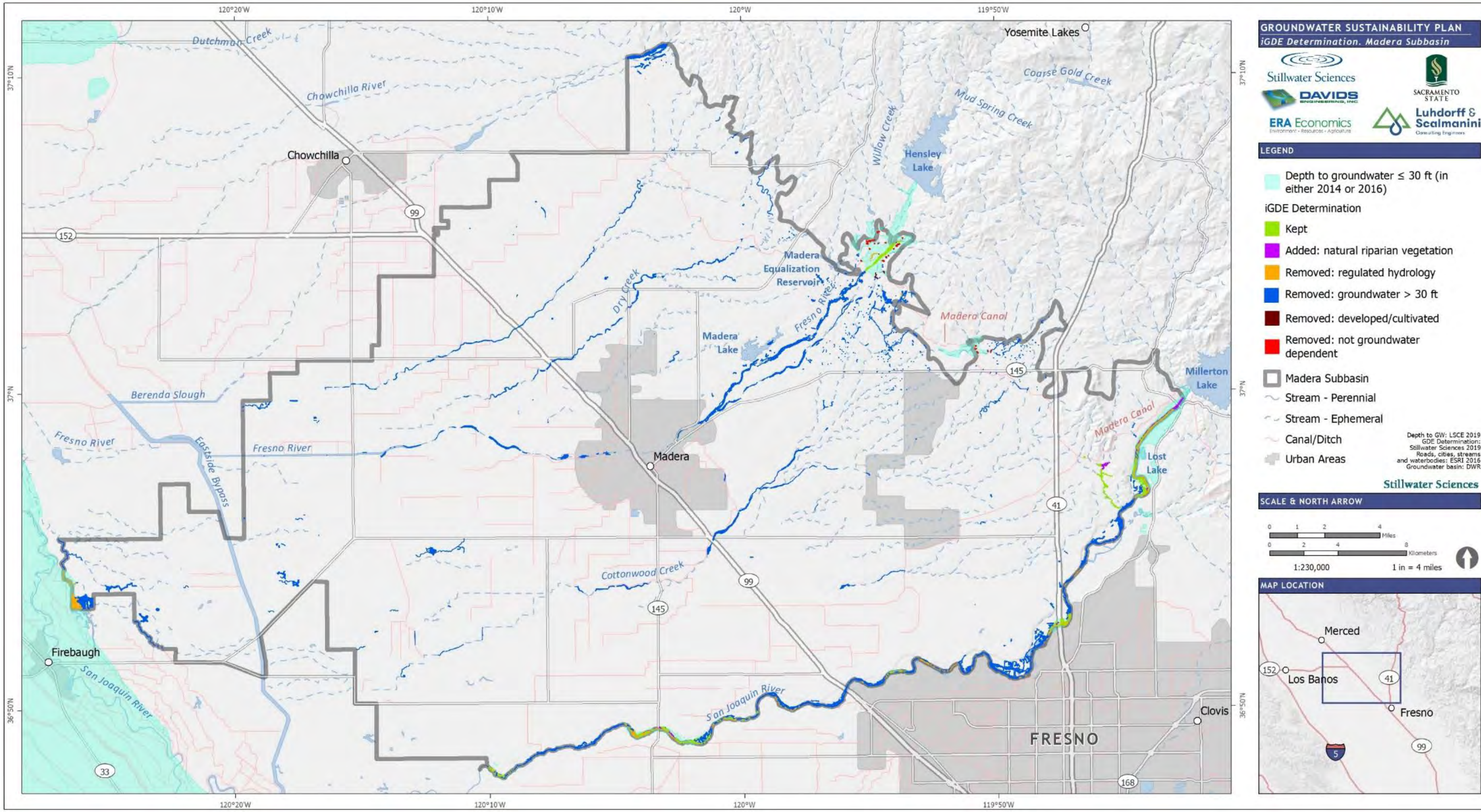

Figure A2.B-1. Potential GDEs in the Madera Subbasin, showing iGDE polygons kept, added, or removed from the DWR Natural Communities Commonly Associated with Groundwater dataset.

1.1.2.3 Identify potentially associated sensitive species and community types

Stillwater Sciences' ecologists queried existing databases on regional and local occurrences and spatial distributions of special-status species and critical habitat. Databases accessed include CNDDB (2019), CNPS (2019), eBird (2019), USFWS (2019) and NMFS (2016). Spatial database queries were centered on the potential GDEs plus a 5-mile buffer. Stillwater's ecologists reviewed the database query results and identified species and community types with the potential to occur within or to be associated with the vegetation and aquatic communities in or immediately adjacent to the potential GDEs. Stillwater's ecologists then consolidated a list of these sensitive species and community types, along with summaries of habitat preferences and any known occurrence reports, for field review.

1.1.2.4 Ground truth vegetation type and condition in field surveys

On May 1, 2019, two Stillwater Sciences biologists, one with expertise in vegetation and the other in wildlife, conducted a reconnaissance-level survey of portions of the areas mapped as potential GDEs. The Stillwater team loaded spatial data on potential GDE locations, sensitive species occurrences, and DTW estimates onto a GPS equipped field tablet. The field crew also brought field maps and other information on potential special-status species to the field and visited a subset of the potential GDEs, selected to represent the range of potential GDE vegetation and hydrologic types in the subbasin. At each site, the field biologists recorded dominant vegetation types and plant species, estimates of percent cover for native and non-native plants by vegetation layer, indications of hydrologic connectivity with surface and/or groundwater, and indications of site alteration (e.g., cattle use, human disturbance, land use changes). Based on field observations, the field crew confirmed or refined mapped vegetation types, qualitatively evaluated the ecological condition, and qualitatively assessed habitat conditions for sensitive species at each representative site. The field crew recorded notes on the ecological conditions of each site visited, such as information on the proportion of live vs. senescent canopy, evidence of native species recruitment, and vegetation density. Habitat conditions for each species were assessed by comparing each species' habitat preferences (e.g., large trees, open water or herbaceous cover, etc.) to conditions present at the site. The field crew also recorded observations to help inform or verify potential linkages to groundwater, such as indications of standing water, water emerging from the ground, or water flowing into or off of the site from a contributing area.

1.1.2.5 Refine vegetation and aquifer association for potential GDEs

We updated our geodatabase with field refinements in mapped vegetation types and extents, as well as location and extent of newly observed potential GDEs identified within the subbasin during the site survey. We then categorized the potential GDEs according to their association with aquifers based on the 2014 and 2016 DTW data. In most cases, the potential GDEs were associated with groundwater where DTW was mapped as less than or equal to 30 feet in 2014 or 2016. However, we also identified one potential GDE located in an area where extrapolated or interpolated DTW was mapped as greater than 30 feet in 2014 and 2016.

1.1.2.6 Document changes to iGDE map and create final GDE map

We consolidated the remaining GDE polygons by type (e.g., vegetated, riparian) and proximity to one another, giving each grouping a descriptive name. Changes made to the original iGDE map were recorded as they were made, based on desktop or field observation of changes in vegetation type or land use, indications of no hydrologic linkage to groundwater, or open water features in areas where the hydrologic regime is dominated by human intervention as described previously in this section. The final GDE map (Figure A2.B-2) shows these consolidated GDEs, grouped into GDE units, each with a unique color and name. The GDE units are considered “potential” GDEs because of uncertainties regarding the hydrologic connection between the GDEs and groundwater and the degree to which vegetation in the units relies on groundwater. Four potential GDE units occur in the Madera Subbasin: the Fresno River Riparian, Friant Riparian, San Joaquin River Riparian and Sumner Hill GDE units. Figures A2.B-3– A2.B-5 show the GDE units in greater detail.

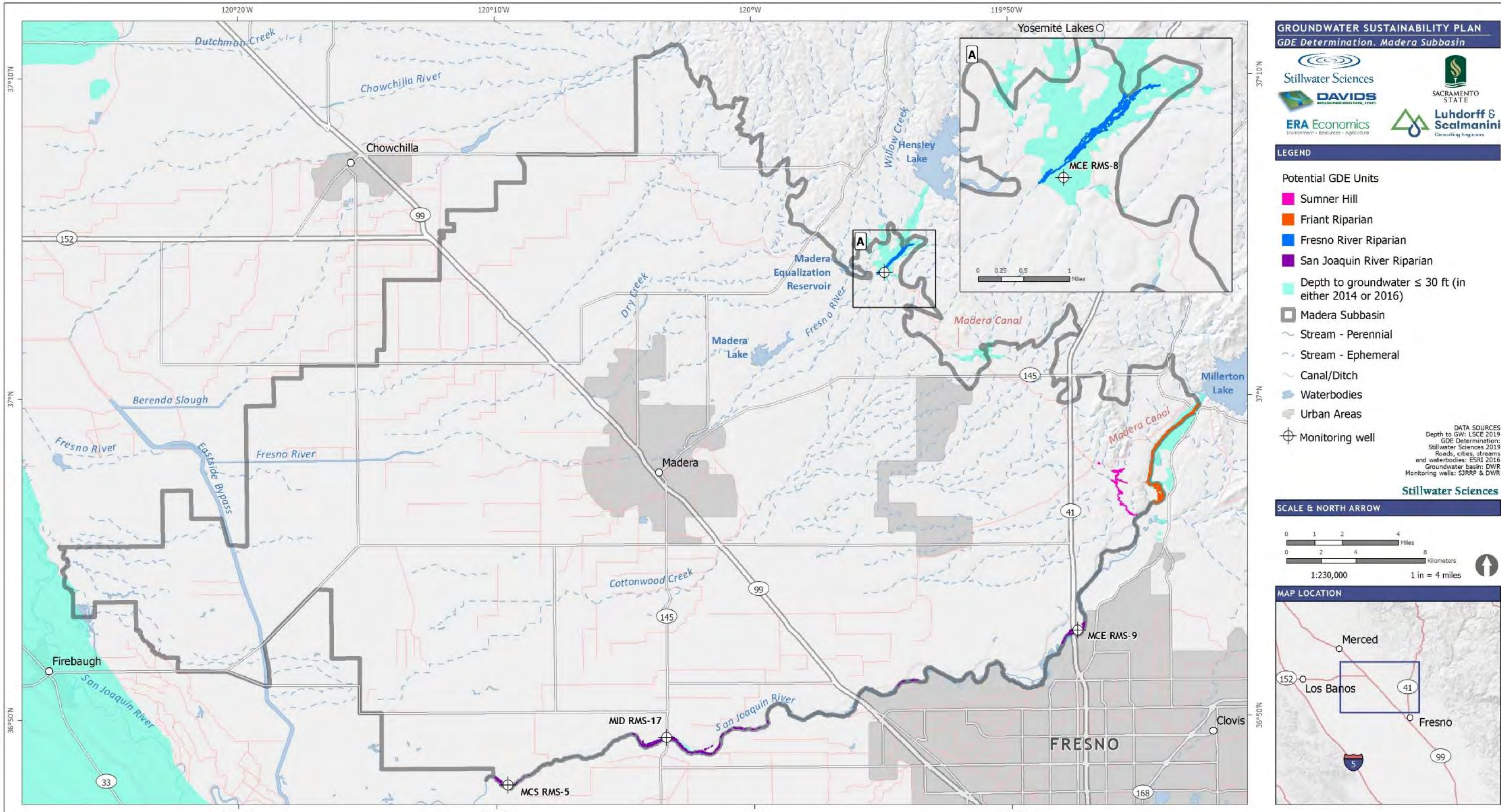

Figure A2.B-2. Potential GDE units, depth to groundwater, and monitoring well locations in the Madera Subbasin.

Figure A2.B-3. Fresno River Riparian Potential GDE Unit.

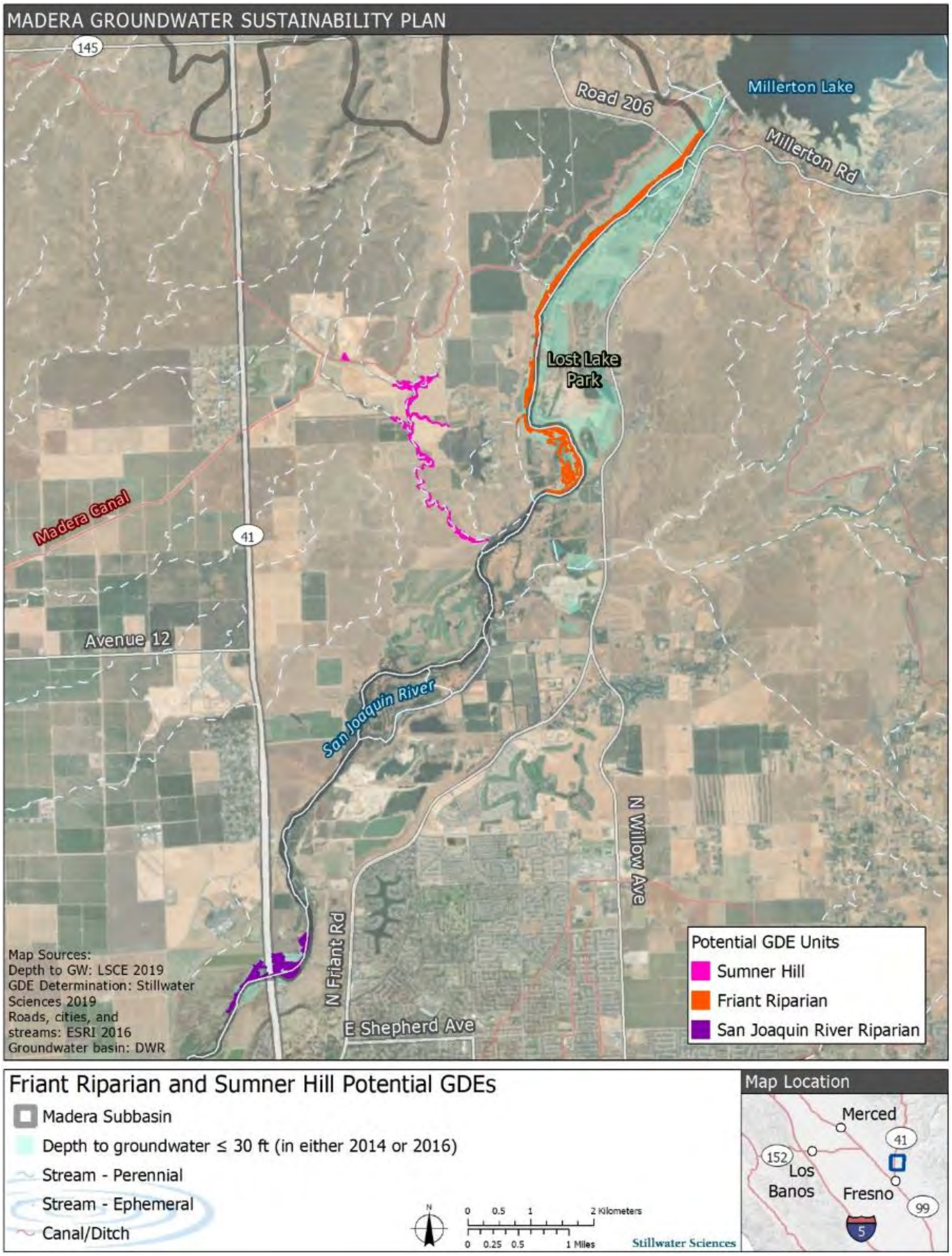

Figure A2.B-4. Sumner Hill, Friant Riparian, and upstream portion of San Joaquin River Riparian potential GDE units.

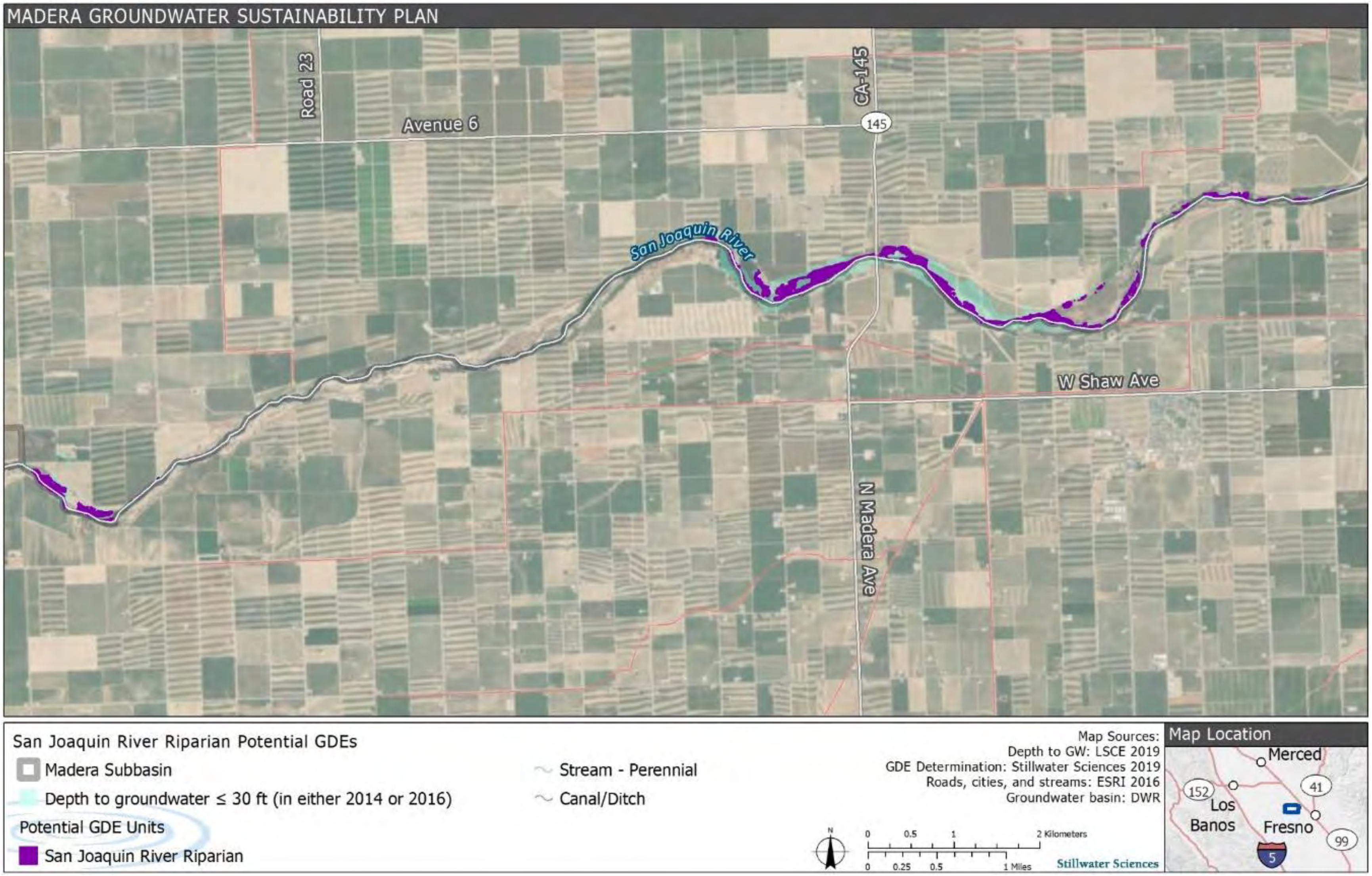

Figure A2.B-5. San Joaquin River Riparian Potential GDE Unit, downstream portion.

2 GDE CONDITION

In this section we characterize the GDE units in the Madera Subbasin based on their hydrologic and ecological conditions and assign a relative ecological value to the units by evaluating their ecological assets and vulnerability to changes in groundwater conditions (Rohde et al. 2018).

2.1 Fresno River Riparian Potential GDE Unit

2.1.1 Hydrologic conditions

The Fresno River Riparian Potential GDE Unit is located at the eastern margin of the Madera Subbasin along the Fresno River (Figure A2.B-3). Approximately two-thirds of the unit is upstream of the Madera Canal along the Fresno River. Most of the unit lies within Quaternary alluvium and fan deposits (see Chapter 2.2 of this GSP), with Mesozoic granitic rocks along the south bank of the river possibly overlain by recent river sediments. The Corcoran Clay is absent beneath this GDE unit, and there is little information about the substrate here. The hydrogeology in the vicinity of this GDE unit is characterized by shallow bedrock ranging from approximately 0 to 100 feet below ground surface. Because of the very steep hydraulic gradient in this area (in excess of 70 feet per mile; see Chapter 2.2 of this GSP) the nature of the hydraulic connection with the main regional groundwater system in the subbasin is such that groundwater or infiltrating surface water in this area may flow down-gradient along the sloping bedrock surface into the main groundwater system, but any groundwater pumping in the main groundwater basin aquifers is unlikely to impact water levels underlying this GDE unit.

The Fresno River flows through this GDE and is impounded by Hidden Dam to form Hensley Lake approximately 2.5 miles upstream of the GDE unit. Flows in the Fresno River were measured approximately 0.9 miles downstream of Hidden Dam from 1941–1990 where the drainage area is 258 square miles (USGS 11258000). During that period flow was recorded as 0 cubic feet per second (cfs) 11.7 percent of the time and less than 1 cfs 25.3 percent of the time, suggesting that riverine flow is not directly sustaining the GDE year-round. However, it is likely that riverine flows infiltrating into the subsurface on top of shallow bedrock during higher flow periods sustain the vegetation composing this GDE during times of no riverine flows. Simulations using C2VSIM, a groundwater-surface water modeling system designed by DWR for the entire Central Valley, suggest that the Fresno River in the Madera Subbasin has been a net losing stream since at least the 1920s (TNC 2014), with surface flow likely contributing directly to the shallow groundwater system that supports the vegetation in the Fresno River Riparian Potential GDE Unit. The Madera Canal also passes through the GDE unit. Seepage or leaks from the canal may provide a portion of the subsurface water in this area of the subbasin, but the magnitude of its contribution is unknown.

Figure A2.B-6 shows observed data and the results of groundwater modeling conducted for this GSP at well MCE RMS-8, located at the downstream end of the Fresno River Riparian GDE unit. Between 1958 and 1980, the well depth declined from about 6–7 ft bgs to 18 ft bgs in 1977. The groundwater elevation then stabilized and shallowed slightly to 12–18 ft bgs through 1987. From 1987 to 1993 the groundwater elevation declined substantially to 29–34 ft bgs and was between 27–39 ft bgs through 2003. The groundwater elevation then increased and remained from 15.9–25 ft bgs from 2005–2014. Observed groundwater depths generally range from slightly below model groundwater depths for layer 1 to slightly below model groundwater depths for layer 2 (Figure A2.B-6). Modeled groundwater depths for model layer 2 ranged up to approximately 50 feet bgs during the recent drought and about 45 feet bgs during the early 1990's drought, both of which are below the 30-foot maximum rooting depth of plants in the GDE as are the observations after 2005. As noted above, observed data range up to 40 feet bgs, which is also deeper than the 30-foot rooting depth. The cause of the change in groundwater elevation post-2005 is not clear from the data or model results.

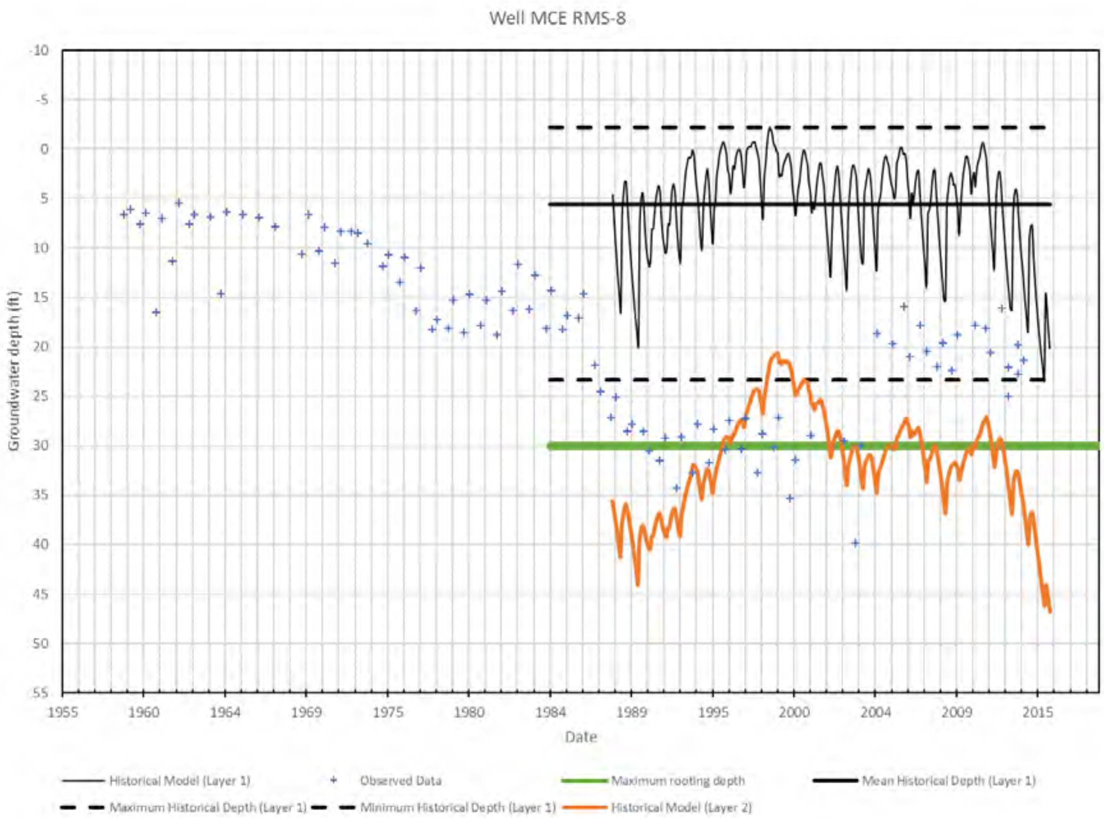

Figure A2.B-6. Groundwater depth observation from 1958-2015 and modeled groundwater depth from WY 1989–WY 2015 for well MCE RMS-8 near the Fresno River Riparian Potential GDE Unit. The black line represents Layer 1 in the model and the orange line represents Layer 2. The mean, minimum, and maximum modeled results are only shown for Layer 1 because it is likely the groundwater layer that supports the GDE. Observed data from 1985-2014 are also shown.

2.1.2 Ecological conditions

The Fresno River Riparian Potential GDE Unit is composed of a mix of riparian forest, shrub, and herbaceous habitat types. Analysis of existing vegetation mapping data (Klausmeyer et al. 2018), color aerial imagery (ESRI 2017), and May 2019 field reconnaissance conducted in representative portions of the unit determined the quality of riparian habitat in this unit to be high. The riverine, aquatic habitat of the Fresno River is not contained within the GDE unit because available hydrologic data indicates no substantial groundwater contribution to the surface flow in the river in this area (i.e., this reach of the Fresno River does not gain but rather loses water to the groundwater system) and because the hydrology of the river in this area is dominated by releases from Hidden Dam.

The reconnaissance survey of representative portions of the Fresno River Riparian Potential GDE Unit conducted in May 2019 identified several areas of mature riparian forest along the river floodplain (Figure A2.B-7). Vegetation in the unit is over 80% native cover in the shrub and tree layer. Access to the GDE unit was constrained by the presence of private land which precluded observation of native/non-native species composition in the herbaceous layer. Dominant vegetation included mature stands of Fremont cottonwood and Gooding's black willow (*Populus fremontii* and *Salix gooddingii*, respectively) with sandbar willow shrubs (*Salix exigua*) lining sections of the channel. Wildlife observed in the vicinity of this unit included red-tailed hawk, California quail, western kingbird, western bluebird, American robin, ash throated flycatcher, tree swallow, house finch, downy woodpecker, and Swainson's hawk.

Figure A2.B-7. Riparian habitat in the Fresno River Riparian Potential GDE Unit. Photo taken May 1, 2019 by Stillwater Sciences.

The potential for special-status species and their habitat to occur in the Fresno River Riparian Potential GDE Unit, including designated critical habitat for federally listed species, was determined by querying databases on regional and local occurrences and spatial distributions of special-status species, as described in Section 1.1.2. Database query results of local and regional occurrences were combined with known habitat requirements of identified special-status species to develop a list of special-status species that satisfy one or more of the following criteria: (1) known to occur in the region and suitable habitat present in the GDE unit, (2) documented occurrence within the GDE unit and (3) directly observed during the May 1, 2019 reconnaissance survey (Table A2.B-1).

This unit contains, or is in close proximity to, critical habitat for federally listed plant species San Joaquin Valley orcutt grass (*Orcuttia inaequalis*), fleshy owl's-clover (*Castilleja campestris ssp.*), hairy orcutt grass (*Orcuttia pilosa*), and Greene's tuctoria (*Tuctoria greenei*) (USFWS 2019). The PG&E San Joaquin Valley Operations and Maintenance Habitat Conservation Plan

(Jones & Stokes 2006) includes covered lands within the Fresno River Riparian Potential GDE Unit and covers some of the same species identified in our queries as potentially occurring within the unit. However, the queries and field reconnaissance we conducted for this analysis provide more recent and site-specific data on the presence or potential for special-status species to occur in the GDE unit, as well as the overall ecological value, ecological condition trend, and vulnerability to future groundwater changes. Therefore, the information contained in the PG&E Habitat Conservation Plan was not incorporated into our analysis. The unit does not include any known protected lands (CPAD 2018).

2.1.3 Ecological value

The Fresno River Riparian Potential GDE Unit was determined to have **high ecological value** because of: (1) the known occurrence and presence of suitable habitat for several special-status species including designated critical habitat for four federally-listed plants (Table A2.B-1); and (2) the vulnerability of these species and their habitat to changes in groundwater levels (Rohde et al. 2018).

Table A2.B-1. Special-status species with known occurrence, or presence of suitable habitat in the GDE units within the Madera Subbasin.

Common name *Scientific name*	Status[1]	Association with GDE unit				Source[2]	Habitat and occurrence
		Fresno River Riparian (FRR)	Sumner Hill (SH)	Friant Riparian (FRI)	San Joaquin River Riparian (SJRR)		
Birds							
Bald eagle *Haliaeetus leucocephalus*	FD, SE, SFP	Likely	Unlikely	Likely	Likely	CNDDB, eBird, USFWS	Moderately suitable foraging, perching, and nesting habitat present (FRR, FRI, SJRR). Several documented occurrences near FRR, and in immediate vicinity of SJRR.
Northern harrier *Circus hudsonius*	SSC	Likely	Likely	Likely	Likely	eBird	Suitable foraging and nesting habitat present (FRR, SH, FRI, SJRR). Several documented occurrences near FRR, SH, and SJRR.
Tricolored blackbird *Agelaius tricolor*	SCE, SSC	Unlikely	Likely	Unlikely	Unlikely	eBird	Moderately suitable nesting and foraging habitat present (SH). Several documented occurrences in the region.
Yellow-headed blackbird *Xanthocephalus xanthocephalus*	SSC	Unlikely	Likely	Unlikely	Unlikely	eBird	Moderately suitable nesting habitat present and adjacent foraging habitat (SH). Occasional documented occurrences in region.
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	FT, SE	Unlikely	Unlikely	Unlikely	Unlikely	CNDDB, eBird, USFWS	Rare but known or believed to occur in Madera County. Moderately suitable nesting and foraging habitat present (SJRR). Thought to be extirpated from the vicinity of FRI, with last documented occurrence in the late 1800s.
Swainson's hawk *Buteo swainsoni*	ST	Likely	Unlikely	Likely	Likely	CNDDB, eBird	Moderate to highly suitable nesting habitat (FRR, near FRI, SJRR), and foraging habitat nearby (FRR, FRI, SJRR). Several documented occurrences near FRR and SJRR. Species was observed adjacent to FRR in May 2019. One active nest recorded within 4 miles of FRI in 2013.
White-tailed kite *Elanus leucurus*	SFP	Likely	Likely	Unlikely	Likely	eBird	Suitable nesting and foraging habitat present (FRR, SH, SJRR). Occurrences in the region common, and occurrences adjacent SJRR.
Mammals							
Pallid bat *Antrozous pallidus*	SSC	Likely	Unlikely	Likely	Likely	CNDDB, eBird	Suitable foraging and roosting habitat (FRR, SJRR).
Western red bat *Lasiurus blossevillii*	SSC	Likely	Unlikely	Likely	Likely	CNDDB, eBird	Suitable foraging habitat and roosting habitat (FRR, SJRR).
San Joaquin kit fox *Vulpes macrotis mutica*	FE, ST	Unlikely	Unlikely	Likely	Likely	CNDDB, USFWS	Known occurrence within SJRR.
Amphibians and Reptiles							
California tiger salamander (Central California DPS) *Ambystoma californiense*	FT, ST	Likely	Unlikely	Likely	Unlikely	CNDDB, USFWS	Suitable aquatic breeding habitat (FRR, near FRI) and moderately suitable terrestrial habitat (near FRI, SJRR). Several documented occurrences near FRR, FRI, and SJRR.
Western spadefoot *Spea hammondii*	SSC	Likely	Unlikely	Unlikely	Unlikely	CNDDB	Suitable aquatic and terrestrial habitat (FRR, FRI, SJRR). Several documented occurrences within the region, including one less than a mile from FRR and several near FRI.
Western pond turtle *Actinemys marmorata*	SSC	Unlikely	Unlikely	Nesting stage likely; foraging and basking do not occur (occupies adjacent San Joaquin River)	Nesting stage likely; foraging and basking do not occur (occupies adjacent San Joaquin River)	CNDDB	Suitable nesting habitat present (SH, FRI, SJRR). Aquatic habitat for foraging and basking is present in San Joaquin River adjacent to FRI, SJRR.

Common name *Scientific name*	Status[1]	Association with GDE unit				Source[2]	Habitat and occurrence
		Fresno River Riparian (FRR)	Sumner Hill (SH)	Friant Riparian (FRI)	San Joaquin River Riparian (SJRR)		
Fish							
Central Valley Spring-Run Chinook Salmon *Oncorhynchus tshawytscha*	FT, ST	Does Not Occur	Does Not Occur	Not in GDE Unit but occupies adjacent San Joaquin River	Not in GDE Unit but occupies adjacent San Joaquin River	known occurrence in San Joaquin River (SJRRP)	Suitable habitat present (migration, rearing); species known to occur in San Joaquin River and is sustained by San Joaquin River Restoration Program
Central Valley Steelhead *Oncorhynchus mykiss irideus*	FT	Does Not Occur	Does Not Occur	Not in GDE Unit but occupies adjacent San Joaquin River	Not in GDE Unit but occupies adjacent San Joaquin River	local/regional occurrence in San Joaquin River (CNDDB, NMFS)	Suitable habitat present (migration, rearing); species known to occur in San Joaquin River
Hardhead *Mylopharodon conocephalus*	SSC	Not in GDE Unit but may occupy adjacent Fresno River	Does Not Occur	Not in GDE Unit but occupies adjacent San Joaquin River	Not in GDE Unit but occupies adjacent San Joaquin River	local/regional occurrence in San Joaquin River (CNDDB)	Suitable habitat present; species known to occur in San Joaquin River
Invertebrates							
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	FT	Likely	Unlikely	Likely	Likely	CNDDB	Suitable habitat (i.e., blue elderberry, the host plant) present within riparian forest and scrub-shrub of FRI and SJRR. Known occurrence in SJRR.
Vernal pool fairy shrimp *Branchinecta lynchi*	FT	Unlikely	Unlikely	Unlikely	Unlikely	CNDDB	Suitable aquatic habitat (FRR). Several documented occurrences in the region
Vernal pool tadpole shrimp *Lepidurus packardi*	FE	Unlikely	Unlikely	Unlikely	Unlikely	CNDDB	Suitable aquatic habitat present (FRR). Several occurrences in the region

Common name *Scientific name*	Status[1]	Association with GDE unit				Source[2]	Habitat and occurrence
		Fresno River Riparian (FRR)	Sumner Hill (SH)	Friant Riparian (FRI)	San Joaquin River Riparian (SJRR)		
Plants							
Spiny-sepaled button celery *Eryngium spinosepalum*	SE, 1B.2	Likely	Likely	Likely	Likely	CNDDB	Known occurrence within FRI.
Sanford's arrowhead *Sagittaria sanfordii*	1B.2	Likely	Likely	Likely	Likely	CNDDB	Known occurrence within FRI, SJRR.
San Joaquin Valley Orcutt grass *Orcuttia inaequalis*	FT, SE, 1B.1	Likely	Likely	Likely	Likely	CNDDB	Known occurrence within SJRR, critical habitat present in or near FRR, SH, FRI.
Fleshy owl's-clover *Castilleja campestris* ssp	FT	Likely	Unlikely	Unlikely	Unlikely	USFWS 2019	Critical habitat present in or near FRR, SH, FRI.
Hairy Orcutt grass *Orcuttia pilosa*	FE	Likely	Likely	Likely	Likely	USFWS 2019	Critical habitat present in or near FRR, SH, FRI.
Greene's tuctoria *Tuctoria greenei*	FE	Likely	Unlikely	Unlikely	Unlikely	USFWS 2019	Critical habitat present in or near FRR, SH, FRI.

[1] Status codes:
G = Global

Federal
FT = Listed as threatened under the federal Endangered Species Act
FD = Federally delisted

State
S = Sensitive
SE = Listed as Endangered under the California Endangered Species Act
ST = Listed as Threatened under the California Endangered Species Act
SSC = CDFW species of special concern
SFP = CDFW fully protected species

Global Rank
1 Critically Imperiled—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
2 Imperiled—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
3 Vulnerable — At moderate risk of extinction or elimination due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
4 Apparently Secure — Uncommon but not rare; some cause for long-term concern due to declines or other factors.

California Rare Plant Rank
1B Plants rare, threatened, or endangered in California and elsewhere
2B Plants rare, threatened, or endangered in California, but more common elsewhere
3 More information needed about this plant, a review list
4 Plants of limited distribution, a watch list
CBR Considered but rejected

CRPR Threat Ranks:
0.1 Seriously threatened in California (high degree/immediacy of threat)
0.2 Fairly threatened in California (moderate degree/immediacy of threat)
0.3 Not very threatened in California (low degree/immediacy of threats or no current threats known)

[2] CNDDB 2019, eBird 2019, CPAD 2019, SJRRP 2017a, NMFS 2016

2.2 Friant Riparian Potential GDE Unit

2.2.1 Hydrologic conditions

The Friant Riparian Potential GDE Unit is located in the uppermost reaches of the San Joaquin River below Friant Dam, extending along the river from the dam approximately 5.5 miles downstream (Figure A2.B-4). The GDE is located within a semi-confined valley lined by bluffs that are 50–100 feet above the river channel (McBain & Trush 2002). The valley is about 0.5 to 1 mile wide, with the valley width increasing downstream. Data from the limited number of DWR well completion reports that are available in this area indicate that depth to bedrock beneath the majority of the Friant Riparian GDE is relatively shallow, ranging from 45 to 75 feet below ground surface (bgs) and increasing from north to south along the river. Atop the shallow bedrock, the Friant Riparian GDE is underlain by Quaternary alluvium derived from the historical gravel and sand deposits from the San Joaquin River. The Corcoran Clay, a major aquiclude, does not occur under the Friant Riparian GDE. The San Joaquin River flows through this area and is impounded by Friant Dam to form Millerton Lake immediately upstream of the GDE unit. Simulations using C2VSIM, a groundwater-surface water modeling system designed by DWR for the entire Central Valley, suggest that the San Joaquin River in this reach has been a net losing stream since at least the 1920s (TNC 2014), with surface flow likely contributing directly to the shallow groundwater that supports the vegetation in the Friant Riparian Potential GDE Unit.

There is essentially no existing shallow groundwater level data for the Friant Riparian GDE area. This area was identified as a shallow groundwater area (DTW less than or equal to 30 feet) based on extrapolation of groundwater level data from farther away. Thus, the actual depth to groundwater in this area is unknown. Review of the limited number of available DWR well logs for wells in this area indicated depths to water ranging from 22 to 39 feet bgs for dates ranging from May 1960 to September 1979 (at the time of well installation). Part of the GSP Implementation Plan will be to further investigate existing wells in this area for verifying presence of shallow groundwater (i.e., less than or equal to 30 feet bgs) and possible inclusion of a well as a representative monitoring station (RMS), if necessary. The combination of shallow depth to bedrock beneath the San Joaquin River in this unit and infiltration of surface flows from the San Joaquin River into the underlying alluvium, along with interpretation of groundwater level data outside the GDE unit area, largely accounts for the interpreted occurrence of shallow groundwater at this location. Seepage or leakage from Friant Dam may also contribute to surface flows and shallow groundwater. A bedrock outcrop area is indicated to occur to the north and northwest and adjacent to this GDE unit. Therefore, groundwater pumping in the main groundwater basin aquifers is unlikely to impact water levels underlying this GDE unit.

2.2.2 Ecological conditions

The Friant Riparian Potential GDE Unit is composed of a mix of riparian forest, shrub, and herbaceous habitat types. Analysis of existing vegetation mapping data (Klausmeyer et al. 2018), color aerial imagery (ESRI 2017), and May 2019 field reconnaissance conducted in representative portions of the unit determined the quality of riparian habitat in this unit to be medium. The riverine, aquatic habitat of the San Joaquin River is not contained within the GDE unit because available hydrologic data indicates no substantial groundwater contribution to the surface flow in the river in this area (i.e., this reach of the San Joaquin River does not gain but rather loses water to the groundwater system) and because the river's hydrology in this area is dominated by releases from Friant Dam. However, the riparian vegetation community of the Friant Riparian Potential GDE Unit fulfills several essential ecosystem functions or provides important habitat elements, such as large wood and riparian shade, on which both semi-aquatic species of the GDE unit and aquatic species of the San Joaquin River depend for completing essential life behaviors. Accordingly, certain special-status species and their habitat in the San Joaquin River are considered in the analyses of potential effects on the Friant Riparian Potential GDE Unit presented herein.

This GDE unit is characterized by pockets of mature riparian forest associated with drainages and surrounded by grasslands on the floodplain of the San Joaquin River (Figure A2.B-8). The canopy is stratified with a moderately open understory. Vegetation in the observed portions of the unit was over 80% native cover in the shrub and tree layer and could be less than 50% native cover in the herbaceous ground layer, with the balance occupied by non-native species. Emergent wetlands observed were dominated by native tules and/or a mix of cattail and tule (*Typha* spp. and *Schoenoplectus spp.*). Dominant vegetation in woody plant communities included Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), and valley oak (*Quercus lobata*) in the overstory, and sandbar willow (*Salix exigua*) in the shrub layer, interspersed with European grass-dominated herbaceous ground cover and emergent vegetation (tules, cattails) lining the channel edge. Wildlife observed in or in the vicinity of the Friant Riparian Potential GDE Unit included acorn woodpecker, turkey vulture, common raven, ash throated flycatcher, common yellowthroat, black phoebe, and California quail. The unit has suitable habitat for a variety of native plants and animals, including several special-status species (Table 1).

Figure A2.B-8. Riparian corridor along the San Joaquin River in the Friant Riparian Potential GDE Unit, observed from Lost Lake Park (Photo taken by Stillwater Sciences, May 1, 2019).

The potential for special-status species and their habitat to occur in the Friant Riparian Potential GDE Unit, including designated critical habitat for federally listed species, was determined by querying state and federal databases and via field reconnaissance as described above for the Fresno River Riparian Potential GDE Unit (Section 2.1.2).

The Friant Riparian Potential GDE Unit overlaps, or is in close proximity to, designated critical habitat for California tiger salamander, San Joaquin Valley orcutt grass, hairy orcutt grass, and fleshy owl's clover (USFWS 2019). This unit also contains or overlaps several known protected lands, including several parcels owned or managed by the San Joaquin River Parkway and Conservation Trust, and the State-owned San Joaquin River Ecological Reserve (CPAD 2018). In addition, the adjacent San Joaquin River contains Essential Fish Habitat (EFH) for Chinook salmon which is partially dependent on riparian inputs to provide important salmon habitat elements including shade, overhead cover, nutrients, and woody material for instream cover and habitat complexity (PFMC 2014). Information contained in the PG&E Habitat Conservation Plan (Jones & Stokes 2006) was not incorporated into our analysis for reasons described in Section 2.1.2.

2.2.3 Ecological value

The Friant Riparian Potential GDE Unit was determined to have **high ecological value** because of: (1) the likely occurrence of several special-status species and presence of suitable habitat for these species in the unit (Table 1), as well as designated critical habitat in or near the unit for several federally-listed species; (2) the presence of protected lands in the unit; and (3) the presence of species and ecological communities considered somewhat vulnerable to slight to moderate changes in groundwater levels (Rohde et al. 2018).

2.3 San Joaquin River Riparian Potential GDE Unit

2.3.1 Hydrologic conditions

The San Joaquin River Riparian Potential GDE Unit extends along the San Joaquin River from Highway 41 downstream to the point near Gravelly Ford where the river is no longer within the Madera Subbasin (Figures A2.B-4 and A2.B-5). The GDE unit is underlain by Quaternary alluvium derived from the historical gravel and sand deposits from the San Joaquin River. Geologic cross sections show that the upper 60–80 ft under the San Joaquin River is sand and gravel/cobbles, with clay along the channel margins (see Chapter 2.2.1 of this GSP). The Corcoran Clay, a major aquiclude, does not occur under the San Joaquin River Riparian Potential GDE Unit. Shallow clay layers likely form perched/mounded zones beneath the river along this GDE unit which, combined with streamflow infiltration, serve to create and maintain shallow groundwater levels along the river.

The San Joaquin River is currently disconnected from groundwater, with groundwater 20–30 ft below the ground surface, within the potential rooting depth of the vegetation along the river. Flow in the San Joaquin River is strongly controlled by releases from Friant Dam and water infiltrates from the channel bed into the disconnected aquifers below the reach. Groundwater elevation below the GDE is therefore strongly dependent on operations of Friant Dam. The GDE is therefore subject to climate change and associated changes in hydrology of the basin, San Joaquin River Restoration Program (SJRRP) flows in the San Joaquin River, and groundwater pumping.

Simulations using C2VSIM, a groundwater-surface water modeling system designed by DWR for the entire Central Valley, suggest the San Joaquin River in this reach was a net losing stream since at least the 1920s (TNC 2014) although the potential for occasional seasonal connection between shallow groundwater and surface flow is not well documented. The average element size for the C2VSIM modeling was 0.64 mi^2, a much coarser grid than used for the modeling conducted as part of this GSP, and hence the C2VSIM model has a much larger uncertainty in its results.

Groundwater modeling results at three monitoring well locations maintained by the SJRRP was used to assess temporal variation and long-term trends in the shallow groundwater depth associated with this GDE unit. The three wells, MCE RMS-9, MID RMS-17, and MCW RMS-5 are located either within or adjacent to the GDE unit along the San Joaquin River from Highway 41 to just downstream of Gravelly Ford (Figure A2.B-2).

Well MCE RMS-9 is within the mapped extent of the San Joaquin River Riparian Potential GDE Unit and is located just upstream of the Highway 41 bridge (Figure A2.B-2). The well is screened from 17–37 feet bgs. Observed groundwater levels range from about 1 to 12 feet bgs, with an average of 10 feet bgs for the period of record since 2009. From 1988–2015 (water years [WY] 1989–2015), the modeled monthly mean groundwater depth for model layer 1 was 8.1 feet bgs (Figure A2.B-9). Observed groundwater depths during this period were up to 6 feet deeper than the modeled results. In general, the observed depth to groundwater is 10 to 12 feet bgs, and only becomes temporarily shallower during peak flows in the river (Figure A2.B-9). Modeled projected future groundwater levels are generally within the range of modeled historical groundwater levels. The baseline hydrologic conditions for the GDE unit (WY 1989–2015), includes wet periods and two significant droughts (the late 1980s and the middle 2010s). The minimum observed groundwater depth did not change significantly from 2010 to 2018, suggesting that the minimum depth is not changing significantly, even during droughts. All of the observed and modeled groundwater depths are shallower than the 30-foot maximum rooting depth of plants in the GDE.

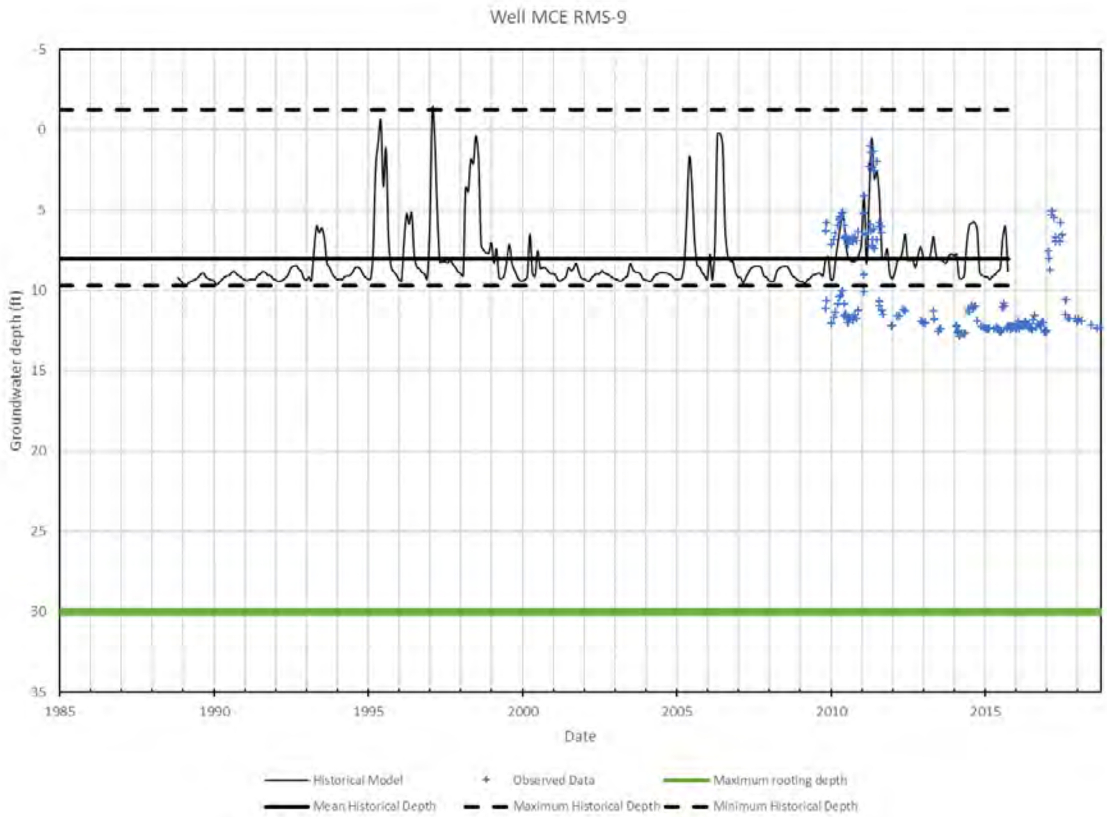

Figure A2.B-9. Modeled groundwater depths for MCE RMS-9 from WY 1989–WY 2015. Observed data from 2010–2018 are also shown.

Well MID RMS-17 is located within the San Joaquin River Riparian Potential GDE Unit next to the Highway 145 bridge. The well is screened from 37–57 feet bgs. The observed depths to groundwater range from approximately 7 to 26 feet bgs, with an average of 18 feet bgs for the period of record since 2009. Observed groundwater levels are primarily 14 to 19 feet bgs except during peak flows on the San Joaquin River. Modeled groundwater levels in model layer 1 are generally about 6 to 7 feet below observed levels (Figure A2.B-10). All of the modeled and observed data are shallower than 30 feet bgs, suggesting that the depth does not exceed the maximum rooting depth of plants in the GDE.

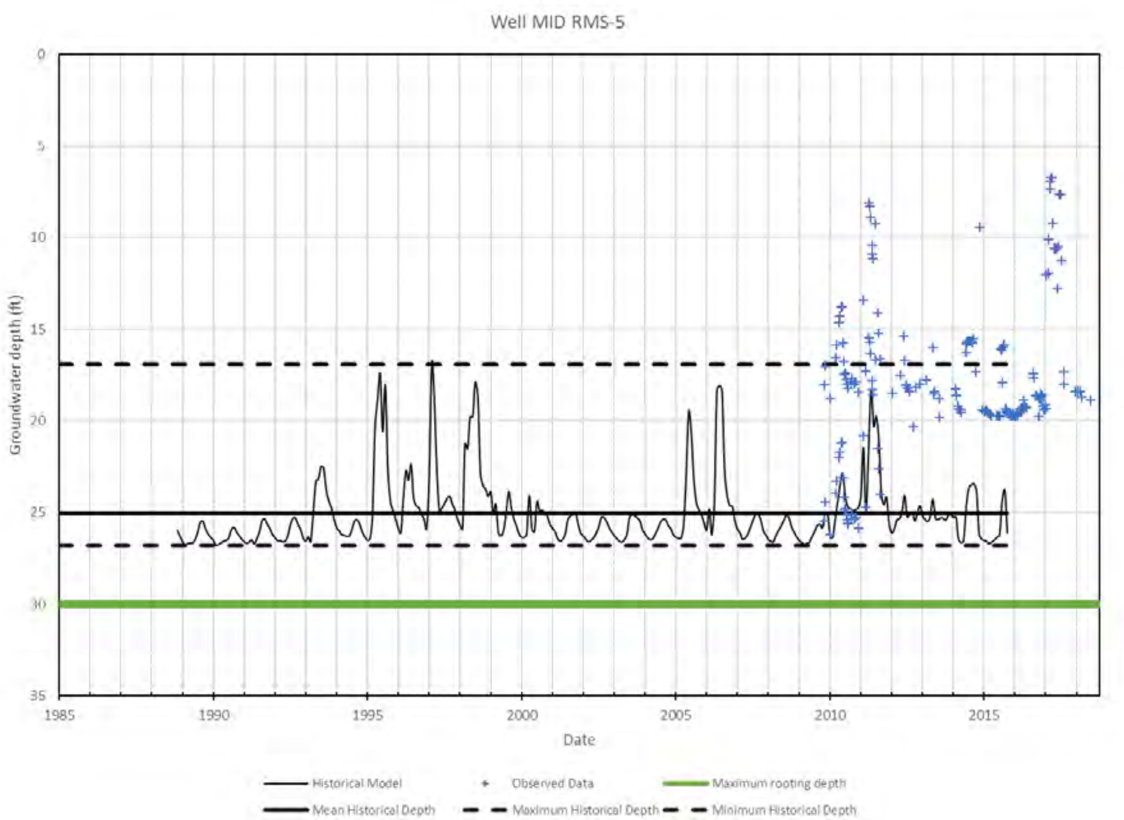

Figure A2.B-10. Modeled groundwater depths for MID RMS-17 from WY 1989–WY 2015. Observed data from 2010–2018 are also shown.

Well MCW RMS-5 is located about 50 feet from the San Joaquin River Riparian Potential GDE Unit about 1.7 miles downstream from Gravelly Ford near the downstream end of the GDE unit. The total depth of the well is 30 feet. The observed groundwater levels range from approximately 4 to 20 feet bgs, with an average of 18 feet bgs for the period of record since 2012. Groundwater levels are generally 15 to 20 feet below ground surface except during San Joaquin River peak flow events. Modeled groundwater levels for model layer 1 were generally 3 to 7 feet shallower than observed levels. All of the modeled and observed depths are shallower than 30 feet bgs (Figure A2.B-11), suggesting that the depth does not exceed the maximum rooting depth of plants in the GDE.

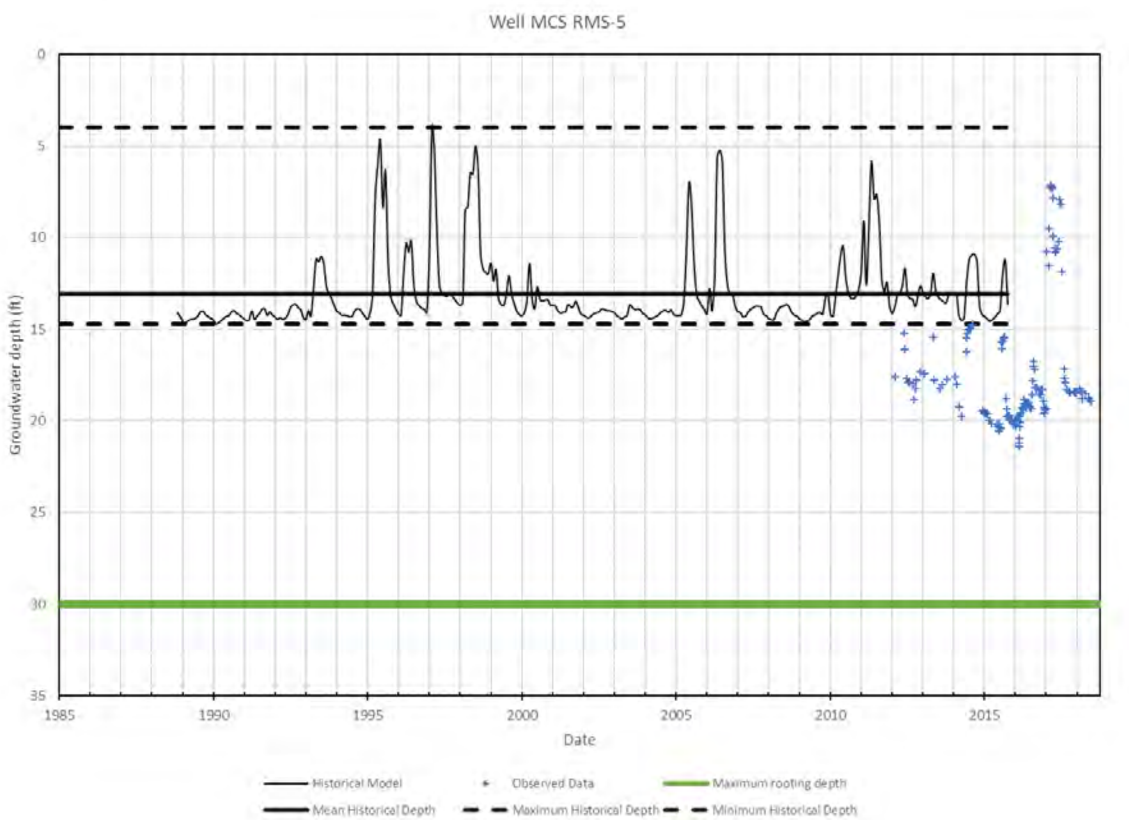

Figure A2.B-11. Modeled groundwater depths for MCW RMS-5 from WY 1989–WY 2015. Observed data are also shown.

2.3.2 Ecological conditions

The San Joaquin River Riparian Potential GDE Unit is composed of several disjunct areas of riparian vegetation along the San Joaquin River from Highway 41 to the point where the river leaves the subbasin south of the intersection of Road 21 and Avenue 5 just downstream of Gravelly Ford (Figures A2.B-4 and A2.B-5). This unit includes portions of the riparian corridor of the San Joaquin River, supporting a mix of riparian forest, shrub, and herbaceous plant communities. Analysis of existing vegetation mapping data (Klausmeyer et al. 2018), color aerial imagery (ESRI 2017), and May 2019 field reconnaissance conducted in representative portions of the unit determined the quality of riparian habitat in this unit to range from low to high, with overall quality considered moderately high.

The riverine, aquatic habitat of the San Joaquin River is not contained within the GDE unit because available hydrologic data indicates no substantial groundwater contribution to the surface flow in the river in this area (i.e., this reach of the San Joaquin River does not gain but rather loses water to the groundwater system) and because the river's hydrology in this area is dominated by releases from Friant Dam. However, the riparian vegetation community of the San Joaquin River Riparian Potential GDE Unit fulfills several essential ecosystem functions or provides important habitat elements, such as large wood and riparian shade, on which both semi-aquatic species of the GDE unit and aquatic species of the San Joaquin River depend for completing essential life behaviors. Accordingly, certain special-status species and their habitat in the San Joaquin River are included in the analyses of potential effects on the San Joaquin River Riparian Potential GDE Unit presented herein.

The reconnaissance survey of representative portions of the San Joaquin River Riparian Potential GDE Unit conducted in May 2019 identified areas of native riparian forest, riparian shrub, grassland (Figure A2.B-12). Vegetation in most of the unit was over 80% native cover in the shrub and tree layer and less than 50% native cover in the herbaceous ground layer, with the balance occupied by non-native species. Dominant vegetation in woody plant communities included Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), and valley oak (*Quercus lobata*) in the overstory, sandbar willow (*Salix exigua*) in the shrub layer, interspersed with European grass-dominated herbaceous ground cover. Non-native eucalyptus and arundo were observed throughout the unit. Wildlife observed within the San Joaquin River Riparian Potential GDE Unit included cliff swallow, house wren, bushtit, California scrub jay, spotted towhee, acorn woodpecker, ash throated flycatcher, common yellowthroat, black phoebe, California quail, red-tailed hawk, Anna's hummingbird, northern rough-winged swallow, spotted towhee, red-tailed hawk, northern flicker, osprey, wrentit, western fence lizard, and California ground squirrel. The unit has suitable habitat for a variety of native plants and animals, including several special-status species (Table A2.B-1).

Figure A2.B-12. Riparian corridor along the San Joaquin River near Floyd Avenue, between Highways 99 and 145 in the San Joaquin River Riparian Potential GDE Unit.

The potential for special-status species and their habitat to occur in the San Joaquin River Riparian Potential GDE Unit, including designated critical habitat for federally listed species, was determined by querying state and federal databases and via field reconnaissance as described above for the Fresno River Riparian Potential GDE Unit (Section 2.1.2).

This GDE unit does not include any known protected lands (CPAD 2018) or critical habitat for federally listed species (USFWS 2019, NMFS 2016) but the adjacent San Joaquin River contains Essential Fish Habitat (EFH) for Chinook salmon which is partially dependent on riparian inputs to provide important salmon habitat elements including shade, overhead cover, nutrients, and woody material for instream cover and habitat complexity (PFMC 2014). Information contained in the PG&E Habitat Conservation Plan (Jones & Stokes 2006) was not incorporated into our analysis for reasons described in Section 2.1.2.

2.3.3 Ecological value

The San Joaquin River Riparian Potential GDE Unit was determined to have **moderate ecological value** because of: (1) the likely occurrence of several special-status species and presence of suitable habitat for these species in the unit (Table A2.B-1); and (2) the presence of species and ecological communities considered somewhat vulnerable to slight to moderate changes in groundwater levels (Rohde et al. 2018).

2.4 Sumner Hill Potential GDE Unit

2.4.1 Hydrologic conditions

The Sumner Hill Potential GDE Unit is located in the eastern portion of the Madera Subbasin, west of the San Joaquin River in the vicinity of the Friant Riparian GDE Unit (Figure A2.B-4). There is considerable uncertainty regarding the potential connection to shallow groundwater in this GDE unit due to a lack of data on depth to shallow groundwater, the source of surface water in the unit, and the connection between shallow groundwater and surface water. Bedrock outcrops of Tertiary non-marine sediments are mapped in the hillslopes adjacent to the GDE unit. The depth to bedrock immediately under the unit is not known, but the presence of the bedrock in adjacent hillslopes suggests that bedrock is very shallow at this site. There are no wells between Highway 41 and the San Joaquin River near Sumner Hill, likely because this area is composed of bedrock. While there is little data on groundwater depth, the paucity of wells suggests that groundwater is limited at this site. Most of the unit is downstream of the Madera Canal, but the degree to which leakage from the canal contributes to the GDE in this unit is unknown. There are also one or more turnouts from Madera Canal into the Sumner Hill drainage. Approximately 0.8 acres of the GDE is upstream of the Madera Canal (Figure A2.B-4), which suggests that the unit is not entirely dependent on leakage and turnouts from the canal. As a result of this uncertainty about the water source and connection to groundwater, the classification of this unit as a GDE is preliminary and biological and hydrologic monitoring is recommended.

The shallow bedrock (and limited groundwater availability) has likely limited groundwater extraction here and would continue to do so in the future. Although changes in hydraulic base level downslope (near the San Joaquin River) are very unlikely, they could potentially affect groundwater elevation near Sumner Hill if groundwater levels along the San Joaquin declined in the future.

2.4.2 Ecological conditions

The Sumner Hill Potential GDE Unit is located along an unnamed tributary to the San Joaquin River west of Sumner Hill in the Madera groundwater basin and is composed of a mix of open water habitat, riparian forest, and emergent wetlands (Figure A2.B-13). This site was evaluated during a reconnaissance visit to the basin and can be characterized as riparian vegetation and a freshwater emergent wetland on a high terrace fed by what is likely an intermittent drainage that connects to the San Joaquin River downstream of the unit. Analysis of existing vegetation mapping data (Klausmeyer et al. 2018), color aerial imagery (ESRI 2017), and May 2019 field reconnaissance conducted in representative portions of the unit determined the quality of wetland and riparian habitat in this unit to be generally good but with habitat patches ranging from somewhat degraded to excellent quality.

The reconnaissance survey of representative portions of the Sumner Hill Potential GDE Unit conducted in May 2019 identified several areas of ponded water surrounded by mature wetland and riparian vegetation. Vegetation in the unit was over 80% native cover in the shrub and tree layer and dominated by red willow (*Salix laevigata*), Goodding's black willow, Fremont cottonwood, rush and sedge species *(Juncus* spp. and *Carex* spp.), as well as cattails and tules (Figure A2.B-13). Wildlife observed in the vicinity of the Sumner Hill Potential GDE Unit included red-winged blackbird and black phoebe. The unit has suitable habitat for a variety of native plants and animals, including several special-status species (Table A2.B-1).

Figure A2.B-13. Open water wetland and associated emergent and riparian habitat in the Sumner Hill Potential GDE Unit. Photo taken by Stillwater Sciences May 1, 2019.

The potential for special-status species and their habitat to occur in the Sumner Hill Potential GDE Unit, including designated critical habitat for federally listed species, was determined by querying state and federal databases and via field reconnaissance as described above for the Fresno River Riparian Potential GDE Unit (Section 2.1.2). This unit overlaps, or is in close proximity to, designated critical habitat for California tiger salamander, San Joaquin Valley orcutt grass, hairy orcutt grass, and fleshy owl's clover (USFWS 2019). This GDE unit does not include any known protected lands (CPAD 2018). Information contained in the PG&E Habitat

Conservation Plan (Jones & Stokes 2006) was evaluated but was not incorporated into our analysis for reasons described in Section 2.1.2.

2.4.3 Ecological value

The Sumner Hill Potential GDE Unit was determined to have **high ecological value** because of (1) the known occurrence of several special-status species and presence of suitable habitat (Table A2.B-1); (2) the presence of designated critical habitat in or near the unit for several federally-listed species; and (3) the presence of species and ecological communities considered somewhat vulnerable to slight to moderate changes in groundwater levels (Rohde et al. 2018).

3 POTENTIAL EFFECTS ON GDEs

This section presents the methods and results of our analysis to identify how groundwater management could affect GDEs in the Madera Subbasin. Adverse effects (impacts) on GDEs are considered undesirable results under SGMA (State of California 2014). The analysis is based on the hydrologic conditions affecting GDEs and their susceptibility to changing groundwater conditions, trends in biological condition of the GDEs, and anticipated conditions or management actions likely to affect GDEs in the future.

3.1 Summary

This section provides a summary of potential effects for each GDE unit in the Madera Subbasin. The methods used to determine a GDE's susceptibility to changing groundwater conditions and its biological condition gradient are described in Section 3.2. Discussion of the methods and rationale for the effects assessments is provided for each GDE unit in Sections 3.3–3.6 below.

3.1.1 Fresno River Riparian Potential GDE Unit

The Fresno River Riparian Potential GDE Unit is characterized as having high ecological value. Based on our assessment that the ecosystem structure and functions of the unit are relatively intact and within the range of natural variability (Biological Condition Gradient Level 2 – Minimal Changes), we have determined that adverse impacts are not likely occurring in the Fresno River Riparian Potential GDE Unit as a result of current groundwater management. The susceptibility of this GDE unit to changing groundwater conditions is low because current and future groundwater conditions are projected to be within the baseline range and because pumping in the main groundwater basin aquifers is unlikely to impact water levels underlying the unit (Table A2.B-2). The methods and rationale for these assessments are described in Section 3.3.

Table A2.B-2. Summary of ecological value, susceptibility, and condition gradient in the Fresno River Riparian Potential GDE Unit.

Ecological value	Rationale
High	1. Presence of special-status species and suitable habitat. 2. Presence of designated critical habitat in or near the unit for several federally listed species. 3. Vulnerability of special-status species and their habitat to changes in groundwater.

Susceptibility to changing groundwater conditions	Rationale
Low	1. Current groundwater conditions (since 2015) and future conditions are projected to remain within the baseline range (prior to 2015). 2. Pumping in the main aquifers is unlikely to impact water levels underlying the unit. 3. Shallow groundwater likely to be maintained by Fresno River flows.
Biological condition gradient	**Rationale**
Level 2 – Minimal Changes	1. No change observed in NDVI/NDMI trends over the period 1985–2018. 2. Relatively intact biotic structure and function as deduced from reconnaissance level assessment of riparian vegetation community condition. 3. Suitable habitat present for those special-status species with likelihood to occur.

3.1.2 Friant Riparian Potential GDE Unit

The Friant Riparian Potential GDE Unit is characterized as having high ecological value. Based on our assessment that the ecosystem structure and functions of the unit are relatively intact and within the range of natural variability (Biological Condition Gradient Level 2 – Minimal Changes), we have determined that adverse impacts are not likely occurring in the Friant Riparian Potential GDE Unit as a result of current groundwater management. The susceptibility of this GDE unit to changing groundwater conditions is low because pumping in the main groundwater basin aquifers is unlikely to impact water levels underlying the unit and because shallow groundwater levels in this unit will be maintained in large part by continued restoration flows in the San Joaquin River under the SJRRP (Table A2.B-3). The methods and rationale for these assessments are described in Section 3.4 below.

Table A2.B-3. Summary of ecological value, susceptibility, and condition gradient in the Fresno River Riparian Potential GDE Unit.

Ecological value	Rationale
High	1. Presence of special-status species and suitable habitat. 2. Presence of designated critical habitat in or near the unit for several federally listed species. 3. Vulnerability of special-status species and their habitat to changes in groundwater.
Susceptibility to changing groundwater conditions	**Rationale**
Low	1. Pumping in the main aquifers is unlikely to impact water levels underlying the unit. 2. Shallow groundwater likely to be maintained by San Joaquin River flows.

Biological condition gradient	Rationale
Level 2 – Minimal Changes	1. No change observed in NDVI/NDMI trends over the period 1985–2018. 2. Relatively intact biotic structure and function as deduced from reconnaissance level assessment of riparian vegetation community condition. 3. Suitable habitat present for those special-status species with likelihood to occur.

3.1.3 San Joaquin River Riparian Potential GDE Unit

The San Joaquin River Riparian Potential GDE Unit is characterized as having moderate ecological value with low susceptibility to changing groundwater conditions (Table A2.B-4). While our assessment of ecosystem structure and functions of the unit suggests certain areas of the unit are relatively intact and within the range of natural variability (Biological Condition Gradient Level 2 – Minimal Changes), other areas of riparian vegetation show evidence of impaired function and condition (Biological Condition Gradient Level 3 – Evident Change). As a result, we have determined that adverse impacts could be occurring in portions of the San Joaquin River Riparian Potential GDE Unit. However, available evidence (i.e., observed and modeled shallow groundwater depths from nearby wells) suggests that adverse impacts are unlikely to be related to recent or current groundwater management. The methods and rationale for these assessments are described in Section 3.5 below.

Table A2.B-4. Summary of ecological value, susceptibility, and condition gradient in the San Joaquin River Riparian Potential GDE Unit.

Ecological value	Rationale
Moderate	1. Potential occurrence of special-status species and presence of suitable habitat. 2. Vulnerability of special-status species and their habitat to changes in groundwater.
Susceptibility to changing groundwater conditions	**Rationale**
Low	1. Recent and projected future trends in depth to water indicate stable groundwater conditions in the unit. 2. Shallow groundwater likely to be maintained by San Joaquin River flows.
Biological condition gradient	**Rationale**
Level 3 – Evident Changes	1. Compromised biotic structure and function in some areas as observed from reconnaissance level assessment of riparian vegetation community condition. 2. No change observed in NDVI/NDMI trends over the period 1985–2018. 3. Habitat for special-status species with likelihood to occur is suitable to marginally suitable, with observed habitat fragmentation.

3.1.4 Sumner Hill Potential GDE Unit

The Sumner Hill Potential GDE Unit is characterized as having high ecological value. Based on our assessment that the ecosystem structure and functions of the unit are relatively intact and within the range of natural variability (Biological Condition Gradient Level 2 – Minimal Changes), we have determined that adverse impacts are not likely occurring in the Sumner Hill Potential GDE Unit. The susceptibility of this GDE unit to changing groundwater conditions is undetermined because of insufficient groundwater data (Table A2.B-5). The methods and rationale for these assessments are described in Section 3.6, below.

Table A2.B-5. Summary of ecological value, susceptibility, and condition gradient in the Sumner Hill Potential GDE Unit.

Ecological value	Rationale
High	1. Presence of special-status species and suitable habitat. 2. Presence of designated critical habitat in or near the unit for several federally listed species. 3. Species and ecological communities considered somewhat vulnerable to slight to moderate changes in groundwater levels.
Susceptibility to changing groundwater conditions	**Rationale**
Undetermined (but likely low)	1. Insufficient hydrologic data. 2. Presence of adjacent bedrock outcrop suggests little to no alluvium (minimal depth to bedrock) and lack of connection to subbasin aquifers.
Biological condition gradient	**Rationale**
Level 2 – Minimal Changes	1. No change observed in NDVI/NDMI trends over the period 1985–2018. 2. Relatively intact biotic structure and function as deduced from reconnaissance level assessment of riparian vegetation community condition. 3. Suitable habitat present for those special-status species with likelihood to occur.

3.2 Methods

This section describes the methods used to determine a GDE's susceptibility to changing groundwater conditions and its biological condition gradient.

To assess potential effects on GDEs, SGMA describes six groundwater conditions that could cause undesirable results. These are (1) chronic lowering of groundwater levels, (2) reduction of groundwater storage, (3) seawater intrusion, (4) degraded water quality, (5) land subsidence, and (6) depletions of interconnected surface water. Rohde et al. (2018) identify chronic lowering of groundwater levels, degraded water quality, and depletions of interconnected surface water as the most likely conditions to have direct effects on GDEs, potentially leading to an undesirable result. Following this guidance and based on available information for the Madera Subbasin, we have eliminated reduction of groundwater storage (groundwater levels are used as a proxy for groundwater storage), seawater intrusion (the subbasin is not located near or hydrologically connected to the ocean), and land subsidence (unlikely to affect GDEs) from consideration.

Current evidence indicates that groundwater pumping from the regional aquifer is unlikely to affect surface water flows in the subbasin, thus depletion of interconnected surface water is considered unlikely. Rivers in the subbasin, including the San Joaquin River and Fresno River, are in a net-losing condition, with surface flow likely contributing directly to the shallow groundwater system that supports the vegetation in the associated GDE units. However, the shallow groundwater system underlying the San Joaquin River does have the potential (albeit quite muted) to be affected by regional groundwater pumping.

In this section we evaluate the potential for chronic lowering of groundwater levels and degraded groundwater quality to cause direct effects on GDEs compared to baseline conditions, with a focus on effects related to groundwater levels. First, we identified baseline hydrologic conditions for the GDE units using available information (see Section 2.2.2 of this GSP). The primary baseline hydrological condition metric used for our analysis was depth to water. Next, we determined each GDE unit's susceptibility to changing groundwater conditions using available hydrologic data and the GDE susceptibility classifications summarized in Table A2.B-6.

Table A2.B-6. Susceptibility classifications developed for evaluation of a GDE's susceptibility to changing groundwater conditions (Rohde et al. 2018).

Susceptibility classifications	
High susceptibility	Current groundwater conditions for the selected hydrologic data fall outside the baseline range.
Moderate susceptibility	Current groundwater conditions for the selected hydrologic data fall within the baseline range but future changes in groundwater conditions are likely to cause it to fall outside the baseline range. The future conditions could be due to planned or anticipated activities that increase or shift groundwater production, causing a potential effect on a GDE.
Low susceptibility	Current groundwater conditions for the selected hydrologic data fall within the baseline range and no future changes in groundwater conditions are likely to cause the hydrologic data to fall outside the baseline range.

We used these susceptibility classifications to trigger further evaluation of potential effects on GDEs by integrating existing biological data, field reconnaissance assessments, and aerial photography analysis. If we determined a GDE unit to have moderate or high susceptibility to changing groundwater conditions, we used biological information to assess whether evidence exists of a biological response to changing groundwater levels or degraded water quality, subject to availability of appropriate data. The biological response analysis consisted of a combined approach of reconnaissance-level biological assessments in representative areas of each GDE unit, and quantitative trend analysis of Normalized Difference Vegetation Index (NDVI), and Normalized Difference Moisture Index (NDMI) data (Klausmeyer et al. 2019). The polygons correspond to different GDE mapping units (i.e., different species compositions) and the size of the GDE polygons varied.

NDVI, which estimates vegetation greenness, and NDMI, which estimates vegetation moisture, were generated from surface reflectance corrected multispectral Landsat imagery corresponding to the period July 9 to September 7 of each year when GDE species are most likely to use groundwater (see Klausmeyer et al. 2019 for further description of methods). Vegetation with higher NDVI values indicate increased density of chlorophyll and photosynthetic capacity in the canopy, an indicator of vigorous, growing vegetation. Similarly, high NDMI values indicate that the vegetation canopy has high water content and is therefore not drought stressed. These indices are both commonly used proxies for vegetation health in analyses of temporal trends in health of groundwater dependent vegetation (Rouse et al. 1974, Jiang et al. 2006; as cited in Klausmeyer et al. 2019). NDVI and NDMI trend analysis included compilation of NDVI and NDMI trend data from 1985 to 2018 for all delineated GDE polygons from the GDE Pulse Interactive Map (Klausmeyer et al. 2019) that are within the GDE unit boundaries. These data were used to calculate mean NDVI and NDMI, and 95% confidence intervals, by year for each GDE unit as a whole, and then change in mean NDVI/NDMI was visually inspected to identify increasing, decreasing, or no change in temporal trends over the period from 1985 to 2018. Negligible changes were identified as those that failed to exceed the level of uncertainty in mean values as indicated by 95% confidence intervals.

To examine the effect of variable precipitation on NDVI/NDMI, annual precipitation data for each GDE was downloaded from the GDE Pulse Interactive Map (Klausmeyer et al. 2019), and multiple linear regression analysis was used to evaluate potential relationships between precipitation and vegetation health. A weak correlation was interpreted as a weak coupling between precipitation and NDVI/NDMI, suggesting a comparatively stronger influence of groundwater conditions on NDVI/NDMI. We also evaluated the effect of surface water flows on NDVI/NDMI using the San Joaquin Valley Index (SJVI), which is calculated by DWR and is a function of San Joaquin flow into Millerton Reservoir, Merced River flow into Lake McClure, Tuolumne River flow to New Don Pedro Reservoir, and Stanislaus River flow into New Melones Reservoir (CDEC 2019). The index is used to determine water year type and flow releases in the San Joaquin River and its major tributaries. Because the SJVI is used to determine flow releases into the San Joaquin Valley and includes the previous year's hydrologic condition, it is a good proxy for hydrologic conditions experienced by GDEs located along San Joaquin Valley rivers. SJVI was not included in the regression analysis because preliminary analysis found that SJVI strongly covaries with annual precipitation. Annual precipitation was selected for use in the regression analysis because of evidence in the scientific literature of its strong correlation with remotely sensed vegetation metrics, and groundwater levels (Huntington et al. 2016, Groeneveld 2008). Results of these analyses are presented in Sections 3.3–3.6 below.

Reconnaissance-level biological assessments were used to determine the overall condition of the vegetation and terrestrial habitat within each GDE unit, assess evidence of recent riparian tree recruitment, and detect biological indications of degraded water quality. Field observations were augmented with analysis of recent (2017 and 2018) aerial photographs to assess the degree to which field observations were consistent with trends detected in aerial photographs as well as spatial variability across the GDE units.

These field-based, and remotely sensed biological data sources were used to identify any apparent trends in biological condition of the GDEs. These trends were evaluated over the period 1985–2018 (NDVI/NDMI) and 2017–2019 (field-based and aerial photograph analysis) within the Biological Condition Gradient classification scheme (USEPA 2016) (Table A2.B-7). To assess impacts to GDEs, minimal or evident changes (Levels 2 and 3) were considered to indicate the potential for impacts due to changing groundwater conditions, with further data collection and analysis (i.e., monitoring) needed to evaluate the connection between impacts and groundwater management, if any. Moderate to severe changes (Levels 4–6), if detected, were considered to indicate adverse impacts to GDEs and therefore undesirable results in the subbasin.

Table A2.B-7. Classifications of the Biological Condition Gradient, a conceptual framework developed for interpretation of biological responses to effects of water quality stressors (USEPA 2016).

Biological condition gradient classifications	
Level 1—Natural or native condition	Native structural, functional, and taxonomic integrity is preserved. Ecosystem function is preserved within the range of natural variability. Functions are processes required for the normal performance of a biological system and may be applied to any level of biological organization.
Level 2—Minimal changes	Minimal changes in the structure of the biotic community and minimal changes in ecosystem function. Most native taxa are maintained with some changes in biomass and/or abundance. Ecosystem functions are fully maintained within the range of natural variability.
Level 3—Evident changes	Evident changes in the structure of the biotic community and minimal changes in ecosystem function. Evident changes in the structure due to loss of some highly sensitive native taxa; shifts in relative abundance of taxa, but sensitive ubiquitous taxa are common and relatively abundant. Ecosystem functions are fully maintained through redundant attributes of the system.
Level 4—Moderate changes	Moderate changes in the structure of the biotic community with minimal changes in ecosystem function. Moderate changes in the structure due to the replacement of some intermediate sensitive taxa by more tolerant taxa, but reproducing populations of some sensitive taxa are maintained; overall balanced distribution of all expected major groups. Ecosystem functions largely maintained through redundant attributes.
Level 5—Major changes	Major changes in the structure of the biotic community and moderate changes in ecosystem function. Sensitive taxa are markedly diminished or missing; organism condition shows signs of physiological stress. Ecosystem function shows reduced complexity and redundancy.
Level 6—Severe changes	Severe changes in the structure of the biotic community and major loss of ecosystem function. Extreme changes in structure, wholesale changes in taxonomic composition, extreme alterations from normal densities and distributions, and organism condition is often poor. Ecosystem functions are severely altered.

3.3 Fresno River Riparian Potential GDE Unit

3.3.1 Hydrologic data

3.3.1.1 Baseline conditions

To determine baseline conditions and assess susceptibility of the Fresno River Riparian Potential GDE Unit, depth to groundwater data was examined for the one well located in close proximity to the unit (well MCE RMS-8; Figure A2.B-14). The location of the well is shown in Figure A2.B-2. The baseline hydrologic conditions for the Fresno River Riparian Potential GDE Unit were assessed using the modeled period from October 1988 to September 2015 (WY 1989–2015). Despite the abrupt change in observed groundwater depth from 2004 to 2005 (Figure A2.B-14), we use the entire 1988–2015 period as the baseline condition because it incorporates two droughts, which are most likely to impact the health of the GDE. This well was determined to be suitable for evaluation of the groundwater dynamics and trends of the Fresno River Riparian Potential GDE Unit because it is in close proximity to the unit, has a depth to water range that includes measurements of less than 30 feet (maximum rooting depth of phreatophytic vegetation), and was monitored and modeled during the entire baseline period.

Groundwater quality data is not available for the shallow groundwater system associated with the Fresno River Riparian Potential GDE Unit.

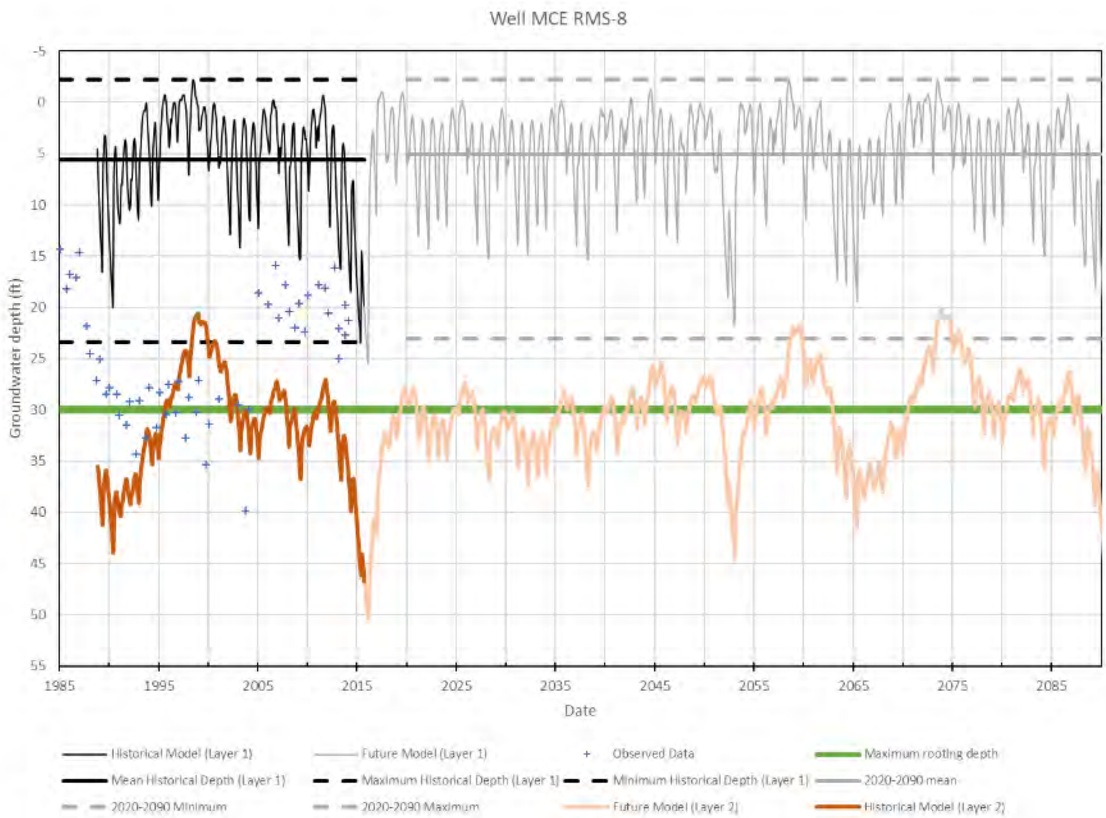

Figure A2.B-14. Simulated historical (black line and dark orange line 1990–2015 for model Layer 1 and Layer 2, respectively) and modeled projected (grey line and light orange line 2016–2090 for Layer 1 and Layer 2, respectively) monthly groundwater depth to water for well MCE RMS-8 near the Fresno River Riparian Potential GDE Unit. Observed data are represented by blue plus signs. The solid horizontal lines represent the mean modeled groundwater depth for the historical (black) and projected post-implementation (2020-2090) (grey) periods, while the horizontal dashed lines represent the maximum and minimum groundwater depth for the historical (black) and projected (grey) periods. The horizontal green line represents the maximum depth (30 feet) at which phreatophytic plants can access groundwater.

3.3.1.2 Susceptibility to potential effects

Modeled depth to water for the historical (i.e., baseline; 1988–2015) and future (2020–2090) periods is very similar for well MCE RMS-8 in the Fresno River Riparian GDE for Layer 1 and Layer 2 (Figure A2.B-14). The observed data from 1985 to 2014 for MCE RMS-8 ranges from approximately 12 to 40 feet bgs, with an average of 28 feet bgs. Projected future modeled groundwater levels for model Layers 1 and 2 fall within the range of modeled historical water levels. Relative to the historical model results (1988–2015), the mean depth for model Layer 1 from 2020–2090 decreases from 5.6 to 5.1 feet, and the maximum and minimum modeled groundwater depths are within 0.3 feet of the historical modeled values (Table A2.B-8). A similar stability is seen for Layer 2 at this site where relative to the historical model results (1988–2015), the mean depth for model Layer 2 from 2020–2090 decreases from 31.6 to 30.4 feet, and the maximum and minimum modeled groundwater depths are within 0.5 feet of the historical modeled value (Table 8). In general, the modeled groundwater elevations for Layer 1 are shallower than the maximum rooting depth (30 feet) and for Layer 2 are close to the maximum rooting depth. Although the observed changes to the groundwater elevation between 2003 and 2005 are not captured by the model, model Layer 2 adequately represents the groundwater elevation variability since 2005 and the observed groundwater elevations are between the Layer 1 and Layer 2 model results. The mean modeled depth of 30.4 feet for model Layer 2 approximates the 30-foot maximum rooting depth of GDE plant species. Observed depths to water recorded at this well suggest the shallow groundwater ranges from about 10 feet above to 10 feet below the modeled values for model Layer 2.

Table A2.B-8. Statistics of observations and monthly modeled well depth for well MCE RMS-8 near the Fresno River Riparian Potential GDE Unit.

	Observations	**Model Results (Layer 1)**		**Model Results (Layer 2)**	
Date range	**1958-2015**	**1988-2015**	**2020-2090**	**1988-2015**	**2020-2090**
Number of data points	100	324	849	324	849
Mean depth (ft)	18.8	5.6	5.1	31.6	30.4
Standard deviation (ft)	8.6	5.1	4.5	0.3	0.1
Maximum depth (ft)	39.8	23.4	23.1	46.7	46.2
Minimum depth (ft)	5.4	-2.2	-2.2	20.6	20.2
Number of data points with depth >30 ft	13	0	0	0	0
Frequency (%) at which depth exceeds 30 ft	13	0	0	0	0

Groundwater level data suggest that future groundwater conditions in the Fresno River Riparian Potential GDE Unit are projected to remain within the baseline range. Modeled trends in depth to water during the historical and projected future time periods suggest stable or slightly increasing groundwater levels in the Fresno River Riparian Potential GDE Unit. The hydrogeology of the unit suggests that pumping in the main aquifers is unlikely to impact water levels underlying the unit. As a result, the Fresno River Riparian Potential GDE Unit was determined to have **low susceptibility** to groundwater conditions falling outside the baseline range. Nevertheless, given the uncertainty in the modeling of groundwater, this GDE should be monitored to assess ecological conditions and trends, particularly during drought or if pumping in the Upper Aquifer increases.

3.3.2 Biological data

Average summer NDVI and NDMI for the period 1985–2018 indicate some fluctuations but very little overall change in both indices in the Fresno River Riparian Potential GDE Unit (Figures A2.B-15 and A2.B-16). NDVI for individual, mapped polygons ranges from approximately 0.25 to 0.55, and mean NDVI for all polygons was lowest in 1986 (0.30) and highest in 2016 (0.45) (Figure A2.B-15). Mean NDVI between 1985 and 2018 showed a negligible increase (0.09) during this period. NDMI for individual, mapped polygons shows a similar trend to NDVI but with values ranging from approximately -0.15 to 0.20 (Figure A2.B-16). Mean NDMI for all polygons was lowest in 2014 (-0.07), and highest in 2017 (0.06). Mean NDMI also showed a small increase (0.06) between 1985 and 2018. NDVI in the Fresno River Riparian Potential GDE Unit is somewhat decoupled from SJVI. While NDVI increased during wet years from 1995–1997, it dropped slightly but was generally high through the 2014–2016 drought (Figure A2.B-15). NDMI was more responsive to droughts and river flow volumes than NDVI (Figure 16).

To evaluate the influence of precipitation on these indices, annual precipitation data for the individual GDE polygons composing the Fresno River Riparian Potential GDE Unit were analyzed using multiple linear regression to assess the effect of year and annual precipitation on NDVI/NDMI. Annual precipitation was not a statistically significant predictor variable of mean NDVI ($p = 0.54$) and explained little of the variation in NDVI ($R^2 = 0.01$). Likewise, annual precipitation was not a statistically significant predictor variable of mean NDMI ($p = 0.45$) and showed little explanatory power of the variation in NDMI ($R^2 = 0.02$). Together, these results suggest that shallow groundwater conditions likely have a greater influence on the health of groundwater dependent vegetation within the Fresno River Riparian Potential GDE Unit than does local, annual precipitation.

A reconnaissance field assessment of the Fresno River Riparian Potential GDE Unit documented presence of recent riparian willow recruitment in a portion of the unit. The riparian vegetation observed appeared very healthy, with dense, green canopies at multiple layers with evidence of recent growth. Analysis of recent satellite imagery corroborates these field observations.

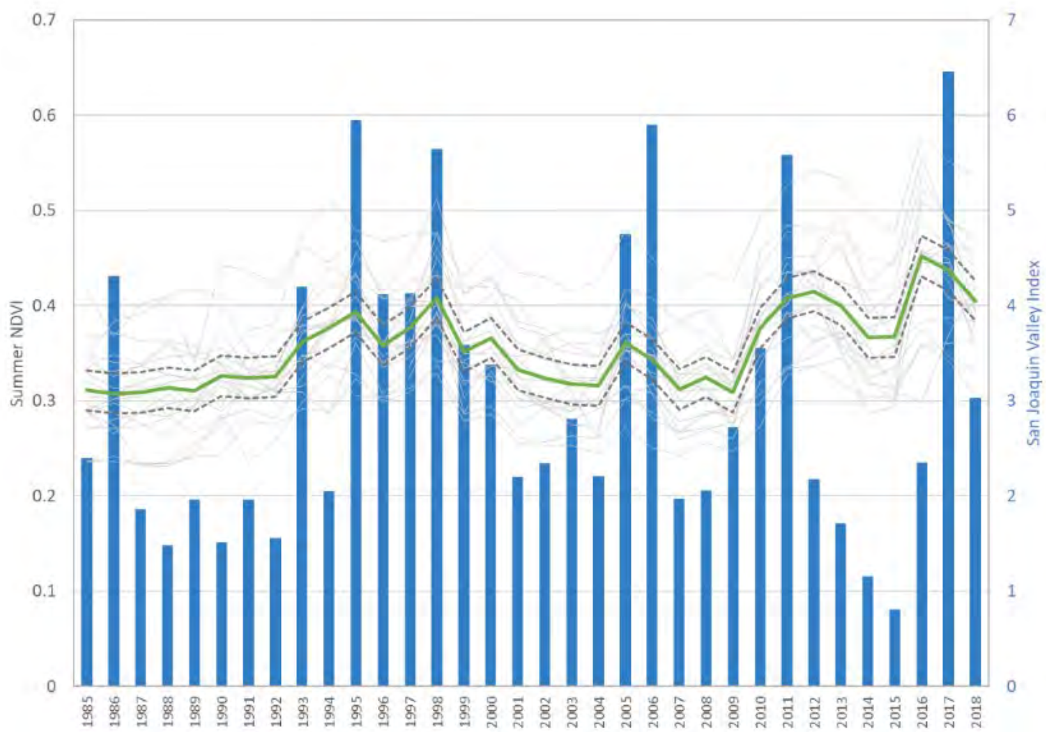

Figure A2.B-15. Summer NDVI from 1985–2018 for all GDE polygons composing the Fresno River Riparian Potential GDE Unit (light grey lines). The green line represents the mean NDVI for all GDE polygons within the Fresno River Riparian Potential GDE Unit and gray dashed lines are 95% confidence intervals around the mean. Blue bars represent the San Joaquin Valley Index for each water year.

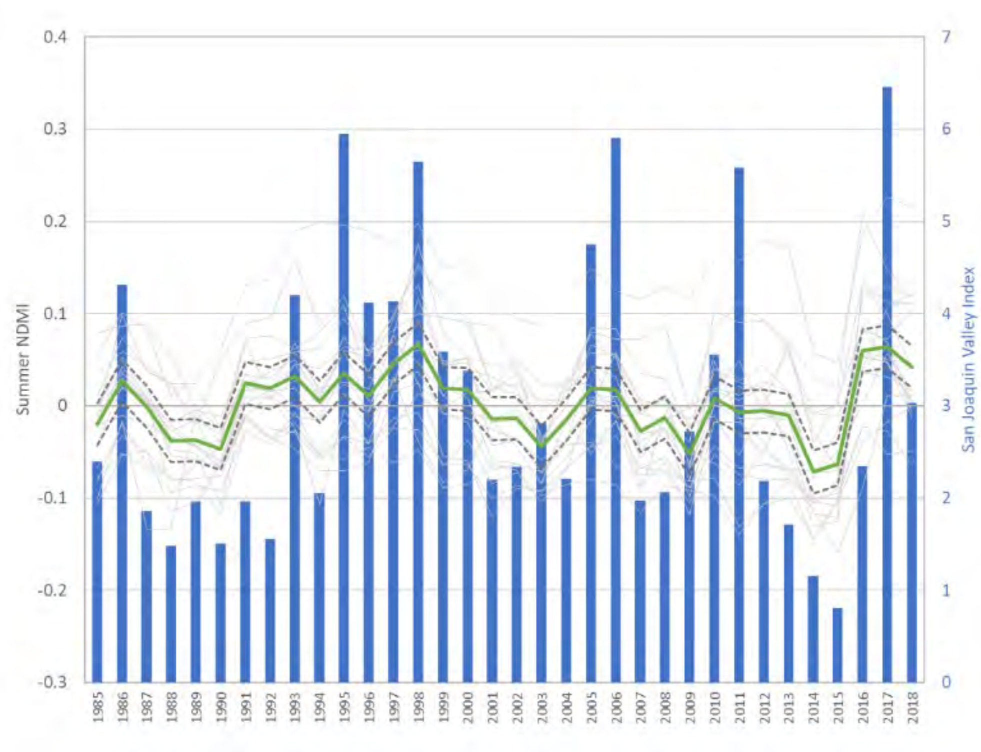

Figure A2.B-16. Summer NDMI from 1985–2018 for all GDE polygons composing the Fresno River Riparian Potential GDE Unit (light grey lines). The green line represents the mean NDMI for all GDE polygons within the Fresno River Riparian Potential GDE Unit and gray dashed lines are 95% confidence intervals around the mean. Blue bars represent the San Joaquin Valley Index for each water year.

3.3.3 Potential effects

Reconnaissance level biological assessments, aerial photograph analysis, and NDVI/NDMI data indicate adverse ecological impacts are not likely occurring in the Fresno River Riparian Potential GDE Unit. Shallow groundwater underlying the Fresno River Riparian Potential GDE Unit appears tightly coupled with surface flow and runoff and likely is generally maintained at depths within or near the rooting depth range of riparian species present in the unit. The Fresno River flows adjacent to the Fresno River Riparian Potential GDE Unit and is in a net-losing condition, with surface flow likely contributing directly to the shallow groundwater system that supports the vegetation in the unit. Evidence of recent riparian tree recruitment (within 5 years) observed in the Fresno River Riparian Potential GDE Unit, along with high-density, healthy vegetation at multiple layers and the presence of these attributes throughout the unit, suggests that baseline groundwater levels (i.e., those occurring prior to 2015) and current groundwater levels (since 2015) are sufficient to maintain ecosystem functions essential for the survival and reproduction of riparian plant species. In addition, trends in NDVI/NDMI show little to no change in overall vegetation health within the unit. Although past fluctuations in these indices appear correlated with periods of drought in the San Joaquin River Basin (e.g., 2012–2016), both indices have rebounded since 2017. Based on these recent historical response patterns, it appears the dominant native vegetation composing the Fresno River Riparian Potential GDE Unit is sufficiently resilient to maintain ecosystem integrity and function in the face of predicted fluctuations in groundwater conditions around the recent historical baseline level. The mean groundwater elevation in the shallow aquifer associated with this GDE unit is predicted to become slightly shallower during the period from 2020–2090, suggesting the potential for maintenance of current conditions or a modest positive ecological response by the vegetation composing the unit.

Riparian vegetation condition and NDVI/NDMI trends within the GDE unit also indicate groundwater quality is not limiting ecosystem functions essential for the survival and reproduction of riparian plant species. Rohde et al. (2018) list declining NDVI/NDMI, reduced tree canopy and understory, shifts in vegetation type, tree mortality, and habitat fragmentation as indicators of adverse impacts, however, none of these was detected within the GDE unit. Because the NDVI/NDMI assessment was confined to the GDEs mostly mapped in 2014, our analysis does not account for potential reduction in the extent of riparian vegetation (and hence a reduction in the area of the polygons) prior to the vegetation mapping.

The response of perennial, resident wildlife and vegetation to groundwater dynamics in the Fresno River Riparian Potential GDE Unit is not well understood because population dynamics during the baseline period are not known. Many of these species survived the droughts in the early 1990s and the mid-2010s, but the effects on the species and their susceptibility to future changes are unknown. Appropriate data for evaluating these relationships is not readily available but, if obtained, could provide insight to additional interactions between groundwater conditions and biological responses, leading to a more complete evaluation of potential adverse impacts. Recommendations for monitoring to provide additional data for this purpose are included in Section 5.

3.4 Friant Riparian Potential GDE Unit

3.4.1 Hydrologic data

3.4.1.1 Baseline conditions

Because there are no representative wells currently available in the vicinity of the Friant Riparian Potential GDE Unit baseline groundwater levels could not be defined. It is likely, however, that shallow groundwater conditions in the Friant Riparian Potential GDE Unit are closely tied to flow releases from Friant Dam. Seepage or leakage from the dam may also contribute to shallow groundwater underlying the GDE unit. If shallow groundwater elevations are closely tied to flow releases from Friant Dam, changes to the operations of Friant Dam have the potential to alter shallow groundwater levels in this GDE unit. In particular, the beginning of SJRRP interim flow releases in 2009 and restoration flow releases in 2014, and since 2017 likely helped to maintain shallower groundwater levels in the GDE since 2009.

3.4.1.2 Susceptibility to potential effects

Given the paucity of data and model limitations, the susceptibility to potential hydrological effects in this GDE cannot be determined using quantitative data (i.e., modeled or observed groundwater levels). Shallow groundwater underlying the GDE unit is likely perched/mounded atop a shallow clay or bedrock layer, and groundwater is likely dependent upon flow releases from Friant Dam. Decreases in flow releases would likely cause the groundwater level to become deeper. Similarly, increased local surface or groundwater pumping could cause the elevation of the groundwater used by the GDE to decline. The increase in the average NDVI and NDMI since the onset of increased flow releases from Friant Dam in 2009, as discussed below, suggests that shallow groundwater depths may be closely linked to Friant Dam releases.

The hydrogeology of the Friant Riparian Potential GDE Unit suggests that pumping in the main aquifers is unlikely to impact water levels underlying the unit. Further, continued SJRRP restoration flow releases from Friant Dam and possibly continued seepage or leakage from the dam are expected to contribute to shallow groundwater levels in this GDE unit. As a result, the Friant Riparian Potential GDE Unit was determined to have **low susceptibility** to groundwater conditions falling outside the baseline range. Nevertheless, given the lack of groundwater data, this GDE should be monitored to assess ecological conditions and trends, particularly during drought or if pumping in the Upper Aquifer increases.

3.4.2 Biological data

Average summer NDVI and NDMI for the period 1985–2018 indicate small increases and modest fluctuations in both indices in the Friant Riparian Potential GDE Unit (Figures A2.B-17 and A2.B-18). NDVI for individual, mapped polygons ranges from approximately 0.15 to 0.72, and mean NDVI for all polygons was lowest in 1987 (0.32) and highest in 2014 (0.51) (Figure A2.B-17). Mean NDVI between 1985 and 2018 showed a small increase (0.14). NDMI for individual, mapped polygons shows a similar trend to NDVI but with values ranging from approximately -0.20 to 0.35 (Figure A2.B-18). Mean NDMI for all polygons was also lowest in 2002 (-0.006), and highest in 2018 (0.14). Mean NDMI also showed a small increase (0.11) between 1985 and 2018.

Prior to 2011, the summer NDVI for the Friant Riparian Potential GDE Unit was slightly coupled to the SJVI, with small increases during wetter water years and small decreases during drier water years (Figure A2.B-17). Large increases in NDVI starting in 2010 were sustained through the dryer years from 2012–2016, with a slight decrease in 2017 and 2018, with these changes decoupled from the SJVI. NDMI was more closely tied to SJVI than NDVI prior to 2009, with decreases in NDMI associated with SJVI decreases (Figure A2.B-18). Since 2009 the steady increase in NDMI showed no relationship with the dryer water years occurring from 2012–2016.

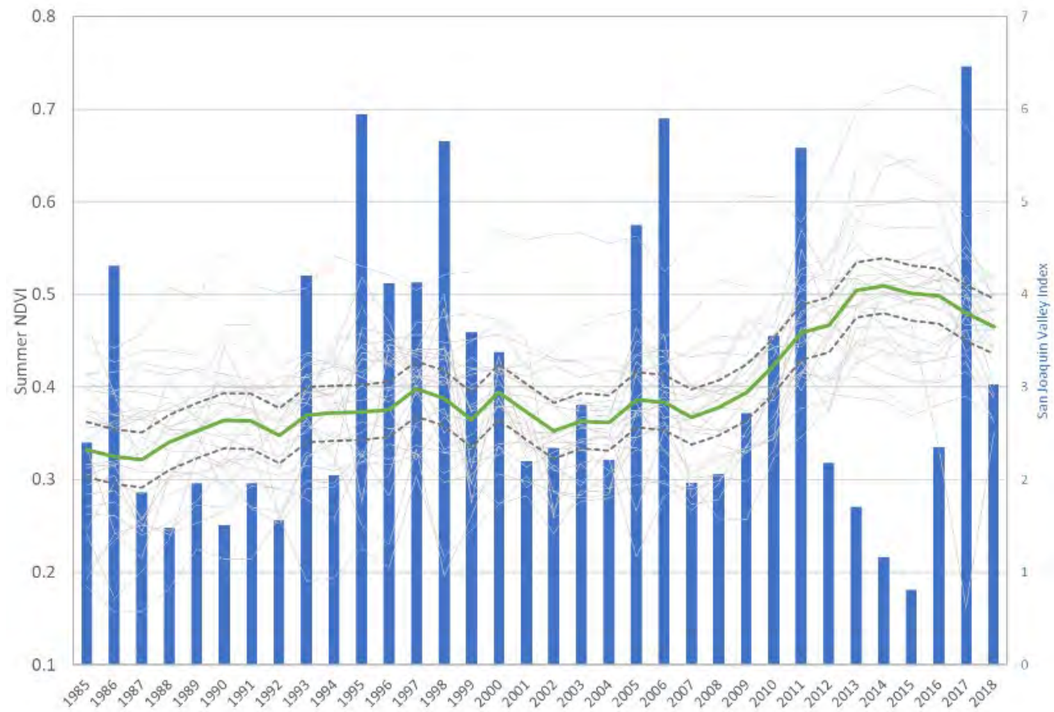

Figure A2.B-17. Summer NDVI from 1985–2018 for all GDE polygons composing the Friant Riparian Potential GDE Unit (light grey lines). The green line represents the mean NDVI for all GDE polygons within the Friant Riparian Potential GDE Unit and gray dashed lines are 95% confidence intervals around the mean. Blue bars represent the San Joaquin Valley Index for each water year.

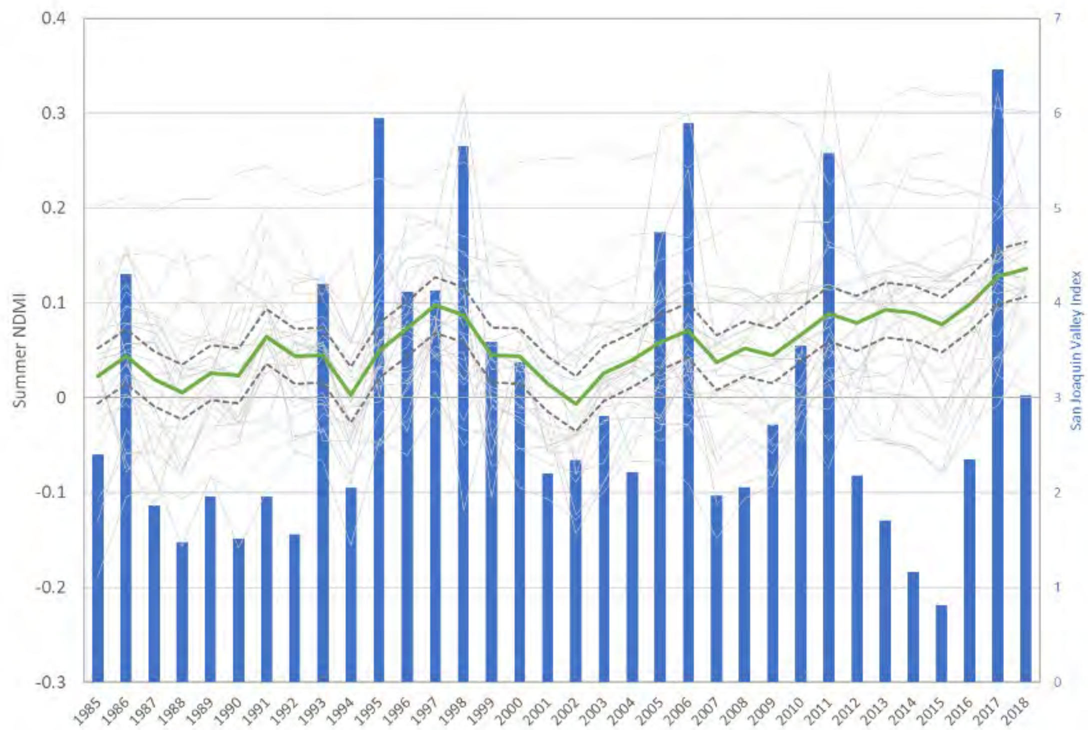

Figure A2.B-18. Summer NDMI from 1985–2018 for all GDE polygons composing the Friant Riparian Potential GDE Unit (light grey lines). The green line represents the mean NDMI for all GDE polygons within the Friant Riparian Potential GDE Unit and gray dashed lines are 95% confidence intervals around the mean. Blue bars represent the San Joaquin Valley Index for each water year.

Annual precipitation was not a statistically significant predictor variable of mean NDVI ($p = 0.88$) and explained little of the variation in NDVI ($R^2 = <0.001$). Likewise, annual precipitation was not a statistically significant predictor variable of mean NDMI ($p = 0.06$) and showed little explanatory power of the variation in NDMI ($R^2 = 0.11$). Together, these results suggest that shallow groundwater conditions likely have a greater influence on the health of groundwater dependent vegetation within the Friant Riparian Potential GDE Unit than does local, annual precipitation.

A reconnaissance field assessment of the Friant Riparian Potential GDE Unit documented presence of recent (within 5 years) willow recruitment in a portion of the unit. The riparian vegetation observed appeared very healthy, with dense, green canopies at multiple layers with evidence of recent growth. Analysis of recent satellite imagery corroborates these field observations.

3.4.3 Potential effects

Reconnaissance level biological assessments, aerial photograph analysis, and NDVI/NDMI data indicate adverse impacts are not likely occurring in the Friant Riparian Potential GDE Unit.

Shallow groundwater levels in the Friant Riparian Potential GDE Unit are likely independent of pumping elsewhere in the subbasin because bedrock outcrops and shallow bedrock help to isolate the shallow groundwater in the unit from the rest of the subbasin. The high-density, healthy vegetation at multiple layers in the unit suggests that current and recent historical groundwater levels are sufficient to maintain ecosystem functions essential for the survival and reproduction of riparian plant species. In addition, trends in NDVI/NDMI show little to no change in overall vegetation health within the unit and no apparent response to periods of drought in the San Joaquin Basin (e.g., 2012–2016) or recent years with wetter conditions since 2017. Based on the recent historical conditions and trends, it appears the dominant vegetation composing the Friant Riparian Potential GDE Unit is sufficiently resilient to maintain ecosystem integrity and function in the face of predicted climate fluctuations and potential increases in drought frequency and magnitude. Based on the limited evidence available, it is unlikely that groundwater pumping is affecting or would affect this GDE unit.

Vegetation condition and NDVI/NDMI trends within the GDE unit also indicate groundwater quality is not limiting ecosystem functions essential for the survival and reproduction of riparian and wetland species. Rohde et al. (2018) list declining NDVI/NDMI, reduced tree canopy and understory, shifts in vegetation type, tree mortality, and habitat fragmentation as indicators of adverse impacts that can result from degraded water quality, however, none of these was detected within the GDE unit. Because the NDVI/NDMI assessment was confined to the GDEs mostly mapped in 2014, our analysis does not account for potential reduction in the extent of riparian vegetation (and hence a reduction in the area of the polygons) prior to the vegetation mapping.

The response of perennial, resident wildlife and vegetation to groundwater dynamics in the Friant Riparian Potential GDE Unit is not well understood because population dynamics during the baseline period are not known. Many of these species survived the droughts in the early 1990s and the mid-2010s, but the effects on the species and their susceptibility to future changes are unknown. Appropriate data for evaluating these relationships is not readily available but, if obtained, could provide insight to additional interactions between groundwater conditions and biological responses, leading to a more complete evaluation of potential adverse impacts. Recommendations for monitoring to provide additional data for this purpose are included in Section 5.

3.5 San Joaquin River Riparian Potential GDE Unit

3.5.1 Hydrologic data

3.5.1.1 Baseline conditions

To determine baseline conditions and assess susceptibility of the San Joaquin River Riparian Potential GDE Unit to changing groundwater conditions, depth to groundwater data was examined for the three monitoring wells along the length of the GDE unit assessed in Section 2: MCE RMS-9, MID RMS-17, and MCW RMS-5 (Figures A2.B-19– A2.B-21). The locations of these wells are shown in Figure 2. These wells were determined to be suitable for evaluation of the groundwater dynamics and trends of the San Joaquin River Riparian Potential GDE Unit because they are in close proximity to the unit, have depths to water less than 30 feet (maximum rooting depth of phreatophytic vegetation), and model results at these locations are available for review over the entire baseline period and can be compared to observed data since 2009. The baseline hydrologic conditions were assessed using the modeled period from October 1988 to September 2015 (WY 1989–2015). We use the entire 1988–2015 period as the baseline condition because it incorporates two droughts, which are most likely to impact the health of the GDE. The initiation of SJRRP flow releases from Friant Dam starting in 2009 likely affected the depth of shallow groundwater associated with this GDE unit, and may have an influence on the groundwater hydrography over the baseline period. Releases from Friant Dam likely have a positive influence on ecological condition of the GDE, but have been curtailed during critically dry years typical of droughts.

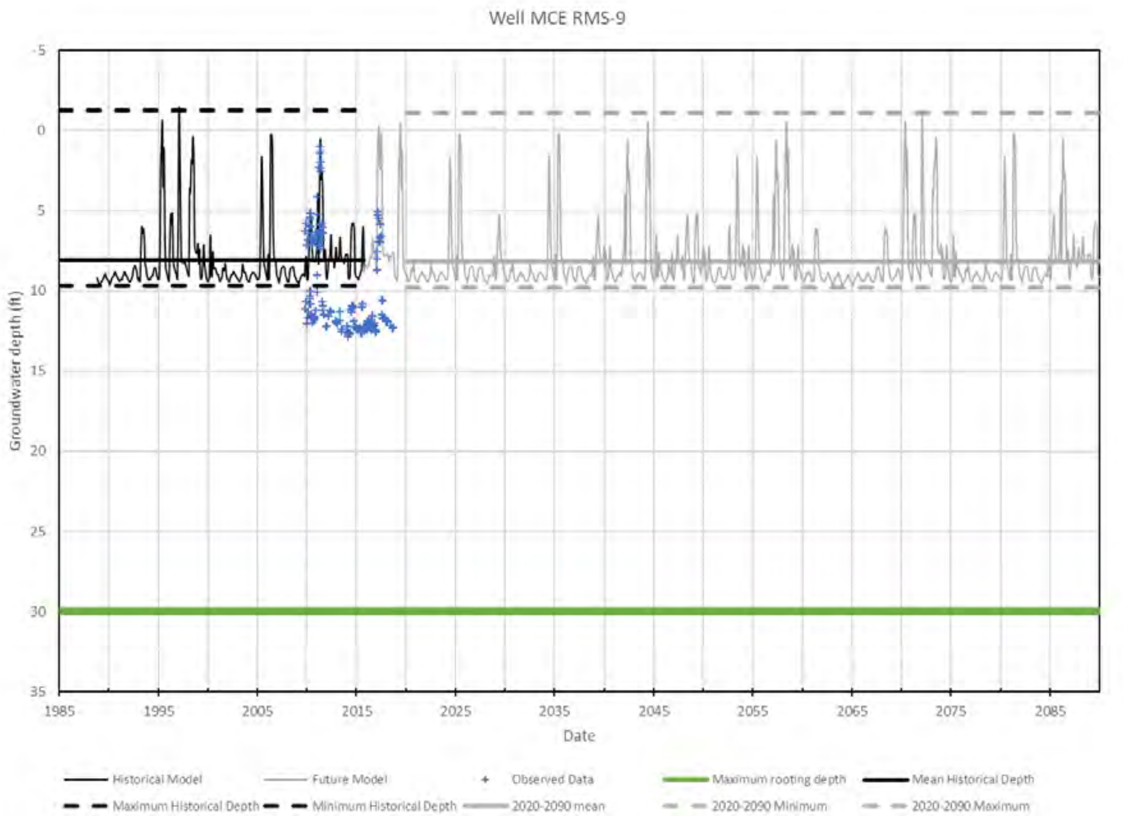

Figure A2.B-19. Simulated historical (black line 1990–2015) and modeled projected (grey line 2016–2090) monthly groundwater depth to water for well MCE RMS-9. Observed data (blue plus signs) were recorded hourly. The solid horizontal lines represent the mean modeled groundwater depth for the historical (black) and projected post-implementation (2020-2090) (grey) periods, while the horizontal dashed lines represent the maximum and minimum groundwater depth for the historical (black) and projected (grey) periods. The horizontal green line represents the maximum depth (30 feet) at which phreatophytic plants can access groundwater.

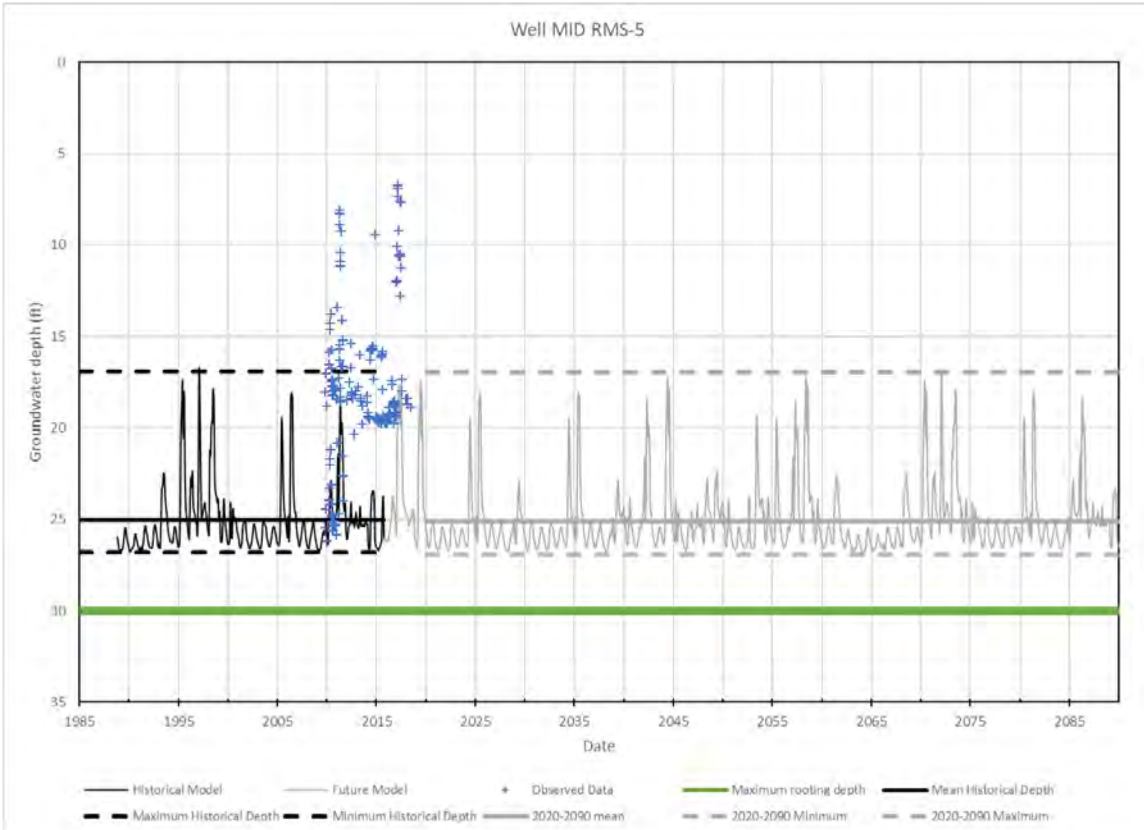

Figure A2.B-20. Simulated historical (black line 1990–2015) and modeled projected (grey line 2016–2090) monthly groundwater depth to water for well MID RMS-17. Observed data (blue plus signs) were recorded hourly. The solid horizontal lines represent the mean modeled groundwater depth for the historical (black) and projected post-implementation (2020-2090) (grey) periods, while the horizontal dashed lines represent the maximum and minimum groundwater depth for the historical (black) and projected (grey) periods. The horizontal green line represents the maximum depth (30 feet) at which phreatophytic plants can access groundwater.

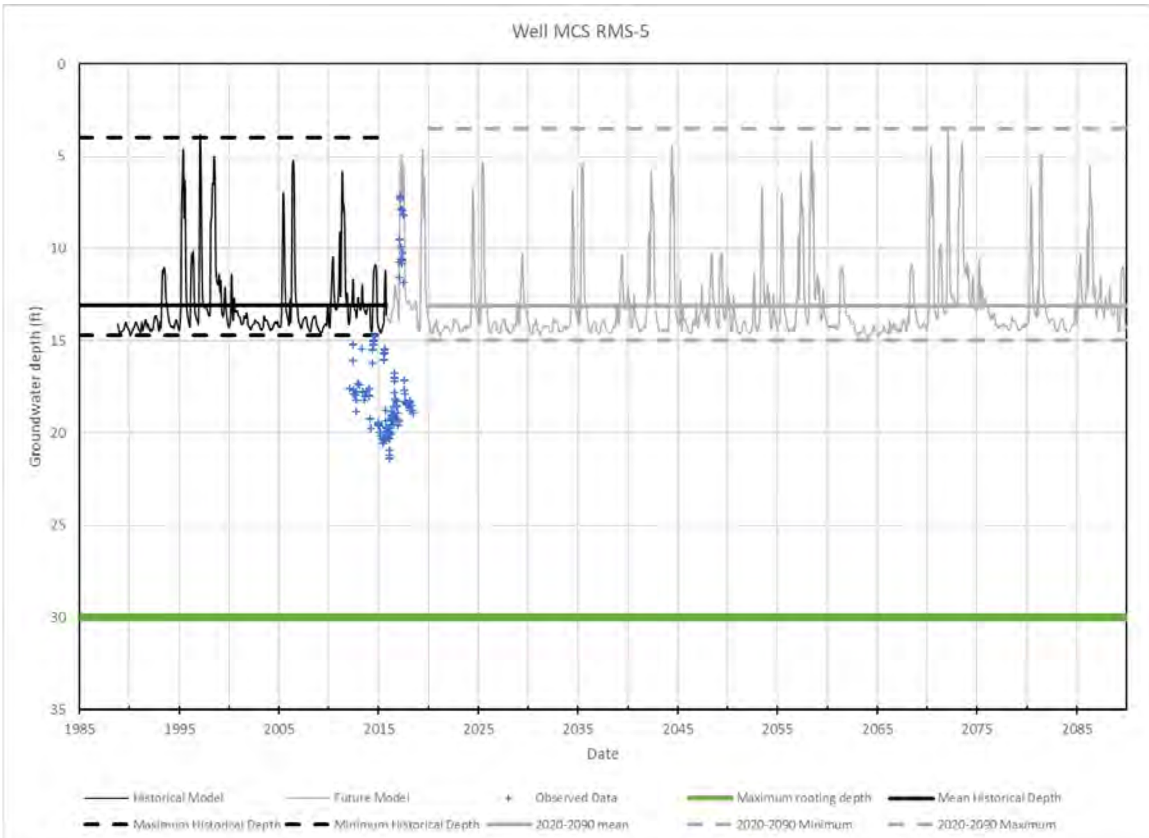

Figure A2.B-21. Simulated historical (black line 1990–2015) and modeled projected (grey line 2016–2090) monthly groundwater depth to water for well MCW RMS-5. Observed data (blue plus signs) were recorded hourly. The solid horizontal lines represent the mean modeled groundwater depth for the historical (black) and projected post-implementation (2020-2090) (grey) periods, while the horizontal dashed lines represent the maximum and minimum groundwater depth for the historical (black) and projected (grey) periods. The horizontal green line represents the maximum depth (30 feet) at which phreatophytic plants can access groundwater.

Data from all three wells suggest a potential tight coupling between variable surface flow in the San Joaquin River and the shallow groundwater associated with the GDE unit. Observed depth to water data is available from 2009-present for wells MCE RMS-9 and MID RMS-17, and from 2012-present for well MCW RMS-5. Observed depth to water varies by approximately 10–20 feet during the periods of observation depending on the well, with all observed water depths well within the maximum phreatophyte rooting depth of 30 feet (Figures A2.B-19– A2.B-21, Table A2.B-9). Simulated values back to 1988 indicate fluctuations of +/- 10 feet, with mean depth ranging from approximately 8 feet (observed mean is 10 feet bgs) for well MCE RMS-9 to 25 feet (observed mean is 18 feet bgs) for well MID RMS-17 and no apparent increasing or decreasing trend at any of the three wells.

Groundwater quality data is available for multiple wells and constituents in the vicinity of the San Joaquin River Riparian Potential GDE Unit (see Chapter 2.2.2.3 of this GSP). Maximum total dissolved solids concentration in the shallow groundwater of the GDE unit is typically < 250 mg/L. Other constituents fall below applicable thresholds for environmental protection and human health at wells near the GDE unit.

Table A2.B-9. Statistics of observations and monthly modeled well depth for MCE RMS-9, MID RMS-17, and MCW RMS-5 near the San Joaquin River Riparian Potential GDE Unit.

Well	MCE RMS-9			MID RMS-17			MCW RMS-5		
	Observations	Monthly model		Observations	Monthly model		Observations	Monthly model	
Date range	2009-2018	1988–2015	2020–2090	2009-2018	1988–2015	2020–2090	2012-2018	1988–2015	2020–2090
Number of data points	208	324	849	194	324	849	144	324	849
Mean depth (ft)	10.0	8.1	8.2	17.8	25.0	25.1	17.5	13.1	13.1
Standard deviation (ft)	3.0	2.0	1.9	4.1	1.9	1.8	3.3	2.0	2.0
Maximum depth (ft)	12.8	9.7	9.8	26.2	26.8	26.9	21.4	14.7	15.0
Minimum depth (ft)	1.0	-1.3	-1.1	6.7	16.9	16.9	7.1	4	3.5
Number of data points with depth >30 ft	0	0	0	0	0	0	0	0	0
Frequency (%) at which depth exceeds 30 ft	0	0	0	0	0	0	0	0	0

Susceptibility to potential effects

Modeled depth to water for the historical (1988–2015) and future modeling (2020–2090) periods are very similar for MCE RMS-9, MID RMS-17, and MCW RMS-5 for the San Joaquin River Riparian Potential GDE Unit (Figures A2.B-19– A2.B-21). Relative to the historical model results, the mean depth is within 0.1 feet for all three wells, and the maximum modeled groundwater depths from 2020–2090 are deeper than historical modeled values by 0.1–0.3 feet for the three wells, while the minimum values are 0.0–0.5 ft deeper (Table A2.B-9). For all three wells, the maximum modeled and observed depths for the 2020–2090 period are shallower than the 30-foot maximum rooting depth of GDE species and do not exceed historical modeled low values. Together, these data suggest that the susceptibility to potential adverse effects related to groundwater management is low for the San Joaquin River Riparian Potential GDE Unit. Nevertheless, given the uncertainty in the modeling of groundwater, this GDE should be monitored to assess ecological conditions and trends, particularly during drought or if pumping in the Upper Aquifer increases.

Projected future trends in depth to water for the representative groundwater wells are similar to recently observed trends with regard to groundwater fluctuations and mean depth to water. Combined, annual trends in depth to water during the observed and projected time periods suggest stable groundwater conditions in the San Joaquin River Riparian Potential GDE Unit. As a result, the San Joaquin River Riparian Potential GDE Unit was determined to have **low susceptibility** to groundwater conditions falling outside the baseline range.

Similar to the baseline data, shallow groundwater elevations in the future will likely be tied to flow releases from Friant Dam. Changes to the operations of Friant Dam therefore have the potential to alter shallow groundwater levels in this GDE. In particular, the continuation of SJRRP restoration flow releases is likely to help maintain shallow groundwater levels in the aquifer associated with the GDE.

3.5.2 Biological data

Average summer NDVI and NDMI for the period 1985–2018 indicate small fluctuations and a small overall increase in both indices in the San Joaquin River Riparian Potential GDE Unit (Figures A2.B-22 and A2.B-23). NDVI for individual, mapped polygons ranges from approximately 0.20 to 0.70, and mean NDVI for all polygons was lowest in 1989 (0.36) and highest in 2014 (0.51) (Figure A2.B-22). Mean NDVI between 1985 and 2018 showed a negligible increase (0.09). NDMI for individual, mapped polygons shows a similar trend to NDVI but with values ranging from -0.15 to 0.40 (Figure A2.B-23). Mean NDMI for all polygons was lowest in 1990 (0.04), and highest in 1998 (0.12). Like NDVI, mean NDMI also showed a negligible increase (0.04) between 1985 and 2018.

Prior to 2011, variations in the summer NDVI of the San Joaquin River Riparian GDE were coupled to the SJVI, with small increases during wetter water years and small decreases during drier water years (**Error! Reference source not found.**). Large increases in NDVI starting in 2010 were sustained through the dryer years from 2012–2016, with a slight decrease in 2017 and 2018, a pattern that is decoupled from the SJVI. NDMI was also coupled to SJVI prior to 2009, with decreases in NDMI associated with SJVI decreases (Figure A2.B-23). Following 2009, there has been a steady but small increase in NDMI that does not reflect the dryer water years from 2012–2016 shown by the large reduction in SJVI.

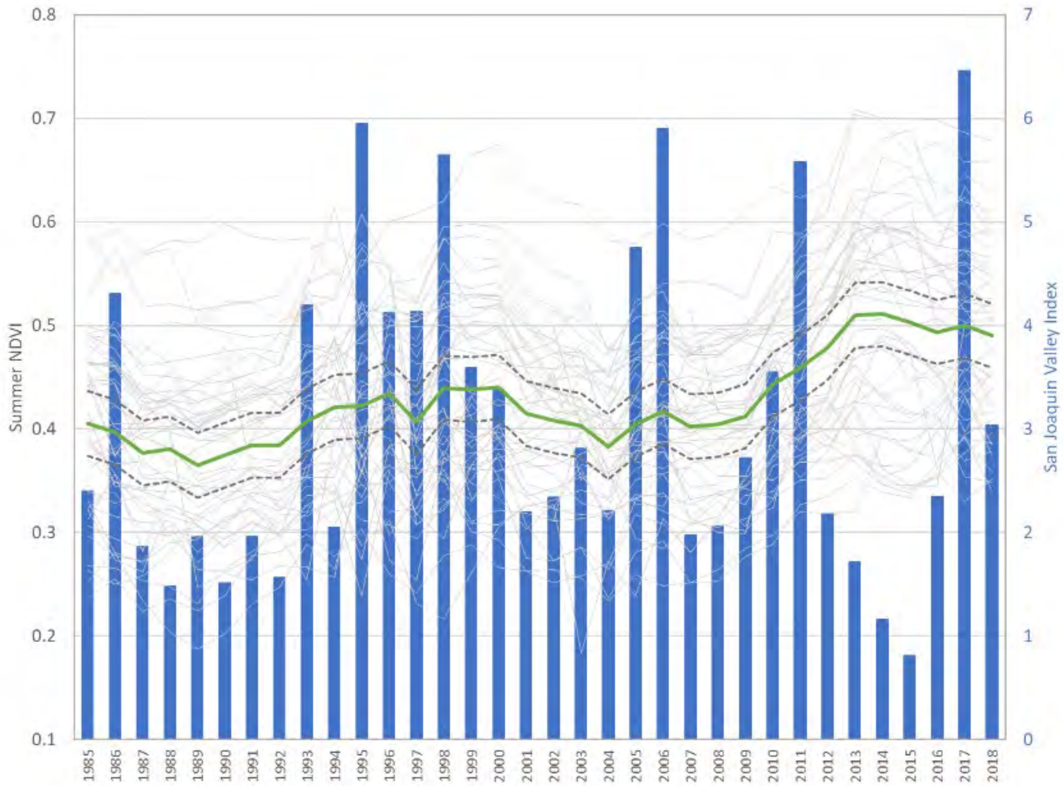

Figure A2.B-22. Summer NDVI from 1985–2018 for all GDE polygons composing the San Joaquin River Riparian Potential GDE Unit (light grey lines). The green line represents the mean NDVI for all GDE polygons within the San Joaquin River Riparian Potential GDE Unit and gray dashed lines are 95% confidence intervals around the mean. Blue bars represent the San Joaquin Valley Index for each water year.

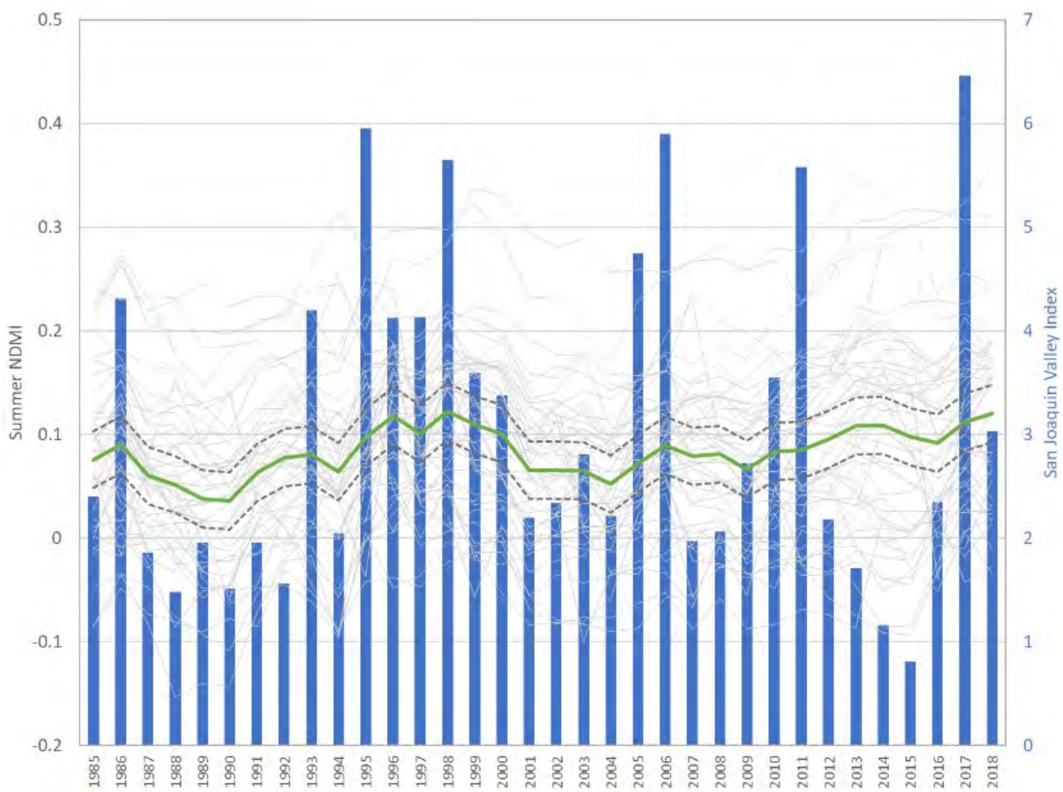

Figure A2.B-23. Summer NDMI from 1985–2018 for all GDE polygons composing the San Joaquin River Riparian Potential GDE Unit (light grey lines). The green line represents the mean NDMI for all GDE polygons within the San Joaquin River Riparian Potential GDE Unit and gray dashed lines are 95% confidence intervals around the mean. Blue bars represent the San Joaquin Valley Index for each water year.

Annual precipitation was not a statistically significant predictor variable of mean NDVI ($p = 0.91$), and explained little, if any, of the variation in NDVI ($R^2 = <0.001$). Likewise, annual precipitation was not a statistically significant predictor variable of mean NDMI ($p = 0.13$), and showed little explanatory power of the variation in NDMI ($R^2 = 0.07$) Together, these results suggest that shallow groundwater conditions likely have a greater influence on the health of groundwater dependent vegetation within the San Joaquin River Riparian Potential GDE Unit than does local, annual precipitation and that, until 2009, vegetation health was correlated with runoff and streamflows in the San Joaquin Basin.

A reconnaissance field assessment of the San Joaquin River Riparian Potential GDE Unit documented little evidence of recent riparian tree recruitment in portions of the unit visited. Some riparian vegetation observed in the unit appeared very healthy, with dense, green canopies at multiple layers with evidence of recent growth, but other areas showed less healthy riparian vegetation. Analysis of recent satellite imagery corroborates these field observations.

3.5.3 Potential effects

Reconnaissance level biological assessments, aerial photograph analysis, and NDVI/NDMI data indicate that some areas of the GDE unit exhibit signs of proper functioning and healthy riparian vegetation communities, while other areas may be experiencing adverse impacts. However, available evidence (i.e., observed and modeled shallow groundwater depths from nearby wells) suggests that adverse impacts are unlikely to be related to recent or current groundwater management. Groundwater in the San Joaquin River Riparian Potential GDE Unit appears tightly coupled with surface flow in the San Joaquin River and is generally maintained at depths within the rooting depth range of riparian species present in the unit. Modeling of shallow groundwater at all three representative wells in the GDE unit suggests no expected changes in mean groundwater levels compared with the baseline period, and no exceedances of historical low groundwater levels. In the Madera Subbasin, the San Joaquin River flows adjacent to the San Joaquin River Riparian Potential GDE Unit and is in a net-losing condition, with surface flow likely contributing directly to the shallow groundwater system that supports the vegetation in the unit. Although evidence of recent riparian tree recruitment and high-density, healthy vegetation at multiple layers is lacking within some areas of the San Joaquin River Riparian Potential GDE Unit, values and trends in NDVI/NDMI for the unit as a whole appear to mask this disparity in vegetation condition among sites.

Despite no apparent decline in NDVI or NDMI in the San Joaquin River Riparian Potential GDE Unit since 1985, current riparian vegetation condition indicates adverse impacts have likely been occurring within portions of the GDE unit. Potential causes of localized degradation of riparian vegetation health could include curtailed SJRRP flow releases in the San Joaquin River during the recent drought (and variable spatial response by shallow groundwater beneath the GDE unit), or locally degraded groundwater quality. However, evidence is insufficient to indicate which, if any, of these factors may be influencing riparian vegetation in the unit. Rohde et al. (2018) list reduced tree canopy and understory, shifts in vegetation type, tree mortality, and habitat fragmentation as indicators of adverse impacts, which were detected within the GDE unit and recommend assessing baseline conditions of at least 10 years. However, because the NDVI/NDMI assessment was confined to the GDEs mostly mapped in 2014, our analysis does not account for potential reduction in the extent of riparian vegetation (and hence a reduction in the area of the polygons) prior to the vegetation mapping.

The response of perennial, resident wildlife and vegetation species to groundwater levels and groundwater quality in the San Joaquin River Riparian Potential GDE Unit is not well understood because population dynamics during the baseline period are not known. Many of these species survived the droughts in the early 1990s and the mid-2010s, but the effects on the species and their susceptibility to future changes are unknown. Appropriate data for evaluating these relationships is not readily available but, if obtained, could provide insight to additional interactions between groundwater conditions and biological responses, leading to a more complete evaluation of potential adverse impacts including the possibility that factors unrelated to groundwater management are causing impacts to the GDE unit. Recommendations for monitoring to provide additional data for this purpose are included in Section 5.

3.6 Sumner Hill Potential GDE Unit

3.6.1 Hydrologic data

3.6.1.1 Baseline conditions

Because data from shallow groundwater wells are not available for the Sumner Hill Potential GDE Unit it was not possible to define the baseline conditions for the unit. Given the likely occurrence of shallow bedrock beneath this GDE unit it is likely that groundwater depths are linked to local precipitation and leakage from the Madera Canal.

Groundwater quality data is available for one well in the vicinity of the Sumner Hill Potential GDE Unit (see Chapter 2.2.2.3 of this GSP). Maximum total dissolved solids concentration in the shallow groundwater of the GDE unit is < 250 mg/L. Other constituents fall below applicable thresholds for environmental protection and human health at the single well near the GDE unit.

3.6.1.2 Susceptibility to potential effects

Due to the shallow bedrock and lack of local wells, it is unlikely that groundwater in the Sumner Hill Potential GDE Unit is currently being affected by groundwater pumping or would be affected in the future. The hydrogeology in the vicinity of this GDE unit limits the potential that groundwater pumping elsewhere in the Madera Subbasin would affect the shallow groundwater associated with the unit.

It is unlikely that the shallow groundwater conditions associated with the Sumner Hill Potential GDE Unit will change in the future due to groundwater pumping in the regional aquifer. However, changes to local precipitation or changes in leakage from the Madera Canal may alter the groundwater condition to some degree. The magnitude of these potential impacts is unknown, and monitoring the health of the GDE may be the best way to assess future impacts. Due to the disconnection from the regional aquifer and the lack of pumping near the GDE, the Sumner Hill Potential GDE Unit was determined to have **low susceptibility** to groundwater conditions falling outside the baseline range.

3.6.2 Biological data

Average summer NDVI and NDMI for the period 1985–2018 indicate modest fluctuations and a small increase in both indices in the Sumner Hill Potential GDE Unit (Figures A2.B-24 and A2.B-25). NDVI for individual, mapped polygons ranges from approximately 0.20 to 0.60, and mean NDVI for all polygons was lowest in 1985 (0.30) and highest in 2013 (0.45) (Figure A2.B-24). Mean NDVI between 1985 and 2018 showed a negligible increase (0.09). NDMI for individual, mapped polygons shows a similar trend to NDVI but with values ranging from -0.30 to 0.25 (Figure A2.B-25). Mean NDMI for all polygons was lowest in 1990 (-0.09), and highest in 2017 (0.08). Similar to NDVI, mean NDMI showed a small increase (0.1) between 1985 and 2018.

Prior to 2011, variations in the summer NDVI of the Sumner Hill Potential GDE Unit were coupled to the SJVI, with small increases during wetter water years and small decreases during drier water years. Large increases in NDVI starting in 2010 or 2011 were sustained through the dryer years from 2012–2016, with a slight decrease in 2017 and 2018, and these trends were decoupled from the SJVI. NDMI was also coupled to SJVI prior to 2009, with decreases in NDMI associated with SJVI decreases. After 2009, however, there has been a steady but small increase in NDMI that was largely decoupled from the SJVI values during the dryer water years from 2012–2016. The reasons for the steady NDVI and NDMI levels during the 2012–2016 drought are not known, but are also observed in the San Joaquin River Riparian and Friant Riparian GDE units. Because the Sumner Hill Potential GDE Unit does not extend into the Sierras and is not associated with a major river or stream, we would expect the unit to be less strongly influenced by the regional SJVI than riparian GDEs along the San Joaquin River.

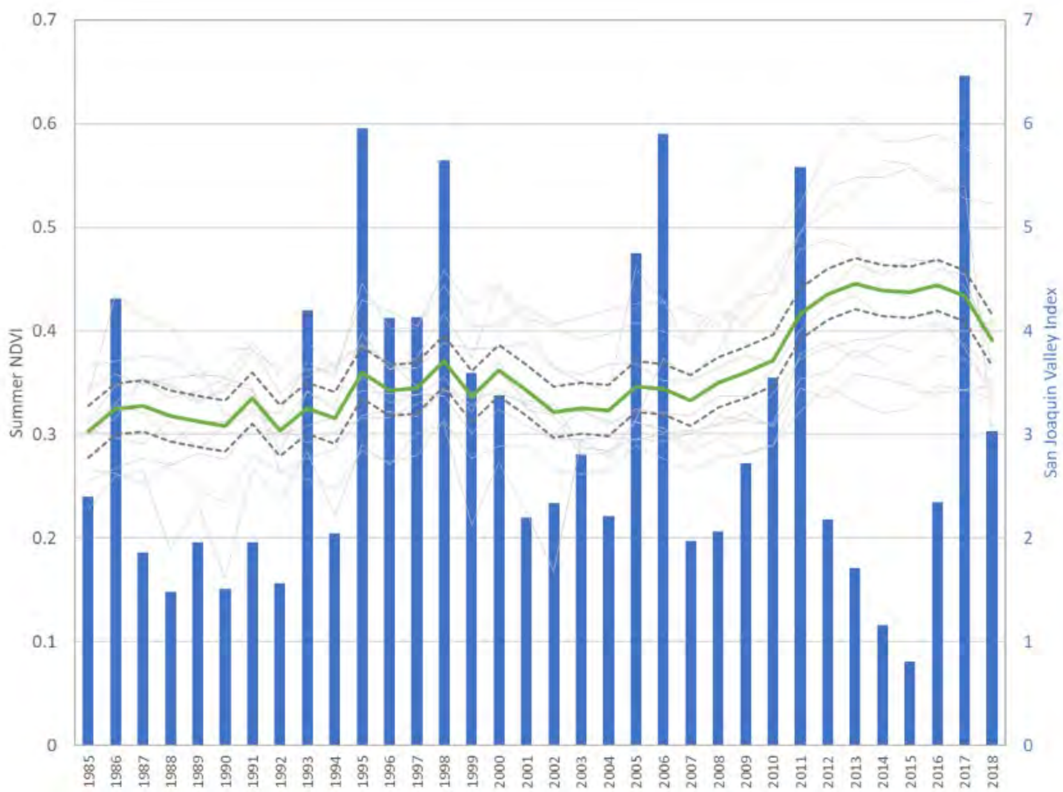

Figure A2.B-24. Summer NDVI from 1985–2018 for all GDE polygons composing the Sumner Hill Potential GDE Unit (light grey lines). The green line represents the mean NDVI for all GDE polygons within the Sumner Hill Potential GDE Unit and gray dashed lines are 95% confidence intervals around the mean. Blue bars represent the San Joaquin Valley Index for each water year.

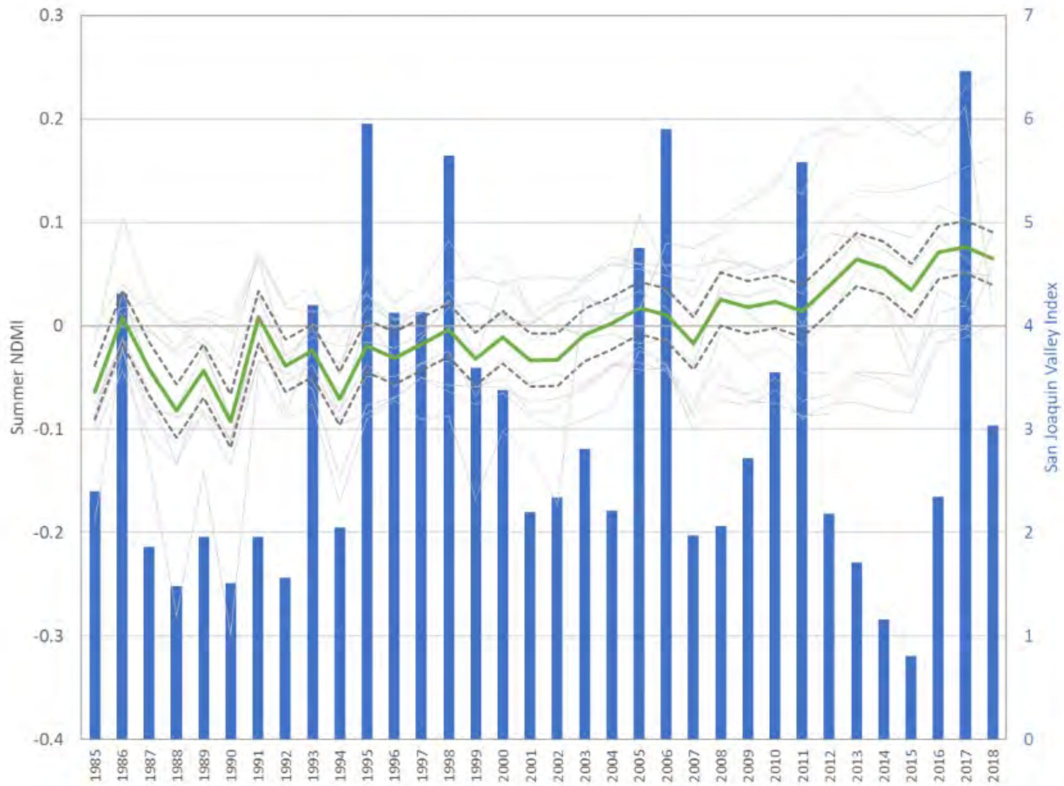

Figure A2.B-25. Summer NDMI from 1985–2018 for all GDE polygons composing the Sumner Hill Potential GDE Unit (light grey lines). The green line represents the mean NDMI for all GDE polygons within the Sumner Hill Potential GDE Unit and gray dashed lines are 95% confidence intervals around the mean. Blue bars represent the San Joaquin Valley Index for each water year.

Annual precipitation was not a statistically significant predictor variable of mean NDVI ($p = 0.53$), and explained little, if any, of the variation in NDVI ($R^2 = 0.012$). Annual precipitation was also not a statistically significant predictor variable of mean NDMI ($p = 0.45$), and showed little explanatory power of the variation in NDMI ($R^2 = 0.0117$). Together, these results suggest that groundwater conditions, or surface water supplies originating from a source other than precipitation and runoff (i.e., the Madera Canal), likely have a greater influence on the health of groundwater dependent vegetation within the Sumner Hill GDE Potential Unit than does local, annual precipitation.

A reconnaissance field assessment of the Sumner Hill Potential GDE Unit in May 2019 did not document presence of recent riparian tree recruitment within the GDE unit, but the mature riparian trees and shrubs observed at the site appeared healthy and vigorous. Analysis of recent satellite imagery corroborates these field observations.

3.6.3 Potential effects

Reconnaissance level biological assessments, aerial photograph analysis, and NDVI/NDMI data indicate adverse impacts are not likely occurring in the Sumner Hill Potential GDE Unit. Groundwater in the Sumner Hill Potential GDE unit is apparently very shallow and unlikely to be affected by pumping in the regional aquifer. The high-density, healthy vegetation at multiple layers in the unit suggests that current and recent historical groundwater levels are sufficient to maintain ecosystem functions essential for the survival and reproduction of riparian plant species and maintenance of wetland habitat. In addition, trends in NDVI/NDMI show little to no change in overall vegetation health within the unit and no apparent response to periods of drought in the San Joaquin Basin (e.g., 2012–2016) or recent years with wetter conditions (2017 and 2018). Rohde et al. (2018) list reduced tree canopy and understory, shifts in vegetation type, tree mortality, and habitat fragmentation as indicators of adverse impacts, none of which were detected within the GDE unit, and recommend assessing baseline conditions of at least 10 years. However, because the NDVI/NDMI assessment was confined to the GDEs mostly mapped in 2014, our analysis does not account for potential reduction in the extent of riparian vegetation (and hence a reduction in the area of the polygons) prior to the vegetation mapping.

Based on the recent historical conditions and trends, it appears the dominant vegetation and wetland habitat composing the Sumner Hill Potential GDE Unit is sufficiently resilient to maintain ecosystem integrity and function in the face of predicted climate fluctuations and associated increases in drought frequency and magnitude. Based on the limited evidence available, it is unlikely that groundwater pumping is affecting or would affect this GDE unit.

Vegetation condition and NDVI/NDMI trends within the GDE unit also indicate groundwater quality is not limiting ecosystem functions essential for the survival and reproduction of riparian and wetland species. Rohde et al. (2018) list declining NDVI/NDMI, reduced tree canopy and understory, shifts in vegetation type, tree mortality, and habitat fragmentation as indicators of adverse impacts that can result from degraded water quality, but none of these was detected within the GDE unit.

The response of perennial, resident wildlife and vegetation species to groundwater levels and groundwater quality in the Sumner Hill Potential GDE Unit is not well understood because of the paucity of groundwater wells and because population dynamics during the baseline period are not known. Many of these species survived the droughts in the early 1990s and the mid-2010s, but the effects on the species and their susceptibility to future changes are unknown. Appropriate data for evaluating these relationships is not readily available but, if obtained, could provide insight to additional interactions between groundwater conditions and biological responses, leading to a more complete evaluation of conditions and trends in this GDE unit. Recommendations for monitoring to provide additional data for this purpose are included in Section 5.

4 SUSTAINABLE MANAGEMENT CRITERIA

Sustainable management criteria for the Madera Subbasin were developed using information from stakeholder and public input, correspondence with the GSAs, public meetings, hydrogeologic analysis, and meetings with GSA technical representatives. The sustainable management criteria and methods used to establish them are described in Chapter 3 of this GSP.

4.1 Sustainability Goals

The sustainability goal developed for the Madera GSP is expected to maintain the ecological integrity and function of the San Joaquin River Riparian GDE Unit. This includes maintenance of riparian habitat conditions for special-status species and other native species in the unit or those likely to occur, and provision of important ecosystem support functions for native aquatic species in the adjacent San Joaquin River. The GSP's sustainability goal would be achieved by implementing a package of projects and management actions that will, by 2040, balance long-term groundwater system inflows with outflows based on a 50-year period representative of average historical hydrologic conditions. The GSP's sustainability goal is unlikely to affect the hydrological or ecological conditions of the other GDE units in the Madera subbasin, as these GDE units are not expected to be affected by groundwater management under the GSP.

4.2 Minimum Thresholds for Sustainability Indicators

Minimum thresholds for the applicable sustainability indicators are described in Section 3.3 of this GSP. The minimum thresholds for chronic lowering of groundwater levels, the sustainability indicator most likely to affect GDEs in the subbasin, are based on selection of representative monitoring sites from among existing production and monitoring wells located throughout the subbasin and screened in both the Upper and Lower Aquifers. The representative monitoring sites for the subbasin include the four wells described herein that represent shallow groundwater conditions associated with the GDE units in the subbasin. Therefore, minimum thresholds have been established that are applicable to GDEs. Model results for wells representing the Fresno River Riparian GDE Unit and the San Joaquin River Riparian GDE Unit indicate that shallow groundwater levels during the GSP implementation and sustainability periods will be maintained at levels consistent with the historical range of depth to groundwater. In addition, restoration flows in the San Joaquin River under the SJRRP are expected to provide continued hydrologic inputs contributing to long-term support of the Friant Riparian Potential GDE Unit and the San Joaquin River Riparian Potential GDE Unit.

Based on this information, the vegetation communities composing the GDE units in the subbasin are expected to be largely unaffected by sustainable groundwater management in the Madera Subbasin and thus the minimum thresholds are not expected to cause adverse impacts to GDEs.

4.3 Objectives and Interim Milestones

Measurable objectives and interim milestones for the applicable sustainability indicators are described in Section 3.3 of this GSP. Measurable objectives and interim milestones for groundwater levels, the sustainability indicator most likely to affect GDEs in the subbasin, have been established for the four wells described herein that are considered to represent the shallow groundwater conditions associated with the GDE units in the subbasin.

5 GDE MONITORING

Data on San Joaquin River riparian forest condition and extent, as well as surface water and shallow groundwater hydrology of the San Joaquin River, are among the types of information that have been collected, analyzed, and reported under the auspices of the SJRRP. The SJRRP is currently monitoring shallow groundwater in several wells along the San Joaquin River in the Madera Subbasin. However, the ecological characteristics and hydrologic dependencies of the San Joaquin River Riparian GDE Unit and the other GDE units in the subbasin are not currently the subject of regular, systematic monitoring as part of any known program. Actions to improve the existing monitoring network may be warranted so that GDE conditions can be thoroughly documented and impacts to GDEs can be detected. Biological data should be collected with sufficient spatial and temporal coverage to adequately characterize the reliance of GDEs on groundwater and, together with evaluation of associated hydrologic data, to monitor the response of GDEs to groundwater management, including projects and management actions proposed to be implemented under this GSP (Section 6).

The Fresno River Riparian and Friant Riparian potential GDE units have high ecological value and low susceptibility to changing groundwater conditions. The Sumner Hill Potential GDE Unit also has high ecological value but its susceptibility to changing shallow groundwater conditions cannot be determined based on a lack of shallow groundwater data. None of these GDE units shows evidence of adverse impacts and the likelihood of future impacts related to groundwater management is low. The San Joaquin River Riparian Potential GDE Unit has moderate ecological value with low susceptibility to changing groundwater conditions, but currently exhibits evidence of some adverse impacts. The cause of these impacts cannot be determined using available data. To improve the understanding of relationships between groundwater management and potential ecological effects, the following types of monitoring recommended by Rohde et al. (2018) should be considered in all four GDE units in the Madera Subbasin:

- Annual desktop monitoring using simple biological indicators such as remote sensing indexes (NDVDaviI/NDMI) and aerial photograph analysis to monitor changes in vegetation condition, growth, and the spatial extent of the GDE.
- Biological surveys (e.g., vegetation transects) conducted at regular intervals (minimum every 5 years or more frequently if needed based on the desktop surveys or biological surveys that indicate the GDE condition or extent has declined) to document baseline biological conditions and changes corresponding to GSP implementation and groundwater management.

Biological monitoring data should be evaluated as part of an adaptive management framework to facilitate improvements in the monitoring program and refinement of projects and management actions or implementation of new actions to avoid adverse impacts to GDEs.

6 PROJECTS AND MANAGEMENT ACTIONS

Implementation of the GSP will require the Madera Subbasin to be operated within its sustainable yield by 2040. To ensure the subbasin meets its sustainability goal by 2040, the GSAs have proposed projects and management actions to address undesirable results (see Chapter 4 of this GSP). To achieve this, GSAs may implement projects to increase groundwater recharge, reduce groundwater pumping, or both.

Because no undesirable results were identified for the GDE units in the subbasin under baseline, existing, or projected future with-project conditions, no GDE-specific projects or management actions were developed for this GSP. Effects on GDEs resulting from increased groundwater recharge and reduced groundwater pumping are expected to be beneficial, as groundwater levels accessed by vegetation in the Fresno River Riparian Potential GDE Unit and the San Joaquin River Riparian Potential GDE Unit are expected to remain relatively similar to historical and recent baseline conditions, thus maintaining an accessible and reliable water source. Increased groundwater recharge and reduced groundwater pumping are not expected to affect the Friant Riparian Potential GDE Unit or the Sumner Hill Potential GDE Unit.

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APPENDIX 2.C. NOTICE AND COMMUNICATION

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

GSP Team:

Davids Engineering, Inc
Luhdorff & Scalmanini
ERA Economics
Stillwater Sciences and
California State University, Sacramento

2.C. Notice and Communication

APPENDIX 2.C. NOTICE AND COMMUNICATION

2.C.a. Madera Subbasin Stakeholders Communication and Engagement Plan

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

GSP Team:

Davids Engineering, Inc
Luhdorff & Scalmanini
ERA Economics
Stillwater Sciences and
California State University, Sacramento

Madera Subbasin

Stakeholder Communication and Engagement Plan

June 2018 (updated October 2018)

NOTE: In order to ensure an adaptive, responsive approach to stakeholder outreach and engagement, it is intended that the components of this plan be developed in collaboration with the Madera Subbasin stakeholders, beginning with the GSA managers, board members, and staff. This process has already begun, and this version incorporates the results of that collaboration to date. The plan will be updated as the collaborative process continues.

Prepared by the California State University of Sacramento (CSUS)

Contents

Madera Subbasin Stakeholder Communication and Engagement Plan
June 2018

Purpose

The purpose of this Stakeholder Communication and Engagement Plan is to assist Madera Subbasin Groundwater Sustainability Agencies (GSAs) in their efforts to develop general and strategic communications to engage stakeholders in groundwater management activities.

Overview and Background

California's Sustainable Groundwater Management Act (SGMA) of 2014 requires broad and diverse stakeholder involvement in GSA activities and the development and implementation of Groundwater Sustainability Plans (GSPs) for 127 groundwater basins around the state, including the Madera Subbasin. The intent of SGMA is to ensure successful, sustainable management of groundwater resources at the local level. Success will require cooperation by all stakeholders, and cooperation is far more likely if stakeholders have consistent messaging of valid information and are provided with opportunities to help shape the path forward.

To that end, the intention of the Communication and Engagement Plan is to:

- Provide GSAs, community leaders, and other beneficial users a roadmap to follow to ensure consistent messaging of SGMA requirements and related Madera Subbasin information and data.
- Provide a roadmap to GSAs and community leaders to ensure stakeholders have meaningful input into GSA decision-making, including GSP development.
- Ensure the roadmap demonstrates a process that is widely seen by stakeholders as fair and respectful to the range of interested parties.
- Make transparent to stakeholders their opportunities to contribute to the development of a GSP that can effectively address groundwater management within the Madera Subbasin.
- Ensure that information reaches all beneficial users who have an interest in the Basin.

Communication Plan Goals

The plan seeks to accomplish the following goals:

1. Educate stakeholders about:
    A. SGMA and its requirements,
    B. Individual GSAs within the Madera Subbasin,
    C. Potential changes to current groundwater management under SGMA, and
    D. How stakeholders will be represented in their GSAs.
2. Communicate important SGMA deadlines and dates.
3. Coordinate outreach and engagement activities between GSAs to ensure efficiency and to support stakeholders in GSP development.
4. Articulate strategies and channels for obtaining ongoing stakeholder input and feedback to inform GSP design and development.
5. Provide a roadmap to GSAs on ways to effectively and efficiently reach ALL elements of the population.
6. Encourage stakeholder engagement (e.g., by establishing dedicated SGMA outreach strategies and channels, communicating information about meeting and workshop dates and content, and highlighting all opportunities for stakeholders to provide input in the GSA decision-making process and GSP planning process).

Major Audiences

A Madera Subbasin stakeholder is a "beneficial user" as described by SGMA. Under the requirements of SGMA, all beneficial uses and users of groundwater must be considered in the development of GSPs, and GSAs must encourage the active involvement of diverse social, cultural, and economic elements of the population. Beneficial users, therefore, are any stakeholders who have an interest in groundwater use and management in the Madera Subbasin community. Their interest may be related to GSA activities, GSP development and implementation, and/or water access and management in general.

To assist in determining who the specific SGMA stakeholders and beneficial users are, DWR has created a Stakeholder Engagement Chart for GSP development in their 2017 *GSP Stakeholder Communication and Engagement Guidance Document*. The following table (Table A2.C.a-1) is based on the DWR chart, modified to fit the circumstances and stakeholders of the Madera Subbasin. It can continue to be updated during the GSP planning process.

Table A2.C.a-1. Stakeholder Engagement Chart for GSP Development

Category of Interest	Examples of Stakeholder Groups [1]	Engagement purpose
General Public	• Citizens groups • Community leaders	Inform to improve public awareness of sustainable groundwater management
Land Use	• Municipalities (City, County planning departments) • Regional land use agencies	Consult and involve to ensure land use policies are supporting GSPs
Private Users	• Private pumpers (domestic and agricultural) • Domestic users • Schools and colleges • Hospitals	Inform and involve in assessing impacts to users
Urban/ Agricultural Users	• Water agencies • Irrigation districts • Municipal water companies • Resource conservation districts • Farmers/Farm bureaus	Collaborate to ensure sustainable management of groundwater
Industrial Users	• Commercial and industrial self-supplier • Local trade association or group	Inform and involve in assessing impacts to users
Environmental and Ecosystem Uses	• Federal and State agencies: CA Dept. of Fish and Wildlife • Environmental groups	Inform and involve to consider/incorporate potential ecosystem impacts to GSP process
Economic Development	• Chambers of commerce • Business groups/associations • Elected officials (Board of Supervisors, City Council) • State Assembly members • State Senators	Inform and involve to support a stable economy
Human Right to Water	• Disadvantaged communities: Fairmead Community and Friends, La Vina Residents, Líderes Campesinas, etc. • Small water systems • Environmental justice groups/community-based organizations: Leadership Council for Justice and Accountability, Self-Help	Inform and involve to provide safe and secure groundwater supplies to all communities reliant on groundwater

[1] The groups and communities referenced are examples identified during initial assessment. GSA Interested Parties lists shall maintain current and more exhaustive lists of stakeholders fitting into these groups.

Category of Interest	Examples of Stakeholder Groups [1]	Engagement purpose
	Enterprises, Community Water Center, etc.	
Tribes	Federally Recognized Tribes and non-Federally Recognized Tribes with lands or potential interests in Madera Subbasin: • Northfork Rancheria of Mono Indians of California • Picayune Rancheria of Chuckchansi Indians • Northfork Band of Mono Indians • Chaushilha Yokuts • Big Sandy Rancheria of Mono Indians of California • Cold Springs Rancheria of Mono Indians of California • Table Mountain Rancheria of California • Tule River Indian Tribe of the Tule River Reservation	Inform, involve and consult with tribal government
Federal Lands	• Bureau of Reclamation (USBR) • Bureau of Land Management	Inform, involve and collaborate to ensure basin sustainability
Integrated Water Management	• Regional water management groups (IRWM regions) • Flood agencies • Recycled water coalition	Inform, involve and collaborate to improve regional sustainability

Key Messages

As GSAs begin the process of reaching out to stakeholders to inform and engage them in groundwater management issues and items, it is critical that GSAs share clear and consistent key messages to avoid confusion and misunderstanding. Key messages are as follows:

1. Seven GSAs have formed to ensure local control of groundwater management in the Madera Subbasin:
    - Madera County GSA
    - City of Madera GSA
    - Madera Irrigation District GSA
    - Root Creek Water District GSA
    - Madera Water District GSA

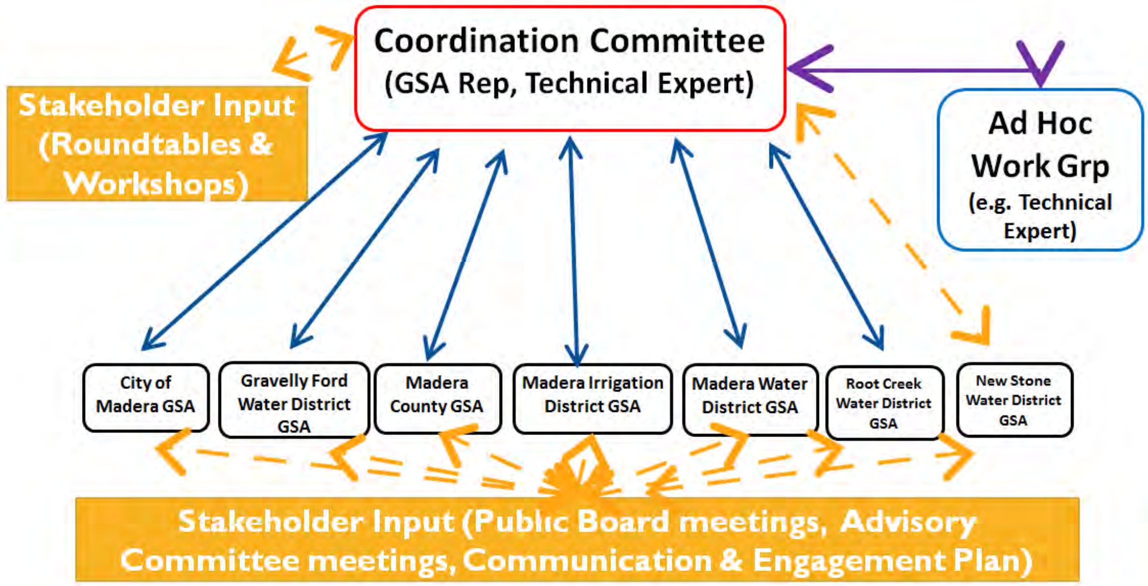
- Gravelly Ford Water District GSA, and
- New Stone Water District GSA

2. Management elements include GSP decision-making, funding, implementation and enforcement.
3. GSAs are committed to proactively and sustainably managing groundwater in the Subbasin.
4. The GSP will manage water usage and impact on diverse groups of beneficial users, including, without limitation, disadvantaged communities, agricultural users, residential users, and environmental water uses.
5. GSAs shall ensure compliance with SGMA to prevent state intervention.
6. GSAs seek to coordinate efforts in managing their respective portions of the Subbasin to achieve compliance with SGMA.
7. Six of the GSAs—Madera County GSA, City of Madera GSA, Madera Irrigation District GSA, Root Creek Water District GSA, Madera Water District GSA, and Gravelly Ford Water District GSA (hereinafter collectively referred to as Coordinating GSAs)—intend to develop a single GSP. New Stone Water District will develop a separate GSP.
8. The Coordinating GSAs and New Stone Water District will enter into a coordination agreement to implement these GSPs.
9. The GSAs are committed to proactive and transparent outreach and engagement with stakeholders and Subbasin community members during the GSP planning process, implementation, and beyond.

Decision-Making

The Madera Subbasin Coordinating GSAs shall be the primary decision-making bodies for the Madera Subbasin. These GSAs shall coordinate and develop recommendations for GSA decision-making through a Coordination Committee. GSAs and their staff representatives will engage with Subbasin stakeholders through the strategies outlined in this plan to help inform the GSAs' decisions, including public participation stakeholder roundtables, GSP workshops, and public comment during Coordination Committee meetings and GSA Board meetings. While the Coordination Committee provides recommendations on GSP development, the GSA Boards shall serve as the final decision-makers for the Madera Subbasin. The following schematic (Figure A2.C.a-1) demonstrates the processes and opportunities for input that are intended to guide decision-making and stakeholder engagement in the Madera Subbasin.

Figure A2.C.a-1. Opportunities for Stakeholder input re: GSA Decision-Making



Recommended Communication Strategies and Mechanisms

This Communication and Engagement Plan is designed to meet the needs of the Subbasin as a whole. To maximize efficiency and support consistent messaging, it is appropriate that some outreach activities be conducted on a basin-wide level. However, it is also important to recognize that under SGMA each GSA has its own responsibility for engagement of the beneficial users within its boundaries.

To support the Subbasin as a whole, the GSP technical team will be responsible for basin-wide outreach planning and implementation. Examples include maintenance of a basin-wide Interested Parties list, emailed announcements of Technical Workshops and Roundtable meetings, and creation of meeting summaries for those meetings.

In addition, individual GSA representatives and staff will need to engage with their own stakeholders and will be responsible for tracking the needs of their local communities. GSAs will consider stakeholder input gathered from outreach efforts as they move through GSP development and implementation processes. Three sets of strategies are important to consider when planning outreach and engagement activities, included in the following categories:

1. SGMA-required: the law requires GSAs to undertake specific types of outreach and engagement activities.
2. Essential strategies centrally communicated at the Subbasin and GSA service area level: activities proven to successfully engage stakeholders.
3. Secondary strategies locally communicated at the GSA service area and beneficial user level: activities that will enhance engagement efforts on a local and as-needed basis. These strategies are recommended for engaging specific stakeholder groups.

SGMA-Required Strategies

SGMA strongly encourages broad stakeholder engagement in development and implementation of GSPs. According to SGMA:

- "The groundwater sustainability agency shall encourage the active involvement of diverse social, cultural, and economic elements of the population within the groundwater basin prior to and during the development and implementation of the groundwater sustainability plan." [CA Water Code Sec. 10727.8(a)]
- "The groundwater sustainability agency shall consider the interests of all beneficial uses and users of groundwater." [CA Water Code Sec. 10723.2]

GSAs are given broad discretion in the methods and processes utilized to meet engagement requirements, but the methods are required to "successfully" engage all stakeholders, including elements of the population that are hard to reach. SGMA explicitly authorizes GSAs to form Public Advisory Committees if they choose, but does not require them to do so. The decision to form an advisory committee is left to the individual GSA based on the need and effectiveness of these processes within their communities. However, SGMA does have several GSA-specific requirements regarding public notice, public hearings, and public meetings. <u>Requirements include:</u>

1. Within 30 days of electing to be (or forming) a GSA, the GSA must inform the State of this development and its intent to manage groundwater sustainably. In doing so, the GSA must:

    A. Include a list of parties who wish to receive "plan preparation, meeting announcements, and availability of draft plans, maps, and other relevant documents," and

    B. Explain how the interested parties' perspectives will be considered, both during the development and operation of the GSA and during development and implementation of the GSP. This information must also be sent to the legislative bodies of any city and county in the area covered by the plan.

    Illuminating the term "interested parties," SGMA requires that GSAs consider the interests of "all beneficial uses and users of groundwater," along with entities expected to share responsibilities for implementing GSPs. As a starting point, SGMA specifies a number of types of "interested parties." The GSA must maintain its list of interested parties on an ongoing basis. Anyone who wishes to be put on this list can do so upon making this request in writing. [CA Water Code Section 10730. (b) (2); 10723.2; 10723.4; and 10723.8. (a)]

2. GSAs planning to develop a GSP must provide notice of their intent to do so to the public and the state before proceeding. The notice must describe opportunities for interested parties to participate in the development and implementation of the GSP. This written notice must be provided to the legislative bodies of any city or county located within the basin to be managed by the GSP. [CA Water Code Section 10727.8. (a)]

Phase 1: 2015–2017

Phase 1 Engagement Requirements

- **Establish and Maintain List of Interested Parties** §10723.4
- **GSA Formation Public Notice** §10723(b)
- **GSA Formation Public Hearing** §10723(b)
- **GSA Formation (due 6/30/17)** §10723(b)
  Notify DWR:
  - Include list of interested parties
  - Explain how parties' interests will be considered
- **Pre-GSP Development** §10727.8
  Provide a written statement describing how interested parties may participate to:
  - DWR
  - Cities within the GSA boundary
  - Counties within the GSA boundary

Phase 2: 2017–2022

Phase 2 Engagement Requirements

- **GSP Initial Notification** §353.6*
- **GSP Preparation** §10727.8 and §10723.2
  - Encourage active involvement
  - Consider beneficial uses and users of groundwater when describing *Undesirable Results, Minimum Thresholds, and Projects & Actions*
- **GSP Communications Section** §354.10*
  - GSA decision-making process
  - Opportunities for engagement and how public input is used
  - How GSA encourages active involvement
  - Method of informing the public
- **Public Notice of Proposed Adoption** §10728.4
- **GSP Adoption Public Hearing** §10728.4
- **GSP Submittal** §354.10*
  - Include a summary of communications: description of beneficial uses/users, list of public meetings, comments received/responses

3. A GSA seeking to adopt or amend a GSP must provide notice to cities and counties within the area encompassed by the proposed plan or amendment, and consider comments provided by the cities and counties. Cities and counties receiving the notice may request consultation with the GSA, in which case the GSA must accommodate that request within 30 days. The GSA also must hold a public hearing prior to adopting or amending a GSP. There must be at least 90 days between the notice issued to cities and counties and the public hearing. [CA Water Code Section 10728.4]
4. If a GSA intends to impose or increase a fee, it must first hold at least one public meeting, at which attendees may make oral or written comments. See below for requirements for public notice of the meeting:
    a. Information about the time and place of the meeting and a general explanation of the topic to be discussed.
    b. Public notice must be posted on the GSA's website and mailed to any interested party who submits a written request for mailed notice of meetings on new or increased fees. (The GSA must establish and maintain a list of interested parties, and the list is subject to renewal by April 1 of each year.)
    c. The public notice must also be consistent with Section 6066 of the Government Code.
    d. In addition, the GSA must share with the public the data upon which the proposed fee is based, and this must be done at least ten days before the public meeting takes place. [CA Water Code Section 10730.(b)(1),(2), and (3). (Note: Additional processes are required under Proposition 218 and 26

related to taxes; these processes are not currently referenced in this communication plan but shall be incorporated as relevant.)

Phase 3: 2018+

Phase 3 Engagement Requirements

- **60 Day Comment Period** §353.8*
  - Any person may provide comments to DWR regarding a proposed or adopted GSP via the SGMA Portal at http://sgma.water.ca.gov/portal/
  - Comments will be posted to DWR's website

Phase 4: 2022+

Phase 4 Engagement Requirements

- **Public Notices and Meetings** §10730
  - Before amending a GSP
  - Prior to imposing or increasing a fee
- **Encourage Active Involvement** §10727.8

Engagement Requirements Applicable to ALL PHASES

- **Beneficial Uses and Users** §10723.2
  Consider interests of all beneficial uses and users of groundwater
- **Advisory Committee** §10727.8
  GSA may appoint and consult with an advisory committee
- **Public Notices and Meetings** §10730
  - Before electing to be a GSA
  - Before adopting or amending a GSP
  - Prior to imposing or increasing a fee
- **Encourage Active Involvement** §10727.8
  Encourage the active involvement of diverse social, cultural, and economic elements of the population within the groundwater basin
- **Native American Tribes** §10720.3
  - May voluntarily agree to participate
  - See Engagement with Tribal Government Guidance Document
- **Federal Government** §10720.3
  - May voluntarily agree to participate

Centralized Outreach and Engagement Strategies

The following strategies are meant to ensure successful engagement of Madera Subbasin stakeholders during the GSP development and implementation process. These centralized activities should be conducted by all Madera Subbasin GSAs for purposes of efficiency and clear messaging. Individual Madera Subbasin GSAs are responsible for identifying and contributing appropriate staff and resources for outreach and engagement activities.

1. Develop and Maintain a List of Interested Parties

A list of stakeholders and beneficial users is to be developed and updated throughout the GSP planning, implementation and enforcement processes. Each GSA is required to maintain its own list, however coordinating these lists into a single Subbasin list will improve stakeholder engagement.

Timely notification of opportunities for interested parties to participate in the development and implementation of the GSP should be given via the channels and strategies described in detail throughout this document. Primary channels are summarized as follows:

- Madera Subbasin Website: http://www.maderacountywater.com
- Madera Subbasin Listserv
- Madera Subbasin Social Media: https://www.facebook.com/MaderaCounty/
- Madera Subbasin Coordination Committee meetings and Roundtable sessions
- Madera Subbasin Technical Workshops
- Madera Subbasin Public Workshops
- Individual Madera GSA Board meetings and GSA Technical Advisory Committee meetings

Additional options for engagement include:

- County flyers
- Press (Newspaper notifications and SGMA articles)
- Engagement Partner events (community workshops, community meetings, etc.)
- Educational tours/field trips

The primary format for engagement in GSP development will involve the Technical Workshops and Coordination Committee Roundtables. This process is outlined in Figures A2.C.a-2 and A2.C.a-3, *Technical Workshop and Roundtable Sequence* and *Workshop Planning Schedule*, and the Opportunities for Engagement table in Appendix 1 provides the dates, topics, and locations for Technical Workshops and Roundtables (as well as other engagement opportunities and relevant meetings).

Figure A2.C.a-2. Technical Workshop and Roundtable Sequence

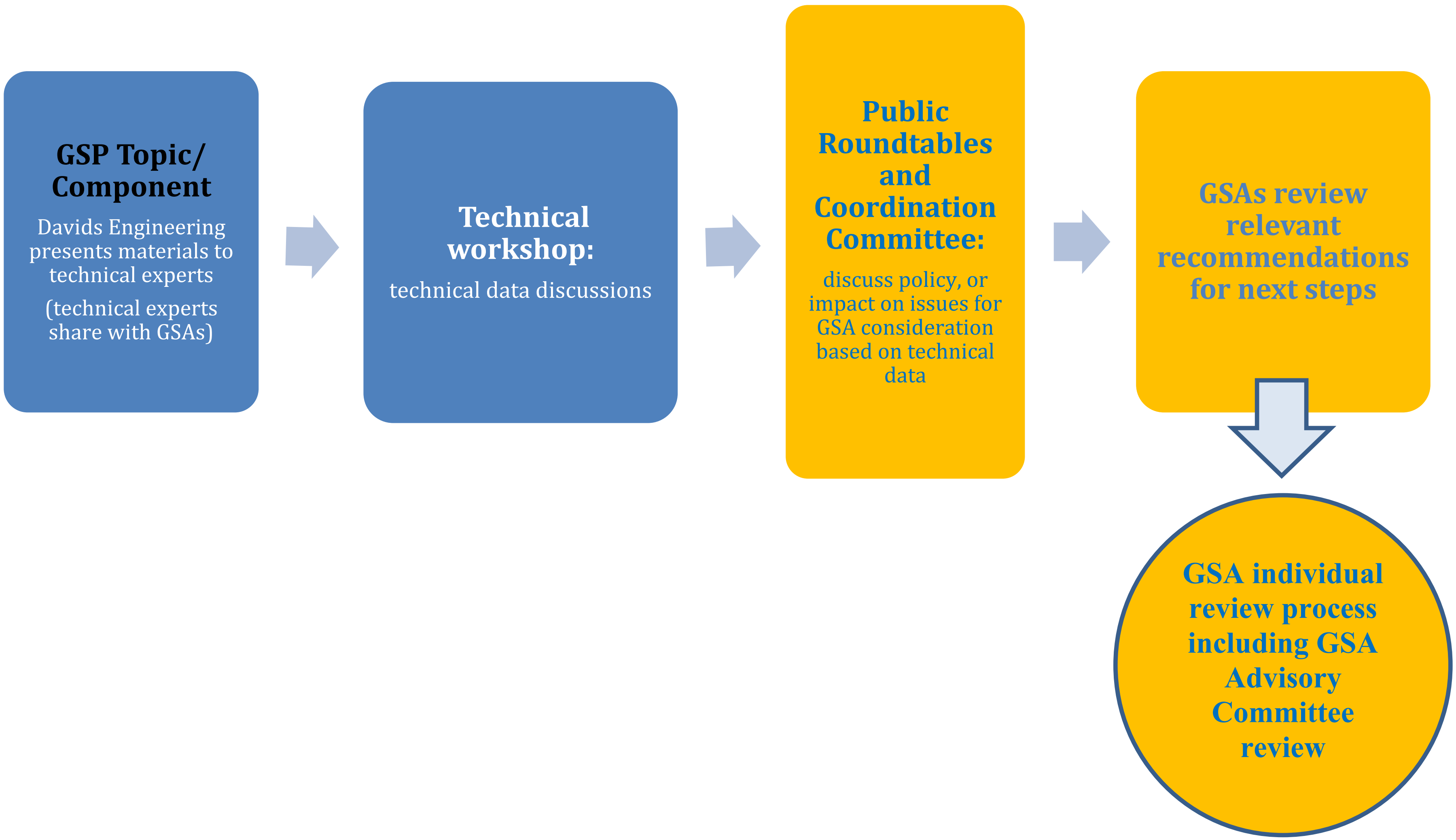
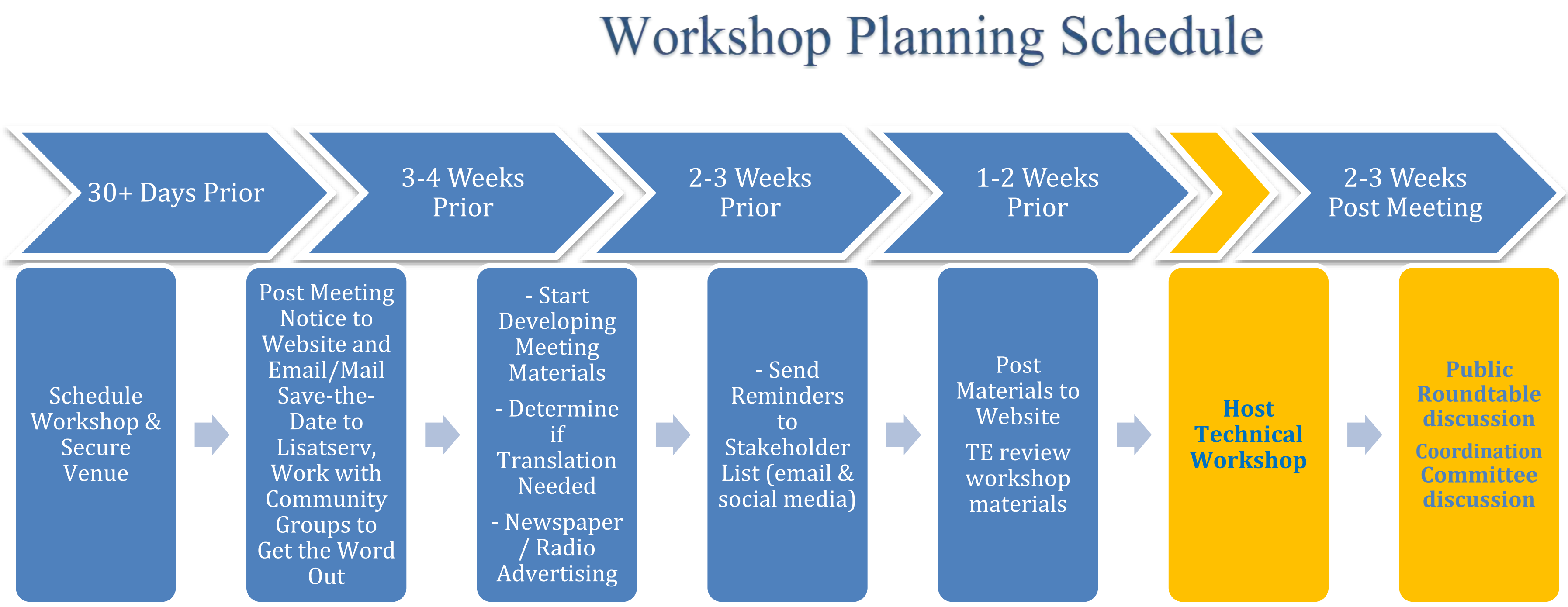


Figure A2.C.a-3. Workshop Planning Schedule



To assist in determining the topics, types, and sequencing of outreach vis-à-vis specific stakeholder interests, DWR has recommended conducting a "Lay of the Land" exercise. Table A2.C.a-2, below, was developed based on stakeholder assessment conversations conducted in the Madera Subbasin.

Table A2.C.a-2. SGMA GSA/GSP Stakeholder Constituency "Lay of the Land" Exercise

Organization/ Individual	Type of Stakeholder	Key Interests	Key Issues	GSP	Rationale
(Name of stakeholder organization or individual)	*(based on water code §10723.2)*	*(stakeholders' key interests related to groundwater)*	*(documented issues (media coverage, statements, reports, etc.) or specific issues such as past events)*	*(which section(s) of the GSP may this interest be applicable to?)*	*(reasons why this is a stakeholder that requires a certain level of engagement)*
Fairmead Community and Friends point of contact Vickie Ortiz	DAC	Access to safe and affordable drinking water Affordability and reliability of water	Engagement and capacity building in decision-making	Interested in all elements of SGMA Key interests: basin setting, sustainable management criteria (i.e., undesirable results and minimum thresholds), monitoring networks, projects and management actions	Impacted stakeholder and beneficial user of groundwater
Individual GSA/water provider customers	All	All	All	All	All
Madera Farm Bureau point of contact Christina Beckstead	Agricultural interest	Affordable and consistent availability of water for agricultural uses,	Formed an advisory group, identified interested party, participates in	All sections, especially technical standards, plan areas, basin	Impacted stakeholder and beneficial user of groundwater

		maintain community culture	media coverage	setting, sustainable management criteria (i.e., undesirable results and minimum thresholds), monitoring networks, projects and management actions	
Valley Children's Hospital, points of contact William Chaltraw and Jesse Hutchins	Industry	Water apportionment	Engagement and role in decision-making	Basin setting, sustainable management criteria (i.e., undesirable results and minimum thresholds), monitoring networks, projects and management actions	Beneficial user of groundwater
Self-Help Enterprises, point of contact Abigail Solis	DAC	Access to safe and affordable drinking water	Engagement and capacity building in decision-making	Interested in all elements of SGMA Key interests: basin setting, sustainable management criteria (i.e., undesirable results and minimum thresholds), monitoring networks, projects and management actions	Impacted stakeholder and beneficial user of groundwater

Líderes Campesinas	DAC	Access to safe and affordable drinking water	Engagement and capacity building in decision-making	Basin setting, sustainable management criteria (i.e., undesirable results and minimum thresholds), monitoring networks, projects and management actions	Impacted stakeholder and beneficial user of groundwater

It is important to note that during the Madera Subbasin stakeholder interests and concerns assessment phase, conducted during Fall 2017, most beneficial users expressed concern regarding their role in GSA decision-making, requesting clear pathways and opportunities for their voices and interests to be meaningfully included in the GSP planning and implementation process. Mutual water companies, farmers, disadvantaged communities, schools, hospitals, and others want to ensure they are able to weigh in on decisions and plans that impact their interests and needs in sustainable groundwater use. As a way of balancing the needs for an inclusive process that considers the needs and perspectives of all beneficial users along with an efficient and effective GSP planning process, see the section on *Stakeholder Roundtables*.

2. Maintain a Centralized Madera Subbasin Website

http://www.maderacountywater.com

The County has allocated staff and resources to maintain a Subbasin website with information about Madera Subbasin-wide planning efforts related to SGMA, such as joint GSP planning activities and meetings and other relevant information. While individual GSAs may seek to maintain separate websites, a centralized location for activities that are subbasin-wide or related to the Coordinating GSAs GSP development will demonstrate coordination and provide consistency in messaging.

The following are recommendations for the Madera Subbasin website:

A. Resources and Materials:

i. Links to external sites (Department of Water Resources and State Water Resources Control Board)
ii. Links to individual GSA websites, relevant blogs, etc.
iii. Frequently Asked Questions (FAQ) and/or white papers

iv. GSA documents (MOUs, by-laws, etc.)
v. GSP documents (draft GSP documents, notices and meeting calendars for GSP workshops)

B. Recommended Structure:
   i. Provide a one-stop location for Coordinating GSAs
   ii. Include tabs for information specific to each GSA, including service areas (if applicable), maps, GSA Board meetings, updates, and opportunities for stakeholder input

3. Provide Regular Public Notices and Updates; Ensure Brown Act Compliance

Coordinate consistent messaging and outreach regarding SGMA information and updates as they relate to Madera Subbasin.

A. Topics to be noticed include and are not limited to:
   i. GSP development and planning updates
   ii. GSP implementation and enforcement updates
      - GSP workshops
      - GSP work plan and timeline
   iii. General GSA updates, including without limitation:
      - GSA Board meetings
      - Coordination Committee meetings
      - Public workshops and/or stakeholder roundtables
      - GSA annual reports
      - Other SGMA related updates

B. Schedule notices to be sent on a regular schedule, for example bi-monthly, monthly, or as needed
   i. Meetings subject to the Brown Act, such as GSA Board meetings, Coordination Committee Meetings, and others, must provide public notice and post an agenda 72 hours in advance of each regularly scheduled meeting (emergency meetings require 24-hour advance notice)

C. Develop content appropriate to the audience and their interests, ensuring information is articulated in a way that is easily understood
   i. Notices to community members with less SGMA or technical experience should be easily understood, with streamlined, relatable, and repetitive information
   ii. Updates and messages should be condensed to one page when possible, providing a succinct summary of the issues discussed, and including links for

further or additional information

iii. As applicable, specific items should have an estimated timeline and a designated point of contact, including the person's position, email and telephone number

iv. Updates and information are needed in both English and Spanish

D. Designate responsible staff and appropriate resources for ongoing inter-agency coordination regarding joint messaging, consistent outreach, and communication with stakeholders

E. Determine appropriate dissemination channels

i. Utilize Constant Contact or a similar email marketing platform for management of interested party stakeholder lists

ii. Utilize member agency listservs delivered via standard email and/or U.S. Mail, e.g., inclusion in water bills, tax assessor documents, etc.

iii. Utilize updated interested party stakeholder list for Madera Subbasin, including organizations and agencies such as the Farm Bureau, DAC groups, schools, hospitals, utilities, mutual water companies, neighborhood groups, and local non-profits such as Self-Help Enterprises and Leadership Counsel for Justice and Accountability

4. Provide Notices and Updates in Local Newspaper Periodicals

Notices can take the form of Public Notices, Op-Ed articles, Letters to the Editor, Advertisements or Earned Media.

A. Send information and/or media releases to regional and local media outlets and contacts

i. KMJ radio is considered a trusted media source in the region

ii. Organization and community newsletters and periodicals

iii. Identify trusted bi-lingual and/or Spanish speaking media outlets

B. Provide follow-up or wrap-up articles written by staff when appropriate

C. Include notices for:

i. Public workshops
ii. Specific stakeholder meetings (targeted or special topic meetings)
iii. GSA Board meetings
iv. Coordination Committee meetings
v. Other standing meetings of particular interest related to SGMA
vi. GSP development and planning updates
vii. GSP implementation and enforcement updates
viii. General GSA and SGMA related updates

5. Institute Regular Stakeholder Outreach and Engagement Opportunities

It is critical that stakeholders and beneficial users are provided regular opportunities for their input to be incorporated into GSA governance and decision-making processes, and that they understand exactly how they are able to contribute to the GSP planning and implementation processes.

Stakeholder engagement opportunities include but are not limited to:

A. Standing Operations Meetings
   i. GSA Board meetings
   ii. Coordination Committee meetings
   iii. GSP Technical Workshops

B. Public Workshops and Roundtables (see section on *Stakeholder Roundtables*)
   i. Schedule workshops and roundtables bi-monthly or as needed
      a. Schedule in evenings and/or near community areas as feasible
   ii. Provide translation and facilitation services in English and Spanish
   iii. Public workshop or roundtable content includes but is not limited to:
      a) Updates on GSA coordination activities
      b) SGMA 101 workshops
      c) Updates on GSP development and planning activities
      d) Opportunities for interested parties to participate in the development and implementation of the GSP (i.e., technical workshops on specific GSP components)
      e) Notice of GSA intent to adopt or amend a GSP
      f) Updates on groundwater management activities in the Subbasin
      g) Notice to impose fees

6. Strategically Engage Local, Special SGMA Identified Groups

Develop a targeted communication strategy to engage difficult-to-reach communities and community members that will be impacted by SGMA. This may include additional activities for specific beneficial users (e.g., posting notices or door-to-door engagement, speaking at pre-existing community meetings) and/or coordination with existing advisory groups or non-profit organizations as part of roundtable discussions.

7. Develop and Update Subbasin Outreach and Engagement Resources Table

Assess and define Coordinating GSAs' outreach tools and resources available for Subbasin-wide outreach and engagement activities.

8. Develop Consistent, Coordinated Messages and Talking Points

Define the key messages needed to effectively convey SGMA-related information to various audiences, and ensure consistency in a coordinated outreach effort to all stakeholders.

A. For each topic being discussed (see work plan), develop a set of talking points that can be used by GSA members when speaking to specific stakeholder groups or audiences. Talking points and messaging may be customized to specific stakeholder groups as appropriate.
B. Develop tools, such as a glossary and a SGMA 101 information piece, that contain easy-to-understand information as well as responses to anticipated questions from stakeholder groups. Consider developing simple brochures and short videos.
C. Identify and communicate opportunities for public engagement and/or public comment during meetings on GSP development.
D. Provide clear messaging that GSAs retain legal responsibility for final GSA- and GSP-related decisions.

Localized Outreach and Engagement Strategies

While consistent messaging is to be coherently coordinated at the Subbasin level, specifically among the Coordinating GSAs, localized outreach is to be coordinated at the GSA level through existing, trusted channels.

1. Utilize Local Agencies with Standing Meetings

The most effective way to inform and engage many stakeholders and beneficial users regarding SGMA requirements and soliciting feedback is through trusted local agencies and community organizations with standing meetings and established communication channels.

A. Support local agencies and community organizations in disseminating information and engaging stakeholders in the following ways:
   i. During standing board and/or community meetings
   ii. Through monthly information pieces in newsletters or included in bills
   iii. By disseminating information in both English and Spanish
B. Local trusted agencies and community organizations include but are not limited to:
   i. Madera Farm Bureau
   ii. Mutual water companies
   iii. Leaders in DAC communities such as Fairmead
   iv. Growers associations and industry organizations (such as wine and dairy)

v. Resource conservation groups

vi. Local non-profits (such as Self-Help Enterprises, Community Water Center, and Leadership Counsel for Justice and Accountability)

vii. Local hospitals and schools

C. Leverage local, trusted resources for community meetings, such as schools, churches, and community centers

D. Organize public meetings around concrete impacts to specific stakeholders, including:

i. SGMA 101 workshop(s) to inform stakeholders of important changes in groundwater management and how it will impact them

ii. Meetings that detail when and how opportunities to provide input to the GSA decision-making and GSP development processes will occur

iii. Public meetings regarding fee structures to help people understand how to interpret the impacts on them

E. Make information and meetings accessible to various stakeholder groups

i. Provide information in easy-to-understand and streamlined terms

ii. Provide information and facilitation in both English and Spanish

iii. Hold meetings during hours that do not conflict with regular work schedules (i.e., nights and weekends)

2. Utilize Existing Local Agency Resources

Effectively inform and engage diverse beneficial users in SGMA through trusted local agencies and community organizations with existing communication channels such as newsletters, websites, and social media.

A. Disseminate consistent, coordinated messages and talking points through existing local newsletters, websites, and social media

B. Customize messages to audiences, providing easy-to-understand updates

C. Provide information in both English and Spanish (most websites and social media allow users to set preferred translation)

3. Build on Strategies to Engage Local, Special SGMA Identified Groups

To build on the Basin-wide outreach referenced above, each GSA will need to develop additional locally-targeted communication strategies to engage difficult-to-reach communities and community members that will be impacted by SGMA. Groups include Disadvantaged Communities (DACs), underrepresented communities, Latino communities, and remote private pumpers.

As mentioned above, some groups may need to be engaged through channels that do not require internet access, via door-to-door outreach and other opportunities for face-to face engagement.

Stakeholder Roundtables: Process for Reporting Stakeholder Input to GSA Coordination Committee and Workgroups

Madera Subbasin GSAs recognize that stakeholder input into the development and implementation of a GSP is critical for GSP acceptance and successful implementation, as well as a SGMA requirement. As such, Stakeholder Roundtables have been identified as the best method to incorporate Madera Subbasin stakeholder/beneficial user input into the GSP development and implementation process.

The circumstances of the Madera Subbasin are such that each of the seven (7) GSAs has vastly different resources, responsibilities, capacities, and stakeholder representation to consider as they form Subbasin committees and workgroups, and coordinate among themselves for the GSP. There is a need to identify tools and processes whereby GSAs and their beneficial users are given fair representation while the resources and capacities of each GSA, as well as beneficial users, are taken into account.

To this end, voluntary participation in Stakeholder Roundtables held in conjunction with Coordination Committee meetings (who will then make recommendations to GSA Boards) is a fair process that provides stakeholders the ability to gather information, share perspectives, and deliberate about options that would best serve the needs of the community at large as the GSP is developed and implemented.

Stakeholder Roundtable Structure

1. Timing: As feasible, Roundtables will be held immediately prior to and in the same venue as Coordination Committee meetings where recommendations are made to GSAs. (Coordination Committee meetings will be open to the public and subject to the Brown Act, as will GSA Board meetings.)
2. Notice: Roundtables will be noticed concurrently with regularly scheduled Coordination Committee meetings, ideally 2-3 weeks in advance.
3. Participation: All interested Madera Subbasin stakeholders/beneficial users are invited to participate. At least one Coordination Committee member will attend all Roundtable meetings.
4. Process: Roundtables will be facilitated, participatory workshops allowing for stakeholder input to be heard and recorded.
5. Financing: Roundtables will be dependent upon identification of resources to support them, determined by GSAs.

See Figure A2.C.a-2 above for details on process.

Recommended Milestones for Engaging Stakeholders

To employ the Stakeholder Communication and Engagement Plan effectively, Madera Subbasin GSAs will need to develop a schedule for outreach and engagement activities. The below table (Table A2.C.a-3) identifies milestones required by SGMA, as well as centralized and localized engagement strategies. This schedule shall be updated into a task-oriented work plan and timeline as communication and engagement tasks are allocated.

Table A2.C.a-3. Summary of Engagement Opportunities and Milestones

Timeframe	Milestone or Stage	Required Community Engagement Under SGMA	Centralized & Localized Communication Strategies
Shortly after GSA formation	After identification of outreach responsibilities among GSA member agencies		• Provide notice of GSA outreach resources: website, email listserv, calendar of GSA Board meetings, Technical Advisory meetings, and GSA Coordination Committee meetings • Develop list of interested parties, to be maintained throughout GSP planning, implementation, and enforcement process
Before GSP planning activities	Prior to beginning GSP development	Provide to the public and State notice of intent to begin GSP planning and description of opportunities for	• Public workshop on SGMA and general GSP development information (e.g., required components of a GSP, how

Timeframe	Milestone or Stage	Required Community Engagement Under SGMA	Centralized & Localized Communication Strategies
		interested parties to participate in GSP development and implementation	sustainability indicators are developed, etc.) • Email notice and updates • Newspaper notice of public workshop
Between Notice of GSP Planning and August 30, 2019	During GSP development	Public workshops and other opportunities providing stakeholder avenues to participate in GSP development	*Centralized:* • Public workshops on GSP development. See topics for GSP development (e.g., basin conditions, GSP roadmap, etc.) • Stakeholder Roundtables, held in conjunction with Coordination Committee meetings • Email notice of public workshops • Newspaper notice of public workshops *Localized:* • Make time in standing meetings for updates and information on GSP development • Develop newsletter updates • Disseminate updates via websites and social media

Timeframe	Milestone or Stage	Required Community Engagement Under SGMA	Centralized & Localized Communication Strategies
Between Notice of GSP Planning and August 30, 2019	During GSP development	Active involvement of diverse social, cultural, and economic elements of the population within the Subbasin	*Centralized:* • Provide monthly email notices and updates • Update website regularly • Convene monthly or bimonthly meetings of GSA Coordination Committee and Technical Advisory Committee • Convene quarterly or monthly meetings of GSA Board • Identify and communicate opportunities for public engagement and/or public comment during meetings on GSP development, (providing clear messages that GSAs retain legal responsibility for final GSA and GSP related decisions) • Develop consistent, coordinated messages and talking points to effectively convey SGMA-related

Timeframe	Milestone or Stage	Required Community Engagement Under SGMA	Centralized & Localized Communication Strategies
			information to various audiences • Arrange for technical support to stakeholder groups through presentations or workshops conducted by GSA representatives/staff • Develop content appropriate to the audience and their interests, ensuring information can be easily understood • Update area legislative bodies at strategic mileposts (and any other groups upon request) • Utilize updated interested party stakeholder list, member agency listservs delivered via email and/or U.S. Mail, and other media outlets such as newspaper and radio to provide notices • Strategically engage local, special SGMA identified groups

Timeframe	Milestone or Stage	Required Community Engagement Under SGMA	Centralized & Localized Communication Strategies
			Localized: • Utilize local channels and meetings to identify and communicate opportunities for public engagement and/or public comment during meetings on GSP development • Leverage and support local agencies and community organizations in disseminating information and engaging stakeholders, including through existing community meetings, newsletters, websites, and social media • Organize public meetings around concrete impacts to specific stakeholders • Develop additional, locally-targeted communication strategies to engage difficult-to-reach

Timeframe	Milestone or Stage	Required Community Engagement Under SGMA	Centralized & Localized Communication Strategies
			communities and community members
GSP adoption no later than January 31, 2020	Prior to GSP adoption or amendment	o Provide notice to cities and counties within area encompassed by the proposed plan or amendment o Consider comments provided by the cities and counties o Accommodate requests for consultation received from the cities and counties within 30 days	SEE ABOVE
GSP adoption no later than January 31, 2020	Prior to GSP adoption or amendment	No sooner than 90 days following public notice, hold public hearing/ public workshop	SEE ABOVE
Prior to GSA imposing fee or increasing fee	If GSA intends to impose or increase a fee	o Provide public with access to the data serving as the basis for the proposed fee,	SEE ABOVE

Timeframe	Milestone or Stage	Required Community Engagement Under SGMA	Centralized & Localized Communication Strategies
		the time and place of explanatory public meeting, and general explanation of topic to be discussed. Post on project website and mail to any interested party who submits written request for mailed notice of meetings on new or increased fees. o No sooner than 10 days following public notice, hold a public meeting	

Evaluation and Assessment

Any communication strategy should include opportunities to check in at various points during implementation to ensure that it is meeting the communication and engagement goals and complying with SGMA law. These check-ins can include:

- ✓ What worked well
- ✓ What didn't work as planned
- ✓ Meeting recaps with next steps
- ✓ Listing lessons learned … and developing mid-course corrections
- ✓ (As relevant) Communications budget analysis

Educational Materials

DWR has developed various educational materials about SGMA and GSA/GSP development. In addition to DWR materials, academic institutions and foundations have published useful reports about SGMA implementation. While not comprehensive, Table A2.C.a-4 lists some essential SGMA educational and reference materials.

Table A2.C.a-4. Educational and Reference Documents for SGMA Implementation

Educational/Reference Document Titles	Publishing Entity	Date/Year of Publication
Groundwater Sustainability Agency Frequently Asked Questions http://www.water.ca.gov/groundwater/sgm/pdfs/DWR_GSA_FAQ_2016-01-07.pdf	DWR	January 7, 2016
Groundwater Sustainability Plan (GSP) Emergency Regulations Guide http://www.water.ca.gov/groundwater/sgm/pdfs/GSP_Final_Regs_Guidebook.pdf	DWR	July 2016
Collaborating for Success: Stakeholder Engagement for Sustainable Groundwater Management Act Implementation http://waterfoundation.net/wp-content/uploads/2015/07/SGMA_Stakeholder_Engagement_White_Paper.pdf	Community Water Center Clean Water Fund Union of Concerned Scientists	July 2015
The 2014 Sustainable Groundwater Management Act: A Handbook to Understanding and Implementing the Law http://www.watereducation.org/sites/main/files/file-attachments/groundwatermgthandbook_oct2015.pdf	Water Education Foundation	October 2015

Educational/Reference Document Titles	Publishing Entity	Date/Year of Publication
SGMA Engagement With Tribal Governments https://www.water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/GD_Tribal_Final_2017-06-28.pdf	DWR	June 2017

Appendix A2.C.a-1: Opportunities for Engagement

The following tables present a schedule of meetings that provide opportunities for engagement, including:

- **Madera Subbasin Public/Technical Workshops:** Technical presentations made by GSP preparation consultants
- **Madera Subbasin Public Roundtable/Coordination Committee Meetings:** Opportunities for local stakeholders to discuss the technical aspects of development and make the required decisions to move the technical process forward. Generally, the GSP Preparation Consultants will not attend the Public Round Table/Coordination Committee meetings, though for certain topics if deemed useful by the Plan Manager, the GSP Preparation Consultants may attend a few of these meetings.
- **Community Meetings:** Meetings that are not SGMA/GSP-specific, but at which information about the GSP will be presented (e.g., standing board meetings)
- **Individual GSA Meetings:** Meetings of the individual GSAs within the subbasin.[2] Madera County GSA meets on an as-needed basis, and does not have a standing meeting scheduled. All other participating GSAs have standing meetings, included in Table A2.C.a-1. See Table A2.C.a-2 for the recurring schedules. The Madera Subbasin GSAs that are participating in developing this GSP include:
    - Madera County GSA
    - City of Madera GSA
    - Madera Irrigation District GSA
    - Root Creek Water District GSA
    - Madera Water District GSA
    - Gravelly Ford Water District GSA
    - New Stone Water District GSA

[2] See Appendix 2 for more information about each GSA.

Table A2.C.a-A. Scheduled Meetings and Workshops

Date	Meeting Purpose/Topics	Time & Location	Meeting Type
12/7/2017	GSP development kick-off, basin setting, basin boundary water budget	9:30 am-1:00 pm Madera County Conference Room	Public/Technical Workshop
4/23/2018	Discuss Coordination Agreement requirements Review criteria for determining management areas Decision criteria discussions generally	9am-12 pm Madera County Board Room Board Chambers, 200 W. 4th Street, Madera, CA	Public Roundtable/Coordination Committee
5/8/2018	Basin Boundary Modification	10:00 a.m. Madera County Board of Supervisors Chambers	*Madera County GSA meeting*
5/9/2018	Standing meeting of the Madera County Subbasin Advisory Committee	6:00 p.m. County Government Center, 200 W. 4th Street, Room 3005, Madera, CA 93637	Community Meeting
5/24/2018	Discuss management areas, base period, GSA water budgets, projects and management actions	1-4pm Madera County Board Room Board Chambers, 200 W. 4th Street, Madera, CA	Public/Technical Workshop
6/25/2018	Discuss GSA water budgets, approve management areas, base period and projects and management actions for detailed evaluation	1-4pm Madera Farm Bureau 1102 S. Pine Street, Madera, CA	Public Roundtable/Coordination Committee

Date	Meeting Purpose/Topics	Time & Location	Meeting Type
8/2/2018	SGMA 101 Workshop hosted by City of Madera, Self-Help Enterprises and Leadership Council for Justice & Accountability	5:30 pm – 7:30 pm Frank Bergon Senior Center Multi-purpose Room 238 S D St Madera, CA	Public/Technical Workshop
8/8/2018	Standing meeting of the Madera County Subbasin Advisory Committee	6:00 p.m. County Government Center, 200 W. 4th Street, Room 3005, Madera, CA 93637	Community Meeting
10/3/2018	*Standing meeting of the City of Madera GSA*	*6:00 pm, in conjunction with City Council meeting* *City Council Chambers*	*City of Madera GSA Meeting*
10/8/2018	*Standing meeting of the Root Creek Water District GSA*	*Approx. 12:30 pm, following 11:00 am board meeting*	*Root Creek Water District GSA Meeting*
10/10/2018	*Standing meeting of the Madera Water District GSA*	*9:00 am, in conjunction with board meeting*	*Madera Water District SGA Meeting*
10/11/2018	*Standing meeting of the Madera Irrigation District GSA*	*2:00 pm, in conjunction with board meeting*	*Madera Irrigation District GSA Meeting*
10/15/2018	*Standing meeting of the Gravelly Ford Water District GSA*	*1:30 pm* *Schafer Ranch Office* *25176 Ave 5 ½* *Madera, CA 93637*	*Gravelly Ford Water District GSA Meeting*
10/16/2018	*Standing meeting of the New Stone Water District GSA*	*2:00 - 3:30 p.m.* *9500 S. DeWolf Ave.* *Selma, CA 93662*	*New Stone Water District GSA Meeting*

Date	Meeting Purpose/Topics	Time & Location	Meeting Type
10/18/2018	Follow-up to the June 25th Technical Workshop. Discussion of what the future of groundwater looks like by GSA and projects/management actions by GSA.	2:30-4:30 p.m. Frank Bergon Senior Center Multi-purpose Room 238 S D St Madera, CA	Public/Technical Workshop
11/7/2018	Standing meeting of the Madera County Subbasin Advisory Committee	6:00 p.m. County Government Center, 200 W. 4th Street, Room 3005, Madera, CA 93637	Community Meeting
11/7/2018	*Standing meeting of the City of Madera GSA*	*6:00 pm, in conjunction with City Council meeting* *City Council Chambers*	*City of Madera GSA Meeting*
11/8/2018	*Standing meeting of the Madera Irrigation District GSA*	*2:00 pm, in conjunction with board meeting*	*Madera Irrigation District GSA Meeting*
11/12/2018	*Standing meeting of the Root Creek Water District GSA*	*Approx. 12:30 pm, following 11:00 am board meeting*	*Root Creek Water District GSA Meeting*
11/14/2018	*Standing meeting of the Madera Water District GSA*	*9:00 am, in conjunction with board meeting*	*Madera Water District SGA Meeting*
11/19/2018	*Standing meeting of the Gravelly Ford Water District GSA*	*1:30 pm* *Schafer Ranch Office* *25176 Ave 5 ½* *Madera, CA 93637*	*Gravelly Ford Water District GSA Meeting*
11/20/2018	*Standing meeting of the New Stone Water District GSA*	*2:00 - 3:30 p.m.* *9500 S. DeWolf Ave.* *Selma, CA 93662*	*New Stone Water District GSA Meeting*

Date	Meeting Purpose/Topics	Time & Location	Meeting Type
12/5/2018	*Standing meeting of the City of Madera GSA*	*6:00 pm, in conjunction with City Council meeting* *City Council Chambers*	*City of Madera GSA Meeting*
12/10/2018	*Standing meeting of the Root Creek Water District GSA*	*Approx. 12:30 pm, following 11:00 am board meeting*	*Root Creek Water District GSA Meeting*
12/12/2018	*Standing meeting of the Madera Water District GSA*	*9:00 am, in conjunction with board meeting*	*Madera Water District SGA Meeting*
12/13/2018	*Standing meeting of the Madera Irrigation District GSA*	*2:00 pm, in conjunction with board meeting*	*Madera Irrigation District GSA Meeting*
12/17/2018	*Standing meeting of the Gravelly Ford Water District GSA*	*1:30 pm* *Schafer Ranch Office* *25176 Ave 5 ½* *Madera, CA 93637*	*Gravelly Ford Water District GSA Meeting*
12/18/2018	*Standing meeting of the New Stone GSA*	*2:00 - 3:30 p.m.* *9500 S. DeWolf Ave.* *Selma, CA 93662*	*New Stone GSA Meeting*
1/2/2019	*Standing meeting of the City of Madera GSA*	*6:00 pm, in conjunction with City Council meeting* *City Council Chambers*	*City of Madera GSA Meeting*
1/9/2019	*Standing meeting of the Madera Water District GSA*	*9:00 am, in conjunction with board meeting*	*Madera Water District SGA Meeting*
1/10/2019	*Standing meeting of the Madera Irrigation District GSA*	*2:00 pm, in conjunction with board meeting*	*Madera Irrigation District GSA Meeting*
1/14/2019	*Standing meeting of the Root Creek Water District GSA*	*Approx. 12:30 pm, following 11:00 am board meeting*	*Root Creek Water District GSA Meeting*

Date	Meeting Purpose/Topics	Time & Location	Meeting Type
1/15/2019	*Standing meeting of the New Stone GSA*	*2:00 - 3:30 p.m.* *9500 S. DeWolf Ave.* *Selma, CA 93662*	*New Stone GSA Meeting*
1/21/2019	*Standing meeting of the Gravelly Ford GSA*	*1:30 pm* *Schafer Ranch Office* *25176 Ave 5 ½* *Madera, CA 93637*	*Gravelly Ford GSA Meeting*
TBD	Recommended: Madera County Subbasin Advisory Committee		
2/6/2019	*Standing meeting of the City of Madera GSA*	*6:00 pm, in conjunction with City Council meeting* *City Council Chambers*	*City of Madera GSA Meeting*
2/11/2019	*Standing meeting of the Root Creek Water District GSA*	*Approx. 12:30 pm, following 11:00 am board meeting*	*Root Creek Water District GSA Meeting*
2/13/2019	*Standing meeting of the Madera Water District GSA*	*9:00 am, in conjunction with board meeting*	*Madera Water District GSA Meeting*
2/14/2019	*Standing meeting of the Madera Irrigation District GSA*	*2:00 pm, in conjunction with board meeting*	*Madera Irrigation District GSA Meeting*
2/18/2109	*Standing meeting of the Gravelly Ford Water District GSA*	*1:30 pm* *Schafer Ranch Office* *25176 Ave 5 ½* *Madera, CA 93637*	*Gravelly Ford Water District GSA Meeting*
2/19/2019	*Standing meeting of the New Stone Water District GSA*	*2:00 - 3:30 p.m.* *9500 S. DeWolf Ave.* *Selma, CA 93662*	*New Stone Water District GSA Meeting*
3/6/2019	*Standing meeting of the City of Madera GSA*	*6:00 pm, in conjunction with City Council meeting*	*City of Madera GSA Meeting*

Date	Meeting Purpose/Topics	Time & Location	Meeting Type
		City Council Chambers	
3/11/2019	*Standing meeting of the Root Creek Water District GSA*	*Approx. 12:30 pm, following 11:00 am board meeting*	*Root Creek Water District GSA Meeting*
3/13/2019	*Standing meeting of the Madera Water District GSA*	*9:00 am, in conjunction with board meeting*	*Madera Water District SGA Meeting*
3/14/2019	*Standing meeting of the Madera Irrigation District GSA*	*2:00 pm, in conjunction with board meeting*	*Madera Irrigation District GSA Meeting*
3/18/2109	*Standing meeting of the Gravelly Ford Water District GSA*	*1:30 pm Schafer Ranch Office 25176 Ave 5 ½ Madera, CA 93637*	*Gravelly Ford Water District GSA Meeting*
3/19/2019	*Standing meeting of the New Stone Water District GSA*	*2:00 - 3:30 p.m. 9500 S. DeWolf Ave. Selma, CA 93662*	*New Stone Water District GSA Meeting*
3/21/2019	Discuss GW model scenario results including draft groundwater pumping allotments, groundwater trading rules, costs, undesirable results/minimum thresholds, and interbasin flows	TBD	Public Roundtable/Coordination Committee
4/3/2019	*Standing meeting of the City of Madera GSA*	*6:00 pm, in conjunction with City Council meeting City Council Chambers*	*City of Madera GSA Meeting*
4/8/2019	*Standing meeting of the Root Creek Water District GSA*	*Approx. 12:30 pm, following 11:00 am board meeting*	*Root Creek Water District GSA Meeting*

Date	Meeting Purpose/Topics	Time & Location	Meeting Type
4/10/2019	*Standing meeting of the Madera Water District GSA*	*9:00 am, in conjunction with board meeting*	*Madera Water District SGA Meeting*
4/11/2019	*Standing meeting of the Madera Irrigation District GSA*	*2:00 pm, in conjunction with board meeting*	*Madera Irrigation District GSA Meeting*
4/15/2109	*Standing meeting of the Gravelly Ford Water District GSA*	*1:30 pm Schafer Ranch Office 25176 Ave 5 ½ Madera, CA 93637*	*Gravelly Ford Water District GSA Meeting*
4/16/2019	*Standing meeting of the New Stone Water District GSA*	*2:00 - 3:30 p.m. 9500 S. DeWolf Ave. Selma, CA 93662*	*New Stone Water District GSA Meeting*
4/18/2019	TBD	TBD	Public/Technical Workshop
TBD	Recommended: Madera County Subbasin Advisory Committee		
5/1/2019	*Standing meeting of the City of Madera GSA*	*6:00 pm, in conjunction with City Council meeting City Council Chambers*	*City of Madera GSA Meeting*
5/8/2019	*Standing meeting of the Madera Water District GSA*	*9:00 am, in conjunction with board meeting*	*Madera Water District SGA Meeting*
5/9/2019	*Standing meeting of the Madera Irrigation District GSA*	*2:00 pm, in conjunction with board meeting*	*Madera Irrigation District GSA Meeting*
5/13/2019	*Standing meeting of the Root Creek Water District GSA*	*Approx. 12:30 pm, following 11:00 am board meeting*	*Root Creek Water District GSA Meeting*
5/16/2019	Present Implementation Plan including GW pumping allotments, GW	TBD	Public Round Table/Coordination Committee

Date	Meeting Purpose/Topics	Time & Location	Meeting Type
	trading rules and undesirable results/minimum thresholds and receive feedback		
5/20/2109	*Standing meeting of the Gravelly Ford Water District GSA*	*1:30 pm* *Schafer Ranch Office* *25176 Ave 5 ½* *Madera, CA 93637*	*Gravelly Ford Water District GSA Meeting*
5/21/2019	*Standing meeting of the New Stone Water District GSA*	*2:00 - 3:30 p.m.* *9500 S. DeWolf Ave.* *Selma, CA 93662*	*New Stone Water District GSA Meeting*
6/5/2019	*Standing meeting of the City of Madera GSA*	*6:00 pm, in conjunction with City Council meeting* *City Council Chambers*	*City of Madera GSA Meeting*
6/10/2019	*Standing meeting of the Root Creek Water District GSA*	*Approx. 12:30 pm, following 11:00 am board meeting*	*Root Creek Water District GSA Meeting*
6/12/2019	*Standing meeting of the Madera Water District GSA*	*9:00 am, in conjunction with board meeting*	*Madera Water District SGA Meeting*
6/13/2019	*Standing meeting of the Madera Irrigation District GSA*	*2:00 pm, in conjunction with board meeting*	*Madera Irrigation District GSA Meeting*
6/17/2109	*Standing meeting of the Gravelly Ford Water District GSA*	*1:30 pm* *Schafer Ranch Office* *25176 Ave 5 ½* *Madera, CA 93637*	*Gravelly Ford Water District GSA Meeting*
6/18/2019	*Standing meeting of the New Stone Water District GSA*	*2:00 - 3:30 pm* *9500 S. DeWolf Ave.* *Selma, CA 93662*	*New Stone Water District GSA Meeting*

Date	Meeting Purpose/Topics	Time & Location	Meeting Type
6/20/2019	Discuss and affirm Coordination Agreement for GSA approval	TBD	Coordination Committee Meeting
7/3/2019	*Standing meeting of the City of Madera GSA*	*6:00 pm, in conjunction with City Council meeting City Council Chambers*	*City of Madera GSA Meeting*
7/8/2019	*Standing meeting of the Root Creek Water District GSA*	*Approx. 12:30 pm, following 11:00 am board meeting*	*Root Creek Water District GSA Meeting*
7/10/2019	*Standing meeting of the Madera Water District GSA*	*9:00 am, in conjunction with board meeting*	*Madera Water District SGA Meeting*
7/11/2019	*Standing meeting of the Madera Irrigation District GSA*	*2:00 pm, in conjunction with board meeting*	*Madera Irrigation District GSA Meeting*
7/15/2109	*Standing meeting of the Gravelly Ford Water District GSA*	*1:30 pm Schafer Ranch Office 25176 Ave 5 ½ Madera, CA 93637*	*Gravelly Ford Water District GSA Meeting*
7/16/2019	*Standing meeting of the New Stone Water District GSA*	*2:00 - 3:30 pm 9500 S. DeWolf Ave. Selma, CA 93662*	*New Stone Water District GSA Meeting*
7/18/2019	Present Complete GSP	TBD	Public/Technical Workshop
TBD		TBD	Public Hearing (Water Code §10728.4)

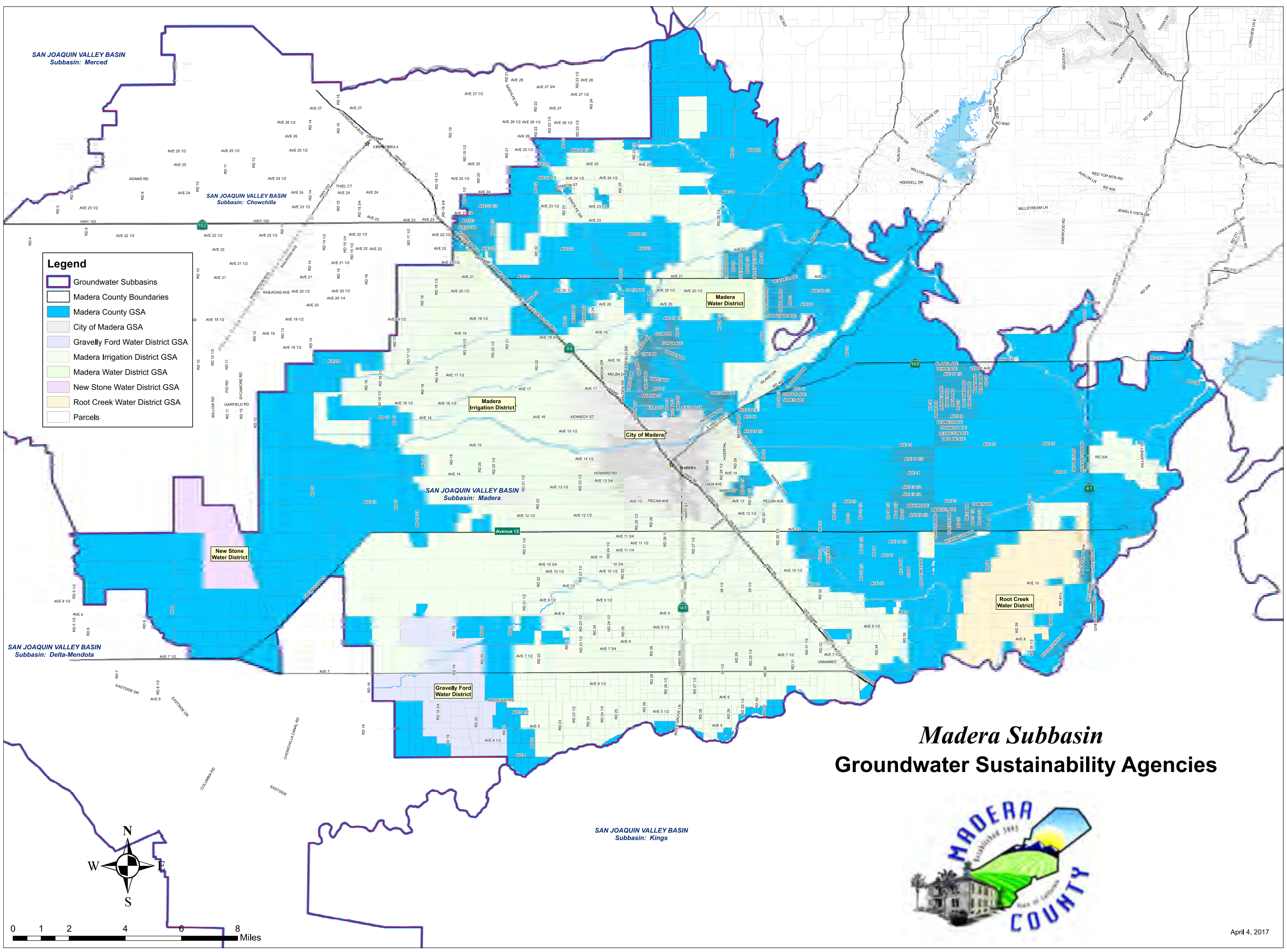
Table A2.C.a-B. Recurring meetings of individual GSAs within the subbasin.

Subbasin	Recurring day	Time and Location
Root Creek GSA	Second Monday of each month	• Approx. 12:30 pm, following 11:00 am board meeting
Madera Water District GSA	Second Wednesday of each month	• 9:00 am, in conjunction with board meeting
Madera Irrigation District	Second Thursday of each month	• 2:00 pm, in conjunction with board meeting
Madera County GSA	As needed	
City of Madera GSA	First Wednesday of each month	• 6:00 pm, in conjunction with City Council Meeting • City Council Chambers
Gravelly Ford GSA	Third Monday of each month (generally no September meeting)	• 1:30 pm • Schafer Ranch Office 25176 Ave 5 ½ Madera, CA 93637
New Stone GSA	Third Tuesday of each month	• 2:00-3:30 pm • 9500 S. DeWolf Ave Selma, CA 93662

Appendix A2.C.a-2: GSAs within the Madera Subbasin

The Madera Subbasin consists of 7 Groundwater Sustainability Agencies (GSAs), depicted in the following map (source: Madera County Water and Natural Resources Department. http://www.maderacountywater.com/wp-content/uploads/2016/10/GSA_417_MaderaMap.pdf).

Figure A2.C.a-C. Map of Madera Subbasin GSAs



See Table A2.C.a-D, below, for information regarding the formation, agency type, contact information, and committees of each GSA[3]. See Table A2.C.a-2 of Appendix A2.C.a-1 for information regarding the standing meetings of the GSAs.

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[3] Note: The table below is in the process of being updated to fill in the gaps.

Table A2.C.a-D. Overview of the GSAs of the Madera Subbasin

MADERA SUBBASIN GSAs		
Madera County Subbasin GSA	Formed	
	Area	
	Board of Directors	Tom Wheeler (Chair), Max Rodriguez, David Rogers, Brett Frazier, Rob Poythress
	Contact Information	Stephanie Anagnoson, Director Water and Natural Resources Department 200 W 4th Street Madera, CA 95637 (559) 675-7703 x. 2265 stephanie.anagnoson@maderacounty.com
	Advisory Committee	James Maxwell and Devin Aviles (at large); Alejandro Vieyra and Victoria Ortiz (disadvantaged communities); Kevin Herman, chair, and Bill Diedrich (agricultural); Madera Valley Water Company (public water systems); Jerrold Kazynski and Brent McCaffrey (residential); Jay Quick and Charles LaRue (alternate)
City of Madera GSA	Formed	August 2016
	Area	City of Madera boundaries (exclusive GSA for this area)
	Board of Directors	
	Contact Information	David Merchen Community Development Director 205 W 4th Street Madera, CA 93637 (559) 661-5430 dmerchen@cityofmadera.com

	Committees	
Madera Irrigation District GSA	Formed	July 2016
	Area	All lands within the Madera Irrigation District except the City of Madera and the Madera Water District (approximately 128,000 acres)
	Board of Directors	Dave Loquaci, Rick Cosyns, Brian Davis, Jim Erickson, Carl Janzen
	Contact Information	Thomas Greci General Manager 12152 Road 28 ¼ Madera, CA 93637 (559) 673-3514 tgreci@madera-id.org
	Committees	
Root Creek Water District GSA	Formed	July 2016
	Area	
	Board of Directors	Nick Bruno, Jeffrey D. Coulthard, Amber Mendoza, Danny Hoffman, Lynn Hoffman, Brian Partridge, Toni Scarborough
	Contact Information	Nick Bruno, President P.O. Box 28548 Fresno, CA 93729 (559) 326-2222 nick@ccdgllc.com
	Committees	
Madera Water District GSA	Formed	
	Area	
	Board of Directors	

	Contact Information	Brad Samuelson Consultant 1663 N. Schnoor Avenue, Suite 105 Madera, CA 93703 (209) 809-2300 fresno@ppeng.com
	Committees	
Gravelly Ford Water District GSA	Formed	
	Area	
	Board of Directors	
	Contact Information	Don Roberts General Manager 18811 Road 27 Madera, CA 93638 (559) 474-1000 donroberts717@gmail.com
	Committees	
New Stone Water District GSA	Formed	
	Area	
	Board of Directors	Jeff Lion, Dan Lion, Bruce Lion, Al Lion Jr., Perl Lion
	Contact Information	Roger Skinner District Representative 9500 S. De Wolf Selma, CA 93662 559-834-6677 rskinner@lionraisins.com
	Committees	

Appendix A2.C.a-3: Tribal Engagement

Relevant DWR Information

SGMA Section 10720.3. …any federally recognized Indian Tribe, appreciating the shared interest in assuring the sustainability of groundwater resources, may voluntarily agree to participate in the preparation or administration of a groundwater sustainability plan or groundwater management plan under this part through a joint powers authority or other agreement with local agencies in the basin. A participating Tribe shall be eligible to participate fully in planning, financing, and management under this part, including eligibility for grants and technical assistance, if any exercise of regulatory authority, enforcement, or imposition and collection of fees is pursuant to the Tribe's independent authority and not pursuant to authority granted to a groundwater sustainability agency under this part.
Draft Discussion Paper Tribal Participation with Groundwater Sustainability Agencies http://www.water.ca.gov/groundwater/sgm/pdfs/SGMA_Tribal_GSAs.pdf
Must a local agency exclude federal and tribal lands from its service area when forming a GSA? No, federal lands and tribal lands need not be excluded from a local agency's GSA area if a local agency has jurisdiction in those areas; however, those areas are not subject to SGMA. But, a local agency in its GSA formation notice shall explain how it will consider the interests of the federal government and California Native American tribes when forming a GSA and developing a GSP. DWR strongly recommends that local agencies communicate with federal and tribal representatives prior to deciding to become a GSA. As stated in Water Code §10720.3, the federal government or any federally recognized Indian tribe, appreciating the shared interest in assuring the sustainability of groundwater resources, may voluntarily agree to participate in the preparation or administration of a GSP or groundwater management plan through a JPA or other agreement with local agencies in the basin. Water Code References: §10720.3, §10723.2, §10723.8

Tribal Outreach Resources

The follow are links to agency tribal outreach resources and considerations, each of which captures important principles and resources for tribal outreach. A short summary of key outreach principles can be found below.

- Draft Discussion Paper Tribal Participation with Groundwater Sustainability Agencies
- CalEPA Tribal Consultation Policy Memo (August 2015)
- DWR Tribal Engagement Policy (May 2016)

- CA Natural Resources Agency Tribal Consultation Policy (November 2012)
- SWRCB Proposed Tribal Beneficial Uses
- Butte County Associate of Governments: Policy For Government-To-Government Consultation With Federally Recognized Native American Tribal Governments *(a model from the transportation sector)*
- CA Court Tribal Outreach and Engagement Strategies
- Traditional Ecological Knowledge resources
- Water Education Foundation Tribal Water Issues

Key Outreach Principles

- Engage early and often
- Consider tribal beneficial uses in decision-making (identified by region here); identify and seek to protect tribal cultural resources
- Share relevant documentation with tribal officials
- Conduct meetings at times convenient for tribal participation with ample notifications
- Request relevant process input/data/information from tribes
- Empower tribes to act as tribal cultural resources caretakers
- Designate a tribal liaison(s) where appropriate
- Share resources for tribal involvement as is feasible
- Develop MOUs where relevant
- Be mindful of the traditions and cultural norms of tribes in your area

Appendix A2.C.a-4: Meeting Locations

The following table presents some options for meeting locations.

Table A2.C.a-E. Meeting locations

Space/Meeting	Address	POC	Capacity	Notes
County of Madera Government Offices • **Board of Supervisors Room** • **Conference rooms 4006** • **Center room 2005**	200 W. 4th Street Room 4006, 4th Floor Madera, CA	Sean Kirkpatrick	25-49	
MID Board room	12152 Rd 28 1/4, Madera, CA 93637	Andrea Sandoval	50 people	Standing Monthly meetings on 20th
The Lodge at Riverstone	370 Lodge Road Madera, CA 93636			
Leadership Council				Monthly meetings
Fairmead and Friends		City of Madera		Mondays and Fridays
Casa de la Vina	23784 Avenue 9 La Vina, CA 93637	Self-Help Enterprises		
Fairmead church				

Frank A. Bergon Senior Center (Multi-Purpose Room)	238 South D Street Madera, CA, 93638	Nicki Rincon	100 people	See here for rates and more

APPENDIX 2.C. NOTICE AND COMMUNICATION

2.C.b. Madera Subbasin Interested Parties List

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

GSP Team:

Davids Engineering, Inc
Luhdorff & Scalmanini
ERA Economics
Stillwater Sciences and
California State University, Sacramento

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Danielle	Duncan			dduncan@suscon.org
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APPENDIX 2.C. NOTICE AND COMMUNICATION

2.C.c. Madera Subbasin Engagement Matrix

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

GSP Team:

Davids Engineering, Inc
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Madera Subbasin Outreach Check List
Subbasin-Wide Centralized Engagement
Informing the Public about GSP Development Progress

Meeting/Event	Location	Meeting/Event date	Topics presented	Audience (estimated # participants; interests represented)	E-blast to Interested Parties list? Which list and when?	Email to Others? Which list and when?	Flyer created?	Flyer distributed at other meetings/events? Where and when?	Information provided at other meetings/events? Where and when?	Additional outreach and publicity (e.g., pop-ups)?	Press release? Which outlets?	Advertised on website? Which website(s)?	Advertised on social media? Which platforms and accounts?	Translation of meeting provided?	Additional comments
SGMA GSP-Specific Events: Subbasin-wide meetings, capacity-building events, educational tours, e-blasts															
Madera Regional Water Management Group	Madera Irrigation District Boardroom	April 11, 2016	SGMA, DWR Grant, Subbasin Boundary lines	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	Oakhurst, Raley's Community Room	May 9, 2016	Groundwater legislation timeline, boundary modifications	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	City of Chowchilla, City Hall	June 13, 2016	Groundwater Management Plan requirements, list of groups filing for their own GSAs	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	Madera Irrigation District Boardroom	July 11, 2016	Madera Grndwtr Authority meeting, DWR Grant PSP, forming a JPA	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	Oakhurst, Raley's Community Room	August 8, 2016	Ea. WD is forming a GSA, Triangle T is becoming a WD	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	City of Chowchilla, City Hall	September 12, 2016	GSP, GSAs, other requirements	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	Madera Irrigation District Boardroom	October 10, 2016	Dissolving GWA/JPA and breaking into SGMA GSAs	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Public Informational Meeting	Harfield Hall, Madera Fair Grounds	October 11, 2016	Basic information to explain SGMA to the public	Approx. 100 landowners and growers	Yes, Interested Party List	Sent out 1,200 invitations to landowners in White Areas						Maderacountywater.com			
Public Informational Meeting	Harfield Hall, Madera Fair Grounds	October 25, 2016	Basic information to explain SGMA to the public	Approx. 100 landowners and growers	Yes, Interested Party List	Sent out 1,200 invitations to landowners in White Areas						Maderacountywater.com			
Madera Regional Water Management Group	Oakhurst, Raley's Community Room	November 14, 2016	Ea. WD is forming a GSA, Triangle T is becoming a WD	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	City of Chowchilla, City Hall	January 9, 2017	Approval of dissolving GWA JPA	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Public Hearing	Madera County Government Center	January 24, 2017	adopt resolution to form 3 GSAs	Public and County	Yes, Interested Party List	RWMG list serve, and the beginnig of interested party list						Maderacountywater.com			
Madera Regional Water Management Group	Madera County Government Center	February 13, 2017	Filing and formation of all the GSAs in each Subbasin	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	Oakhurst, Raley's Community Room	March 13, 2017	EIR and Plan studies have started	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	City of Chowchilla, City Hall	April 10, 2017	SGMA Consolidation and Data Collection Phase reporting	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	Madera County Government Center	May 8, 2017	SGMA and GSA formation and Financial aspects	Public and County	Yes, RWMG list	RWMG list serve, and the beginnig of interested party list						Maderacountywater.com			
Madera Regional Water Management Group	Oakhurst, Raley's Community Room	June 12, 2017	Deadline for GSA formation	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	City of Chowchilla, City Hall	July 10, 2017	Applying for DWR funding, Outreach to DACs	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	Madera County Government Center	August 14, 2017	Creation of the Advisory Committees	Public and County	Yes, RWMG list	RWMG list serve, and the beginnig of interested party list						Maderacountywater.com			

Meeting/Event	Location	Meeting/Event date	Topics presented	Audience (estimated # participants; interests represented)	E-blast to Interested Parties list? Which list and when?	Email to Others? Which list and when?	Flyer created?	Flyer distributed at other meetings/events? Where and when?	Information provided at other meetings/events? Where and when?	Additional outreach and publicity (e.g., pop-ups)?	Press release? Which outlets?	Advertised on website? Which website(s)?	Advertised on social media? Which platforms and accounts?	Translation of meeting provided?	Additional comments
Madera Regional Water Management Group	Oakhurst, Raley's Community Room	September 11, 2017	Chose David's Engineering and Ludhorff and Scalmanini	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	City of Chowchilla, City Hall	October 9, 2017	Reported on writing DWR grant with consultant's assisting	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	Madera County Government Center	November 13, 2017	CWD submitted their DWR App.	Public and County	Yes, RWMG list	RWMG list serve, and the beginnig of interested party list						Maderacountywater.com			
Madera Regional Water Management Group	Oakhurst, Raley's Community Room	January 8, 2018	2 DWR Apps completed	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	Madera County Government Center	February 12, 2018	Advisory Committee created and reporting	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	Madera County Government Center	March 12, 2018	Preliminary water budget was discussed	Public and County	Yes, RWMG list	RWMG list serve, and the beginnig of interested party list						Maderacountywater.com			
Madera Regional Water Management Group	Oakhurst, Raley's Community Room	April 9, 2018	Groundwater model was discussed	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	City of Chowchilla, City Hall	May 14, 2018	Discussions of county white areas	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Public Technical Workshop (#1)	Madera County Juvenile Detention Facility Meeting Room	May 24, 2018	Mngmnt areas, Base Period, GSA Water Budgets, Projects/Mngmnt actions	100 in attendance	Yes, Subbasin List	Interested Party List	Yes					Maderacountywater.com; County Facebook		Yes	
Madera Regional Water Management Group	Madera County Government Center	June 11, 2018	Discussion of groundwater shortages	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Public Technical Workshop (#2)	Madera Farm Bureau	June 25, 2018	Basin Boundary Surface water system - Projects and Mngmnt	60 in attendance	Yes, Subbasin List	Interested Party List						Maderacountywater.com; County Facebook		Yes	
Friends of Fairmead Presentation	Fairmead Galilee Missionary Baptist Church	June 25,2018	SGMA	Fairmead Community	Fairmead and Friends		Yes					Maderacountywater.com			
Madera Regional Water Management Group	Oakhurst, Raley's Community Room	July 9, 2018	Discussion of Management areas	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Groundwater Workshop	Frank Bergon Senior Center	August 2, 2018	SGMA & How to Participate	General Public	Yes, Subbasin List	Interested Party List	Yes					Maderacountywater.com			
Madera Regional Water Management Group	City of Chowchilla, City Hall	August 13, 2018	Working with SHE on DAC outreach	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Supervisor Tom Wheeler, Town Hall Meeting	Bass Lake, The Pines Resort	August 30, 2018	Introduction to SGMA for the Up Stream Users	District 5 Constituents	Yes, District List	District 5 Constituents						Maderacountywater.com			
Madera Regional Water Management Group	Madera County Government Center	September 10, 2018	FloodMar and WAFR and DAC outreach	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Community Outreach	Century 21 for Realtors	September 27, 2019	Introduction to SGMA for the Up Stream Users	25 in attendance	N/A	Realtor Association						Maderacountywater.com			
Madera Regional Water Management Group	Oakhurst, Raley's Community Room	October 8, 2018	Discussion of Modeling and DAC outreach	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
California Coordination with Denmark	Madera County Government Center	October 10, 2018	Knowledge sharing Workshop	50 in attendance	Yes, County List	N/A						Maderacountywater.com			
Public Technical Workshop (#3)	Frank Bergon Senior Center	October 18, 2018	Review SGMA Requirements & subbasin overdraft estimate, GSA conditions & solutions	100 Interested Parties; Consultants	Yes, Subbasin List	Interested Party List						Maderacountywater.com; County Facebook		Yes	
Supervisor Frazier - Coffee and Conversation	Supervisor Frazier and Constituants	October 25, 2018	Introduction to SGMA for the Up Stream and some Valley Users	District 1 Constituents	Yes, District List	District 1 Constituents						Maderacountywater.com			

Meeting/Event	Location	Meeting/Event date	Topics presented	Audience (estimated # participants; interests represented)	E-blast to Interested Parties list? Which list and when?	Email to Others? Which list and when?	Flyer created?	Flyer distributed at other meetings/events? Where and when?	Information provided at other meetings/events? Where and when?	Additional outreach and publicity (e.g., pop-ups)?	Press release? Which outlets?	Advertised on website? Which website(s)?	Advertised on social media? Which platforms and accounts?	Translation of meeting provided?	Additional comments
Madera Regional Water Management Group	City of Chowchilla, City Hall	November 13, 2018	Discussions of joint Subbasin meetings and Groundwater Dependent Ecosystems	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	Oakhurst, Raley's Community Room	January 14, 2019	Discussion of DAC outreach	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Community Pop-Up event	Madera Main Library	January 30, 2019	SGMA and other water information for the public	General Public	N/A	N/A						Maderacountywater.com			
Supervisor Tom Wheeler, Town Hall Meeting	Oakhurst Community Center	January 31, 2019	Introduction to SGMA for the Up Stream Users	District 5 Constituents	Yes; District list	District 5 Constituents						Maderacountywater.com			
Supervisor Frazier, Coffee and Conversation	Ranchos Café	January 31, 2019	Introduction to SGMA for the Up Stream and some Valley Users	District 1 Constituents	Yes; District list	District 1 Constituents						Maderacountywater.com			
Madera and Chowchilla Subbasins Joint Meeting		February 7, 2019	Conceptual Undesirable Results	agriculture, small water users, DACs	Madera Subbasin, County GSA, RWMG	1/28/19 MID send flyer e-blast	Yes	Madera/Chowchilla RCD - 01/09/19, Red Top Landowners - 01/25/19, Triangle T Water District Board and GSA- 02/01/19, Fairmead & Friends meeting	Madera RWMG, Yosemite/Sequoia RC & DC	Pop-up - Madera Library - w/SHE and LC - 01/30/19	Advertised in the "Chatter"	Maderacountywater.com	Self Help SM	Yes	co-sponsored by Self-Help Enterprises and Leadership Counsel for Justice & Accountability
Madera Regional Water Management Group	City of Chowchilla, City Hall	February 11, 2019	Discussion of the GSP and continued DAC outreach	RWMG Board and guests	Yes, RWMG list	RWMG list serve						Maderacountywater.com			
Supervisor Frazier - Coffee and Conversation	Axis Coffee Shop	February 20, 2019	Introduction to SGMA for the Up Stream and some Valley Users	District 1 Constituents	Yes, District List	District 1 Constituents						Maderacountywater.com			
Madera Regional Water Management Group	Madera County Government Center	March 11, 2019	Discussion of SGMA, DAC Outreach, Upcoming meetings	RWMG Board and guests	Yes, RWMG list	RWMG List Serve						Maderacountywater.com			
Supervisor Tom Wheeler, Town Hall Meeting	Raymond Elementary School	March 14, 2019	Introduction to SGMA for the Up Stream Users	District 5 Constituents	Yes; District list	District 5 Constituents						Maderacountywater.com			
Subbasin Informational Pop-Up	Madera County Main Library	March 20, 2019	Discuss Stakeholder Water issues	Public input	N/A	N/A						Maderacountywater.com			
SGMA Madera Subbasin Coordination Committee	Frank Bergon Senior Center	March 21, 2019	State Water Board's Role in SGMA	100 Interested Parties; Consultants	Yes, Subbasin List	Interested Party List; County GSA List	yes					Maderacountywater.com		Yes	
Madera Regional Water Management Group	Raleys Community Room, Oakhurst	April 8, 2019	Discussion of the GSP and continued DAC outreach	RWMG Board and guests	Yes; RWMG list	RWMG list serve						Maderacountywater.com			
Supervisor Tom Wheeler, Town Hall Meeting	Yosemite Lakes Park's Clubhouse	April 9, 2019	Introduction to SGMA for the Up Stream Users	District 5 Constituents	Yes; District list	District 5 Constituents						Maderacountywater.com			
Madera Subbasin Technical Meeting	Madera County Govt Center	April 18, 2019	Minimum Thresholds	100 Interested Parties; Consultants	Yes; Subbasin list	County list						Maderacountywater.com			
SGMA Madera Subbasin Coordination Committee	Frank Bergon Senior Center	April 25, 2019	State Water Board's Role in SGMA	120 Interested Party List; SWRCB	Yes; Subbasin list	Interested Party List; County GSA List	yes					Maderacountywater.com		Yes	
Madera Subbasin Technical Meeting	Madera County Govt Center	May 6, 2019	Minimum Thresholds	Consultants and Interested Parties	Yes; Subbasin list	County list						Maderacountywater.com			
San Joaquin Valley Region, Area IX - of Resource Conservation Districts	Clovis Veterans Memorial Building	May 10, 2019	SGMA Overview and possible roles for RCDs	Resource Conservation Districts, NRCS, other agencies	Yes; RWMG list	RWMG List & Area IX List	yes					Maderacountywater.com			
Madera Regional Water Management Group	City of Chowchilla, City Hall	May 13, 2019	Discussion of the GSP and continued DAC outreach	RWMG Board and guests	Yes; RWMG list	RWMG list serve						Maderacountywater.com			
Release of Water & Natural Resources Newsletter	Internet	May 14. 2019	Introduction to SGMA, Chapter 1 & 2 of the GSP, Tree Mortality	447 Interested Parties & 109 RWMG	Yes	RWMG list serve						Maderacountywater.com			
Pop-Up Event	Madera Fair Grounds	May 15, 2019	General SGMA Information	Various Stakeholders	N/A	N/A						Maderacountywater.com			

Meeting/Event	Location	Meeting/Event date	Topics presented	Audience (estimated # participants; interests represented)	E-blast to Interested Parties list? Which list and when?	Email to Others? Which list and when?	Flyer created?	Flyer distributed at other meetings/events? Where and when?	Information provided at other meetings/events? Where and when?	Additional outreach and publicity (e.g., pop-ups)?	Press release? Which outlets?	Advertised on website? Which website(s)?	Advertised on social media? Which platforms and accounts?	Translation of meeting provided?	Additional comments
Supervisor Tom Wheeler, Town Hall Meeting	Coarsegold Community Center	May 23, 2019	Introduction to SGMA for the Up Stream Users	District 5 Constituents	Yes; District list	District 5 Constituents						Maderacountywater.com			
SGMA Madera Subbasin Coordination Committee	County Government Building, Madera	May 29, 2019	State Water Board's Role in SGMA	100	Yes; Subbasin list	Interested Party List; County GSA List	yes					Maderacountywater.com		Yes	
Water & Natural Resources Newsletter	Internet	May 31. 2019	SGMA and related Grants, Flood Related Grant Awards, Chapter 1 & 2 of the GSP, Keeping Your Property Firesafe	447 Interested Parties & 109 RWMG	Yes	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	County Government Building, Madera	June 24, 2019	Discussion of the GSP and continued DAC outreach	RWMG Board and guests	Yes; RWMG list	RWMG list serve						Maderacountywater.com			
Supervisor Tom Wheeler, Town Hall Meeting	North Fork Mono Rancheria Community Center	June 27, 2019	Introduction to SGMA for the Up Stream Users	District 5 Constituents	Yes, District List	District 5 Constituents						Maderacountywater.com			
Water & Natural Resources Newsletter	Internet	June 28. 2019	Advisory Committee for the County GSAs, Flood Control and Water Conservation Agency, Chapter 1 & 2 of the GSP,Non-Native Plants on Rangelands	447 Interested Parties & 109 RWMG	Yes	RWMG list serve						Maderacountywater.com			
Madera Regional Water Management Group	Raleys Community Room, Oakhurst	July 22, 2019	Discussion of the GSP and continued DAC outreach	RWMG Board and guests	Yes; RWMG list	RWMG list serve						Maderacountywater.com			
Brett Frazier Coffee and Cnversation	Rancho's Café - Madera Ranchos	July 24, 2019	Release of the SGMA Plan	Madera Ranchos Community Members	Yes; District list							Maderacountywater.com			
Water & Natural Resources Newsletter	Internet	July 31. 2019	Advisory Committee for the County GSAs, Flood Control and Water Conservation Agency, Chapter 1 & 2 of the GSP,Non-Native Plants on Rangelands	447 Interested Parties & 109 RWMG	Yes	RWMG list serve						Maderacountywater.com			
On the Road - Board of Supervisor Meeting and GSA Update	Fairmead Middle School	August 6, 2019	GSA Update	Community Members	Yes							Maderacountywater.com			
Madera Subbasin GSA Meeting	Madera County Board of Supervisor Chambers	August 7, 2019	GSA Update	Advisrory Committee and Interested Parties	Yes	Interested Party						Maderacountywater.com			
Brett Frazier Coffee and Cnversation	Rancho's Café - Madera Ranchos	August 21, 2019	Release of the SGMA Plan	Madera Ranchos Community Members	Yes; District list							Maderacountywater.com			
Supervisor Tom Wheeler, Town Hall Meeting	The Pines - Bass Lake	August 22, 2019	Introduction to SGMA for the Up Stream Users	District 5 Constituents	Yes; District list	District 5 Constituents						Maderacountywater.com			
Madera Regional Water Management Group	City Hall, Chowchilla	August 26, 2019	Discussion of the GSP and continued DAC outreach	RWMG Board and guests	Yes	RWMG list serve						Maderacountywater.com			
Water & Natural Resources Newsletter	Internet	August 30. 2019	Advisory Committee for the County GSAs, Flood Control and Water Conservation Agency, Chapter 1 & 2 of the GSP,Non-Native Plants on Rangelands	447 Interested Parties & 109 RWMG	Yes	RWMG list serve						Maderacountywater.com			
Supervisor Frazier - Coffee and Conversation	Axis Coffee Shop	September 18, 2019	Introduction to SGMA for the Up Stream and some Valley Users	District 1 Constituents		District 1 Constituents									
Supervisor Tom Wheeler, Town Hall Meeting	Ahwahnee Elementary School	September 19, 2019	Introduction to SGMA for the Up Stream Users	District 5 Constituents		District 5 Constituents									
Madera Regional Water Management Group	County Government Building, Madera	September 23, 2019	Discussion of the GSP and continued DAC outreach	RWMG Board and guests		RWMG list serve									
Water & Natural Resources Newsletter (October)	Internet	October 1, 2019	Links to all GSAs, Sediment Removal Permits,Protect your waterways	447 Interested Parties & 109 RWMG	Yes	RWMG list serve									
San Joaquin Valley Region, Area IX - of Resource Conservation Districts	Vineyard Restaurant Community Room	October 11, 2019	SGMA Overview and possible roles for RCDs	Resource Conservatin Districts, NRCS, other agencies		RWMG List & Area IX List	yes								
Supervisor Tom Wheeler, Town Hall Meeting	Oakhurst Community Center	October 17, 2019	Introduction to SGMA for the Up Stream Users	District 5 Constituents		District 5 Constituents									
SGMA Madera Subbasin Coordination Committee	County Government Building, Madera	October 22, 2019	Comment Period Listening Session	40 interested parties, consultants		Interested Party List; County GSA List	yes							Yes	
Madera Regional Water Management Group	Raleys Community Room, Oakhurst	October 28, 2019	Discussion of the GSP and continued DAC outreach	RWMG Board and guests		RWMG list serve									

Meeting/Event	Location	Meeting/Event date	Topics presented	Audience (estimated # participants; interests represented)	E-blast to Interested Parties list? Which list and when?	Email to Others? Which list and when?	Flyer created?	Flyer distributed at other meetings/events? Where and when?	Information provided at other meetings/events? Where and when?	Additional outreach and publicity (e.g., pop-ups)?	Press release? Which outlets?	Advertised on website? Which website(s)?	Advertised on social media? Which platforms and accounts?	Translation of meeting provided?	Additional comments
Water & Natural Resources Newsletter (November)	Internet	October 31. 2019	County GSA Fees, Flood Control and Water Conservation Agency, Links to all GSPs,Fractured Rock Groundwater	447 Interested Parties & 109 RWMG	Yes	RWMG list serve									
Yosemite/Sequoia Resource Conservation & Development Council	Clovis Veterans Memorial Building	October 31. 2019	Introduction to SGMA for the Up Stream Users	Members of agencies, RCDs, Tribes, etc over four counties											
SGMA Madera Subbasin Coordination Committee	County Government Building, Madera	December 2, 2019	Review of GSP and vote on Recommendation to Adopt Plan			Interested Party List; County GSA List	yes							Yes	
Other Events/Meetings: non-SGMA meetings at which information was provided about GSP development, updates provided to area legislative bodies															

APPENDIX 2.C. NOTICE AND COMMUNICATION

2.C.d. Madera Subbasin Stakeholder Input Matrix

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

GSP Team:

Davids Engineering, Inc
Luhdorff & Scalmanini
ERA Economics
Stillwater Sciences and
California State University, Sacramento

Madera Subbasin Stakeholder Input

Type of Beneficial User	Interests of Beneficial User	How interests were taken into consideration in GSP development

APPENDIX 2.C. NOTICE AND COMMUNICATION

2.C.e. Responses to Comments

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

GSP Team:

Davids Engineering, Inc
Luhdorff & Scalmanini
ERA Economics
Stillwater Sciences and
California State University, Sacramento

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1 COMMENTS RECEIVED

Under the Sustainable Groundwater Management Act (SGMA), the four GSAs, City of Madera, Madera County--Madera GSA, Madera Irrigation District GSA, and Madera Water District GSA for the Madera Subbasin (Subbasin) have solicited and responded to comments from the public and from other agencies concerned with the Draft Groundwater Sustainability Plan (GSP). The Draft GSP was made available by the GSA's for public review on August 7, 2019. The public comment period for the Draft GSP ended on November 9, 2019. Agencies, organizations, and individuals submitting comments on the plan are listed below.

- Al Solis (4/2)
- Anonymous (7/16) – two copies
- Bill Diedrich (5/19)
- Bill Diedrich (11/8)
- California Poultry Federation (11/8)
- Erik Smith (4/3)
- Food Commons Fresno/Road 20 Farm (11/8)
- Fresno Irrigation District (11/8)
- Hancock Farmland Services (11/8)
- James Paul Provenzano (9/4)
- James Paul Provenzano (10/22)
- Jeannie Habben (4/17)
- Joint Letter/Ag Innovations (11/8)
- Leadership Counsel for Justice and Accountability (LCJA) (6/27)
- Leadership Counsel for Justice and Accountability (11/8)
- Madera Valley Water Company (11/8)
- Mark Hutson (11/2)
- Madera Agricultural Water Association (11/9)
- McCormick, Barstow, Sheppard, Wayte & Carruth LLP (10/21)
- North Kings GSA (11/8) – submitted twice (once by Kassy Chauhan and once by Lynn Rowe)
- Provost & Pritchard (11/1)
- Root Creek Water District (11/9)
- Sarb Johal (10/22)
- Self-Help Enterprises (11/8)
- San Joaquin River Exchange Contracts GSA (11/8)
- The Nature Conservancy (7/1)
- The Nature Conservancy (11/8)
- Valley Children's Hospital (11/8)
- Verbal comments from 10/22 meeting
- Wonderful Citrus (11/8)

To finalize the GSP, the GSA's have prepared the following responses to comments that were received during the public review period. First, in Section 2, responses are given for subjects with multiple comments. The next section, Section 3, provides a table of all the comments and responses, with reference to the multiple comment subject area responses where appropriate. The last section, Section 4, provides every comment received for review.

2 MULTIPLE COMMENT SUBJECT AREA RESPONSES

2.1 Demand Management Reduction Program

2.1.1 Comment Summary

Numerous comments have been received from the community stating that the GSP does not adequately develop the details of the demand management program. Many commenters believe that pumping restrictions should only be implemented if necessary to achieve sustainability, and should gradually ramp down pumping over the implementation period to avoid a sudden adverse impact on the local economy. Other commenters believe that demand management should start immediately. The overarching sentiment is that the demand management program should be developed through a stakeholder driven process.

2.1.2 Response

The demand reduction targets described in the GSP correspond to the estimated subbasin groundwater budget shortage (i.e., incorporates only vertical inflows/outflows within Subbasin boundaries) after inclusion of planned water supply projects. The details of demand reduction are being evaluated and vetted with stakeholders and the public through numerous venues including the Madera County GSA's Advisory Committee (Committee), Madera County GSA meetings, Coordination Committee meetings, discussions with Madera County Farm Bureau, and the Madera Ag Water Association. The vast majority of demand reduction is anticipated to occur within the Madera County GSA area. The required scale of the demand management program will be reassessed every five years as part of the five-year review. It will be scaled down, or up, as necessary to balance groundwater extraction and groundwater recharge as other projects are implemented over the 20-year implementation period and subsequent sustainability period. The Madera County GSA has been meeting regularly and will continue to meet regularly with stakeholders, the Committee and the other organizations highlighted above with the objective of formulating workable demand management programs acceptable to stakeholders that meet subbasin sustainability objectives, and providing such information to the Madera County Board of Supervisors (the elected body for the Madera County GSA) for implementation consideration.

Based on the best available data and appropriate analytical tools applied in the GSP, significant demand reductions are necessary in the Madera Subbasin in order to achieve long-term groundwater sustainability. These reductions are focused primarily within the Madera County GSA's service area. To avoid a sudden and adverse disruption to the local economy, the anticipated demand reductions will be introduced gradually during the implementation period, as described in Section 4.4.4 of the GSP.

The method for monitoring and enforcing anticipated demand reduction is being developed by the GSAs, with input provided to Madera County GSA from the various stakeholders and groups identified above. Demand reductions will likely be verified through a combination of remote sensing and water meters, the details of which will be further developed during the initial year of the implementation period.

2.2 Groundwater Dependent Ecosystems

2.2.1 Comment Summary

Comments regarding groundwater dependent ecosystems (GDEs) focused on the methods used to identify potential GDEs, data gaps related to shallow groundwater, the analysis of potential impacts to potential GDEs, consideration of protected species and habitats, and the consideration of potential GDEs in setting sustainability goals, measurable objectives, and minimum thresholds. Comments included recommendations that environmental uses and users of groundwater, including potential GDEs, should receive additional attention in the GSP and that environmental priorities and benefits should be a consideration in selecting and describing projects and management actions. Several comments identified perceived deficiencies in the data used to map shallow groundwater levels, the use of a depth to water (DTW) criterion to screen potential GDEs, and the assumptions regarding surface water – groundwater interactions in the San Joaquin River and Fresno River in the subbasin. Comments regarding surface water – groundwater interactions are addressed in Section 2.3 below. One comment expressed appreciation for the comprehensive evaluation of the four potential GDE units identified in the subbasin and acknowledged the appropriate use of tools and guidance recommended by The Nature Conservancy.

2.2.2 Response

Methods used to identify and screen potential GDEs for further analysis included analyzing shallow groundwater depth beneath areas mapped as potential GDEs. A DTW of 30 feet was used as one of the primary criteria in the initial screening of potential GDEs. Potential GDEs were retained for further analysis if the underlying DTW in either winter/spring 2014 or winter/spring 2016 was equal to or shallower than 30 feet. The 2014 and 2016 DTW data were the most accurate and recent DTW data available for the Madera Subbasin. While the 2016 data represent conditions after the 2015 SGMA baseline, the use of shallow groundwater data from both years was deemed appropriate because it provided a more conservative (i.e., more inclusive) indicator of potential GDEs than the use of a data from a single year. Where DTW was greater than 30 feet, other criteria including surface flow characteristics of waterbodies were used to determine whether potential GDEs should be subject to further analysis. The GSP has been revised to clarify the data and approach used for identification and screening of potential GDEs and to provide additional description of environmental uses and users of groundwater, including potential GDEs. The GDE Appendix (Appendix 2.B) has also been revised to include these clarifications.

Identification of final potential GDEs and analysis of potential impacts related to groundwater use was based on multiple sources of information to identify historical and current ecological conditions and trends, ecological value, and vulnerability to future changes in groundwater and interconnected surface water (if any). Information sources included multiple vegetation mapping datasets; field evaluation of potential GDEs; climate and surface hydrology data; satellite-derived vegetation data; hydrogeology data; lists and spatial data for potentially-occurring special-status and groundwater-dependent species and natural communities provided by the California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, National Marine Fisheries Service, Pacific Fishery Management Council, and The Nature Conservancy; and beneficial uses of water from the Basin Plan. Appendix 2.B describes the sources of data used for the GDE analysis and how protected species and habitats were considered in the analysis of potential impacts to GDEs. It also describes gaps in the shallow groundwater data for some of the potential GDE units and recommended methods for collecting data to fill these gaps and periodically re-evaluate potential GDE conditions using an adaptive management approach

The GDE analysis determined there were no undesirable results related to potential GDEs. Groundwater in the Friant Riparian, Fresno River, and San Joaquin River Riparian potential GDE Units are tightly coupled with surface flow and runoff, with surface flow likely contributing directly to the shallow groundwater systems that support the vegetation in the units. Based on current evidence and recent historical response patterns, the dominant native vegetation composing these potential GDE units and the Sumner Hill Potential GDE Unit appear sufficiently resilient to maintain ecosystem integrity and function in the face of predicted fluctuations in groundwater conditions around the recent historical baseline level. The susceptibility of the Sumner Hill Potential GDE Unit to changing shallow groundwater conditions cannot be determined based on a lack of shallow groundwater data. Evidence suggests that groundwater quality is not limiting ecosystem functions essential for the survival and reproduction of riparian plant species in these potential GDE units.

The sustainability goal developed for the Madera Subbasin is expected to maintain the ecological integrity and function of the potential GDE Units. This includes maintenance of riparian habitat conditions for special-status species and other native species in the units or those likely to occur, and provision of important ecosystem support functions for Central Valley spring-run Chinook salmon, Central Valley steelhead, and other special-status species and native aquatic species in the adjacent San Joaquin River (for applicable potential GDE Units in these areas). Restoration flows in the San Joaquin River under the San Joaquin River Restoration Program (SJRRP) are expected to provide continued hydrologic inputs contributing to long-term support of the Friant Riparian Potential GDE Unit and the San Joaquin River Riparian Potential GDE Unit. The GSP's sustainability goal is unlikely to affect the hydrological or ecological conditions of the other potential GDE units in the Madera Subbasin, as these potential GDE units are not expected to be affected by groundwater management under the GSP. The vegetation communities composing the potential GDE units in the subbasin are expected to be largely unaffected by sustainable groundwater management in the Madera Subbasin and thus the minimum thresholds are not expected to cause adverse impacts to potential GDEs. The native vegetation communities composing the potential GDE units are expected to be maintained in good health by sustainable groundwater management in the Madera Subbasin and are therefore resilient to short-term adverse impacts, thus the minimum thresholds are not expected to cause substantial adverse impacts to potential GDEs. Measurable objectives and interim milestones for groundwater levels, the sustainability indicator most likely to affect potential GDEs in the subbasin, have been established for the four wells that are considered to represent the shallow groundwater conditions associated with the potential GDE units in the subbasin.

2.3 Surface Water – Groundwater Interactions

2.3.1 Comment Summary

The comments received regarding surface water – groundwater interaction center around there being insufficient characterization of surface water – groundwater interactions, insufficient description of data gaps and how they will be filled, that the GSP states a surface water – groundwater connection did exist for the San Joaquin River prior to 2008, and disagreement with the conclusion that surface water and groundwater are disconnected in the subbasin.

2.3.2 Response

The evaluation of surface water – groundwater interaction included: evaluation of DWR unconfined groundwater elevation contour maps and data from the late 1950s through 2016; compilation and contouring of shallow groundwater level data representative of SGMA baseline conditions for winter/spring 2014 and winter/spring 2016 time periods (to bracket January 2015 conditions for which very limited data are available); evaluation of the presence of shallow clay layers – particularly the "A" and "C" Clays of the Tulare Formation (and other shallow clay layers at equivalent depths or shallower) that are above the Corcoran Clay; evaluation of perched groundwater conditions relative to conditions in the regional unconfined groundwater system; review of existing studies on stream infiltration; stream gaging data; and discussion with local GSA representatives regarding seepage of irrigation water conveyed through natural waterways during the irrigation season.

As described in various sections of the GSP, these data consistently demonstrate a lack of groundwater – surface water interaction throughout the vast majority of the subbasin because of the great depths to the regional groundwater system. As noted previously, based on groundwater levels alone, only the San Joaquin River has a potential for a surface water – groundwater connection, although hydrogeologic conditions along the San Joaquin River are considerably more complicated than for other rivers/streams. This is due to the presence of shallow clay layers along the San Joaquin River combined with stream infiltration leading to unusually shallow groundwater levels in isolated areas. These shallow clay layers extend a short distance into the Madera Subbasin in some areas, causing pockets of shallow groundwater levels along the San Joaquin River within Madera Subbasin.

The depths to shallow groundwater increase rapidly where the shallow clay layers pinch out within Madera Subbasin (see Figures 2-71 and 2-72), which demonstrates the important role that shallow clay layers play in maintaining shallow groundwater levels and impeding vertical water movement. Were it not for the shallow clay layers, shallow groundwater levels would likely be considerably deeper. The connection between regional groundwater pumping at greater depths within the Upper Aquifer and shallow groundwater levels that are essentially perched/mounded on shallow clay layers is not well defined.

As described in the GSP, even when considering the very shallowest wells screened above the shallow clay layers, shallow groundwater levels for winter/spring of 2014 and 2016 appear to be below the San Joaquin River thalweg. While shallow groundwater levels rise and fall from wet to dry season and wet year to dry year and may become connected to surface water for short durations, defining an interconnected surface water – groundwater system should require that such a connection exists under a broad range of seasonal and climatic year conditions. It is important to note that regional groundwater pumping is most substantial during dry seasons and dry years, when the connection between groundwater and surface water is least likely to exist.

While it appears that a surface water – groundwater connection to the San Joaquin River did exist historically (prior to 2008), SGMA does not require restoration of basin groundwater conditions prior to January 2015. However, there remains a possibility that projects/management actions implemented to reach sustainability may ultimately restore the surface water – groundwater connection for the San Joaquin River.

As described above, a detailed analysis of surface water – groundwater connection has been conducted for the GSP based on available data. In addition, seven new monitoring locations are currently under construction for nested monitoring wells screened at three different depths, including a shallow well to represent the unconfined aquifer water table at each location. This new nested monitoring well data, data being collected under the GSP monitoring program, and other ongoing data collection efforts (e.g., SJRRP, ILRP) will be evaluated in terms of surface water – groundwater connections as part of the five-year progress evaluation report.

2.4 Outreach (including DACs/SDACs)

2.4.1 Comment Summary

The comments received regarding outreach and disadvantaged/severely disadvantaged communities (DACs/SDACs) relate to stakeholder engagement during plan development and implementation, and to protecting the needs of DACs and drinking water users. One comment says that certain kinds of beneficial users, such as small sustainable farmers, socially disadvantaged farmers, and drinking water users, have not been adequately involved in development of the GSP and their input has not been sufficiently incorporated into the GSP. Another requests a specific plan be set forth for stakeholder engagement throughout implementation. A comment recommends that a stakeholder-driven process to establish details of demand management policy should also ensure that the allocation methodology is consistent with established water rights doctrines.

Comments related to DACs and SDACs focus on the need for the GSP to clearly demonstrate how DACs and drinking water users will be protected. One comment asserts that 63% of wells are likely to go dry under the current plan and adequate funding to address these impacts is not provided. Multiple comments state that the monitoring network fails to capture drinking water impacts to DACs, small water systems, and domestic wells, so the Plan is likely to cause a disparate impact on these groups. A comment suggests additions to the monitoring network should consider the locations of these beneficial users. A comment says that the GSP should provide additional information about how the risks associated with projects such as on-farm recharge will be monitored and evaluated. Another says that the GSP should explain how drinking water use and users are being considered in development of the demand management program, especially the allocation framework and groundwater market. Another comment advises that in establishing project priorities, criteria should include multi-benefit projects that address water quantity as well as providing environmental benefits or benefits to DACs.

2.4.2 Response

Some of the comments cited above are addressed under Section 2.7 of this response to comments. Further detail was added to Section 2.1.5.3 of the GSP about how engagement efforts encouraged the active involvement of DACs. Madera County worked with Self-Help Enterprises (SHE) and the Leadership Counsel for Justice and Accountability (LCJA), organizations that represent DAC communities, to inform DAC members about the plan and encourage their involvement. LCJA and SHE were also consulted to help determine how to facilitate participation by DAC members in outreach activities, for example by holding workshops at different times or locations. LCJA and SHE each received grants between $750,000 to $1 million from the Department of Water Resources for outreach to promote meaningful participation of SDACs in groundwater sustainability activities in multiple subbasins in the state, including Madera subbasin. Under the grants, they promoted community participation through community involvement, outreach, and technical assistance. The GSAs provided letters of support for SHE and LCJA's applications for this funding.

Engagement matrices in Appendix 2.C.c list the numerous opportunities for engagement and the participation in these events. Participants in engagement efforts, such as attendees of public meetings, were not asked to identify themselves by beneficial user category.

The Environmental and Ecosystem category of interest in Table 2-4 has been expanded with the names of specific groups. Throughout GSP development and beyond, any interested person or organization could be added to the Interested Parties list by submitting a request at https://www.maderacountywater.com/join-list/.

2.5 Subsurface Inflows

2.5.1 Comment Summary

The comments received on subsurface inflows relate to the need to calculate subsurface inflows/outflows separately for the Upper Aquifer and Lower Aquifer, subsurface inflows/outflows were calculated using an uncalibrated numerical model, there have historically and consistently been subsurface inflows to Madera Subbasin from Delta-Mendota Subbasin, net subsurface inflows to Madera Subbasin from the Delta-Mendota Subbasin have caused migration of high TDS groundwater into Delta Mendota Subbasin, and that Madera Subbasin is not properly accounting for subsurface inflows from Kings Basin in its water balance and sustainable yield calculations.

2.5.2 Response

In the Madera Subbasin area, subsurface groundwater flows between subbasins likely occurred naturally under historical and pre-development conditions. More recently, groundwater development in and around the Madera and adjacent Subbasins has likely resulted in alterations of groundwater flows between subbasins; however, SGMA does not require correction of conditions that existed prior to 2015. The estimates of projected future conditions based on the best available data and scientific methods show lateral inflow decreasing over the 2020 to 2040 implementation period and the 2040 through 2090 sustainability period, such that the lateral inflows from adjacent subbasins will be significantly reduced during the sustainability period. Calibrated model estimates indicate that due to projects and management actions implemented in the Madera Subbasin, the cumulative lateral inflows from other subbasins to the Madera Subbasin will be significantly less than they would be without SGMA.

The calibrated numerical groundwater model estimates of net subsurface inflow/outflow are highly dependent on available groundwater level data for the Upper and Lower Aquifers in adjacent subbasins, which provide important boundary conditions for the model. There is a particular lack of data for the Lower Aquifer in the Delta-Mendota Subbasin and Kings Subbasin, which impact reliability of absolute estimates of groundwater inflow/outflow regardless of whether a calibrated numerical groundwater model (computer model) or analytical approaches (e.g., Darcy's Law calculation) is being used. Numerical and analytical modeling techniques rely on many of the same assumptions and both rely heavily on observed data for calibrating a numerical model or for input in analytical methods. A numerical modeling approach provides the additional ability to evaluate conditions at a higher temporal resolution that is typically possible with analytical techniques and also enables the ability to simulate outcomes under future scenarios of conditions/activities. It is more important to evaluate how historical/current groundwater inflows/outflows are anticipated to change as the Madera Subbasin and surrounding subbasins evolve towards sustainability in 2040 and beyond, and a calibrated numerical groundwater model is a commonly used and widely accepted tool that can be used to evaluate the relative change in groundwater levels and subsurface inflow/outflows. The calibrated numerical groundwater developed and utilized in the Madera Subbasin GSP analyses was refined from DWR's C2VSim regional model and recalibrated to local conditions. Still, there is need for additional review and analysis of hydrogeologic conditions within and around Madera Subbasin, particularly in the area adjacent to the southeast boundary with Kings Subbasin, and it is anticipated that revisions to the model will be conducted as part of the model update to be completed in conjunction with five-year reporting in 2025. It is expected that the model revisions will likely reduce the estimated inflows currently being simulated from Kings and Delta-Mendota Subbasins.

Regardless of how subsurface inflow/outflow is quantified and what the estimated values are historically, currently, and in the future; the most important point to recognize related to the Madera Subbasin GSP is that net subsurface inflow does not factor into the water balance shortage (also described as net recharge in the GSP) that forms the basis for required projects and management actions to reach sustainability. Thus, relative to sustainability as defined in the GSP, subsurface inflows do not contribute to meeting the sustainability goals.

The comment regarding migration of high TDS groundwater related to subsurface flow between subbasins appears to be based on analyses conducted for the Delta-Mendota Subbasin GSP (for SJREC Plan Area) that are not yet available for public review and comment. Thus, it is not possible to evaluate this comment. It is notable that groundwater occurring on the west side of the San Joaquin Valley associated with Coast Range-sourced sediments from the west, including throughout much of the Delta-Mendota Subbasin, has naturally high salinity, at levels considerably higher than in most of the Madera Subbasin. However, the mechanism and/or conditions that would cause or exacerbate migration of high TDS groundwater into the Delta-Mendota Subbasin is not described in the comment.

The Madera Subbasin anticipates updating the calibrated numerical groundwater model with new information collected between now and the five-year update in 2025. Subsurface inflows and outflows from the updated model will be re-evaluated during preparation of the five-year update report in 2025. These updates will include a review of a refined calibrated regional model (Central Valley IWFM) that DWR is continuing to work on in 2019, additional water level data from existing and new monitoring wells being installed in Madera Subbasin, and possibly additional water level data in adjacent subbasins that are lacking key data as of 2019 (e.g., Lower Aquifer in Delta-Mendota Subbasin).

2.6 Groundwater Quality

2.6.1 Comment Summary

Several comments were received regarding how the GSP addresses the groundwater quality degradation sustainability indicator. Comments received focus on constituents not specifically included as key constituents in the GSP (e.g., manganese, uranium, DBCP, EDB, 1,2,3-TCP, perchlorate, BTEX, pesticides); uncertainty regarding what are being used as water quality MTs; confusion regarding RMS sites for water levels vs. water quality; general concern about groundwater contamination impacting domestic wells and associated lack of SMCs for various potential groundwater contamination constituents; SGMA charges GSAs with responsibility to protect groundwater quality from further degradation due to groundwater management practices; proposed GSP activities present groundwater quality risks (e.g., increase in naturally occurring contaminants; movement of contaminant plumes; on-farm recharge causing vertical migration of various constituents); the GSP should include monitoring for a long list of constituents including all constituents with primary drinking water standards, PFOSs/PFOAs at all RMS sites and wherever domestic wells are present; the MTs/MOs are set are too high; the definition of undesirable results for groundwater quality degradation is inadequate; and the groundwater quality monitoring network is inadequate.

2.6.2 Response

The SGMA process and GSPs are not the primary means of addressing groundwater quality issues resulting from waste discharges, which are under the jurisdiction of the other regulatory programs overseen by the State Water Resources Control Board (SWRCB) and Regional Water Quality Control Board (RWQCB). By far, the main constituent of concern to domestic wells in Madera Subbasin is nitrate. Nitrate contamination is already being addressed by the RWQCB and SWRCB, which have primary responsibility for addressing groundwater quality issues in general. The RWQCB also addresses other contaminants that are or may become a concern in the subbasin in the future. The responsibility of the GSP relative to groundwater quality mainly falls into the following categories: 1) Altering the movement and spread of known contaminant plumes due to GSP projects/management actions; 2) Impacts that are specifically related to declining groundwater levels (e.g., arsenic, possibly TDS); 3) Flushing of contaminants from the vadose zone in recharge project areas (although this may be more of a short-term impact issue with ultimately beneficial impacts to the basin through dilution and recharge of higher quality water). These three issues are described and addressed in the GSP.

With regard to comments on groundwater quality MTs, we note the following:

- it is not reasonable to set MTs below existing concentrations because there would be an exceedance of the MT before GSP Implementation even starts;
- policies specifically designed solely to improve water quality issues unrelated to GSP implementation are not required for a GSP; nonetheless, recharge projects have the potential to improve water quality in the long term;
- it is unreasonable to set MTs for all potential contaminants; one of the tasks of the studies conducted for the GSP is to identify the primary constituents of concern for setting MTs;
- oversight of subbasin groundwater quality is primarily the responsibility of the RWQCB and SWRCB and corresponding programs, not the GSP.

Following up on item 3 in the above paragraph, it is not the responsibility of the GSAs or GSP to monitor all groundwater contaminants. Public and community small water systems have certain groundwater sampling and reporting requirements for a range of constituents. Such information is collected and reported to various State agencies (e.g., Division of Drinking Water). When specific contaminants of concern are identified, the RWQCB and SWRCB have jurisdiction on requiring additional monitoring and remediation for protection of beneficial uses, if required.

The RMS networks for groundwater levels and groundwater quality are shown in GSP Figures 3-1 and 3-2. While there is considerable overlap between the two RMS networks that will result in many RMS locations collecting both groundwater level and quality data, the RMS locations for groundwater levels and groundwater quality are not the same. Each RMS network presented in the GSP is considered adequate as a starting point, but will be supplemented as data gaps are filled during the Implementation Period.

2.7 Groundwater Levels Related to Domestic Wells

2.7.1 Comment Summary

The comments on this topic are related to the number of domestic wells to be impacted by declining groundwater levels during the Implementation Period; the GSP did not fully and/or equally consider input from disadvantaged communities and potential impacts to domestic wells vs. agricultural groundwater users; groundwater level MTs/MOs are too low and do not protect domestic wells; and presenting alternative analyses regarding the estimated number of domestic wells that will be partially dewatered or go dry during the Implementation Period.

2.7.2 Response

The GSAs have seriously and meaningfully considered various inputs received from disadvantaged communities and other beneficial users in the subbasin, which often present conflicting opinions on GSP sustainable management criteria. During the GSP development process, reactions and concerns of basin stakeholders regarding initial draft MOs/MTs ranged broadly from those concerned they were too high to others feeling they were too low. With specific regard to the basin stakeholders claiming the currently proposed groundwater level MTs are too low, we note the following:

- the MTs cannot be interpreted in isolation from the rest of the Plan; the MTs are designed to work in conjunction with the domestic well mitigation program;
- the MTs are generally not an indication of where the basin water levels are expected to be with proper implementation of the GSP; rather the interim milestones and the MO's represent anticipated typical basin water levels after 2020 and 2040, respectively;
- The most challenging period for groundwater levels moving forward is expected to be the early to middle portions of the Implementation Period, and the single biggest factor impacting groundwater levels during this time is expected to be climatic fluctuations in wet and dry years and the sequence of these wet and dry years.

The comment letters' characterization of domestic wells expected to go dry does not appear to be accurate; however, at a minimum the underlying assumptions and methodology for the analysis are not presented and/or are not clear. For example, stating that a large number of wells (570) will go dry if the groundwater levels represented by MOs are reached does not consider that virtually all RMS sites show recent and/or current groundwater levels below the MO, indicating such wells would already be dry and (in most cases) have been dry for several years now. In addition, any such analysis needs to have a time element in the analysis to understand how many currently viable wells are impacted during the Implementation Period.

Furthermore, for RMS wells that are screened below typical domestic wells, the groundwater levels represented on the hydrographs for Lower Aquifer wells are typically deeper than what would be experienced at the shallower domestic wells – meaning impacts to domestic wells will be less than indicated by this review of hydrographs. Again, the domestic well mitigation plan component of the GSP is being designed to address domestic wells that may go dry.

The projects and management actions by GSAs to be put in place during the Implementation Period (including some projects that have already been implemented) will protect a number of domestic wells from going dry after implementation begins in 2020. It is anticipated that owners of domestic wells that do go dry and meet conditions set forth in the planned domestic well mitigation program will have recourse through the domestic well mitigation program. Setting much higher minimum thresholds to ensure no domestic wells go dry will cause major economic impacts to the community at large, including DACs/SDACs and domestic well owners. The GSP provides the most reasonable solutions available to address concerns of all basin stakeholders, while still achieving sustainability by 2040 as required by SGMA. Alternatives that may reduce the decline in groundwater levels have sudden economic impacts to all beneficial users.

The Self-Help Enterprises (SHE) analysis of the number of domestic wells projected to go dry yielded considerably different results than described in the public draft GSP. Such analyses can vary widely depending on key assumptions applied. It appears that one of the major differences in assumptions is that the analysis presented in the GSP is focused on how many domestic wells may be impacted after 2020 (i.e., it is time dependent), whereas the analysis conducted by SHE does not appear to distinguish between wells that were previously impacted versus wells that would be impacted during the Implementation Period. To address these different results, a sensitivity analysis was added to Appendix 3.D to examine costs to replace 500 to 1,000 domestic wells during the Implementation Period. As described in Appendix 3.D, the costs for replacement of up to 1,000 domestic wells remains a very small fraction of the economic cost of the alternative involving immediate implementation of the full volume of demand management.

Madera County prepared and recently submitted a Prop 68 grant application to conduct a detailed domestic well inventory. This more detailed analysis of domestic wells will provide a considerably more accurate database to support development of the domestic well mitigation program through analyses of potential domestic well impacts during the Implementation Period.

2.8 Subsidence Issues

2.8.1 Comment Summary

The comments on this topic are related to the reported occurrence of significant infrastructure impacts related to subsidence in Madera Subbasin; the GSP should set SMC for subsidence regardless of the historical non-occurrence of significant impacts to infrastructure, the GSP is not in compliance with SGMA related to lack of subsidence SMC being established in the GSP; the GSP should set subsidence SMC now instead of doing adaptive management; there is no discussion of subsidence along the Eastside Bypass near the Fresno River, there is no discussion of collapsed wells; western Madera County adjacent to Delta-Mendota Subbasin should be implementing similar mitigation measures as provided for the in the Triangle T Water District agreement with SJREC – including reducing pumping from the Lower Aquifer to no more than the sustainable yield ; and the GSP fails to identify/address subsidence occurring along the Eastside Bypass and near the Delta-Mendota Subbasin.

2.8.2 Response

The GSP consultant team and GSA representatives reviewed their understanding of the occurrence of significant impacts to infrastructure related to subsidence. The GSAs concluded that, while some small amounts of subsidence had occurred in Madera Subbasin (within the area of the joint GSP), there had not been significant infrastructure impacts in the Plan Area. This conclusion was presented in public meetings and the GSAs received no comments claiming significant infrastructure impacts had occurred related to subsidence.

It is acknowledged that significant infrastructure impacts have occurred along the Eastside Bypass near the Fresno River; however, this location is in the adjacent Chowchilla Subbasin. One commenter mentions collapsed wells without providing well locations or supporting data, while another commenter mentions "well casing fractures caused by subsidence affecting two wells" without supporting documentation/evidence. It is difficult to evaluate potential well casing issues (which can be caused by a number of factors not related to subsidence as well) without being provided specific well locations and supporting documentation. At this time there is no indication of this being a significant problem in the Madera Subbasin; however, the GSAs' ongoing evaluation of subsidence will look more closely at this potential issue. While it is true that the GSP concluded a lack of significant infrastructure impacts within Madera Subbasin as support for not yet establishing specific subsidence sustainable management criteria, the GSP does provide for close monitoring of subsidence with triggers for adaptive management in the future.

The agreement between SJREC and Triangle T Water District covers an area in the adjacent Chowchilla Subbasin that has experienced documented and significant infrastructure impacts related to subsidence over the last 10 years. Such infrastructure impacts did not occur in Madera Subbasin over the same time frame, and therefore, western Madera Subbasin was not involved in establishing a similar agreement. Some of the comments received appear to be assuming that Madera Subbasin has had similar historical subsidence impacts as seen in western Chowchilla Subbasin; however, this is not the case and subsidence is treated accordingly in the Madera Subbasin GSP. That being said, groundwater levels and subsidence that may occur within Madera Subbasin during the Implementation Period will be closely monitored by Madera Subbasin GSAs and adaptive management actions implemented related to subsidence, if necessary. In addition, Madera Subbasin GSA technical representatives are currently working with SJREC GSA representatives to establish a technical group to collaborate in ongoing data collection and review regarding issues of interest to both subbasins, including subsidence.

3 ALL COMMENTS AND RESPONSES

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Demand Management	4-27	HFS encourages the development of a coordinated basin-wide data management system (DMS) that is capable of tracking groundwater and surface water use at the landowner, field, or parcel level, and a coordinated methodology for measuring landowner-level use of groundwater. The DMS should also include, or be capable of interfacing with, a groundwater market platform that allows for individual users to conduct transactions. Markets are essential in facilitating the highest and best use of a limited resource and will be most effective if there is trust in the accuracy of measurements and consistency in data sources, and flexibility available to allow for transactions across the basin.	See Multiple Comment Subject Area Response.	Hancock Farmland Services
Demand Management	4-27	HFS applauds Madera County's efforts to work with stakeholders in developing specific details of a demand management policy. We encourage the GSAs in the basin to initiate a stakeholder-driven process to develop a methodology for establishing landowner-level allocations of native yield that are coordinated across the basin. The allocation methodology should be consistent with various legal considerations drawn from applicable case law and attempt to be consistent with groundwater rights, recognizing that GSAs do not have statutory authority to make a final determination of water rights. An equal-per-gross acre approach to allocations is not likely to be consistent with established water rights doctrine, which must recognize many equitable considerations, in addition to acreage owned, to determine a legally defensible allocation. Further information regarding allocation methodology can be found in Groundwater Pumping Allocations Under California's Sustainable Groundwater Management Act – EDF and NCWL, dated July 2018.	See Multiple Comment Subject Area Response.	Hancock Farmland Services

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Demand Management	4-28	While HFS encourages the use of remote sensing to calculate crop evapotranspiration (ET) as a measurement of consumptive use, we also request the development of methodologies and quality assurance elements to allow for grower provided information to be included into the ET calculation and calibration. These methodologies should be developed in consultation with the vendor providing ET data to ensure it is applicable and useful in creating the best available data set. Additionally, GSAs should establish criteria and procedures to address apparent inaccuracies in the ET calculations. An obvious use of the procedure would be in instances where the grower can demonstrate that applied water, plus precipitation, is less than the calculated ET. In these instances, and subject to any requirements established by the GSA, the grower's use of groundwater should be reduced to the applied water total as the ET calculation should not be greater than applied water.	See Multiple Comment Subject Area Response.	Hancock Farmland Services
Demand Management	4-28	Section 4.2.3.2 also describes groundwater pumping limits, beginning in 2020, to be imposed by Madera County. The GSA should implement pumping restrictions, only if necessary to achieve sustainability, when supported by the best available data and appropriate analytical tools and implement such reductions by gradually ramping down pumping over the implementation period to avoid a sudden disruption in economic activity. The ramp down schedule should include an initial period where current levels of pumping can continue as data is gathered and potential water supply projects are pursued. As with native yield allocations, ramp down schedules should be developed in a coordinated manner across the basin. Any imposed pumping restrictions should be "eased" or "flexed" during drought periods provided that overdraft during those periods can be replenished.	See Multiple Comment Subject Area Response.	Hancock Farmland Services

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Demand Management	4-41	The GSP lacks sufficient detail in defining how potential reductions will be applied, measured, enforced and responded to if not met. These are critical details that must be addressed. For example, what is the baseline pumping period that the reductions will be applied to? At a minimum, the baseline period should be multiple years to avoid unnecessary and perhaps unintended penalization of lands in redevelopment or not yet in full demand due to planting schedules. Additionally, there is no significant discussion of how use will be measured and calculated, or of the costs to perform these activities.	See Multiple Comment Subject Area Response.	Hancock Farmland Services
Description of general plans and other land use plans relevant to GDEs and their relationship to the GSP (23 CCR §354.8	not noted	Description of Plan Area omits relevant and crucial policies from the County and City General Plans which will affect water use; should cite and consider community plans and SB 244 analysis; should supplement gaps in DAC information in existing SB 422 (e.g. La Vina)	GSP Sections 2.1.2.1 and 2.1.3 have been updated to address these specific concerns.	Leadership Counsel for Justice and Accountability
Groundwater Quality and Groundwater Levels Related to Domestic Wells	not noted	GSP's analysis of drinking water impacts is inaccurate (conclusion regarding the number of wells that could be dewatered or contaminated due to the GSAs' proposed policies and activities, including the proposed sustainable management criteria, demand reduction schedule, and projects like on-farm recharge that could threaten groundwater quality)	See Multiple Comment Subject Area Response	Leadership Counsel for Justice and Accountability

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	Domestic well mitigation program is missing from the projects section, and the details that are included in Appendix 3D are missing key information regarding the program's operationalization and scope.	The domestic well mitigation program is not included in the GSP projects listed in Chapter 4 because this chapter focuses on the cost and yield of projects (or management actions) that will result in additional groundwater (or reductions in pumping) in the Subbasin. Regarding the details of the operations and scope of the domestic well mitigation program, these are currently being developed by the Madera County GSA Ad Hoc Committee in coordination with other GSAs. The GSP includes general description of how such a mitigation program could be implemented in the Subbasin, and specific details of the program will be developed through a public process as the GSAs work to implement the GSP policy directions and ensure that the Subbasin meets sustainability objectives.	Leadership Counsel for Justice and Accountability
Water Budget	not noted	The GSP's description of the water budgets lacks the necessary data, assumptions and approaches used to determine the water budgets, maps of the basins, and in some cases, there have been sections left empty	The data sources, assumptions, and approaches have been updated with further detail (Section 2.2.3.3 Water Budget Components and Uncertainties). Additional and updated maps of the basins are included in Sections 2.2.1 (HCM) and 2.2.2 (Current and Historical Groundwater Conditions). All sections have been completed in the GSP.	Leadership Counsel for Justice and Accountability
Demand Management	not noted	The Draft GSP fails to show how it will achieve its sustainability goal with the proposed policies and activities, which it is required to do under SGMA. Given that the GSAs' proposed projects will still leave 90,000 acre feet of overdraft per year, and the GSP has no clear strategy for management actions such as demand reduction, the GSAs have not shown how they will "balance long-term groundwater system inflows with outflows based on a 50-year period representative of average historical hydrologic conditions" and "ensure no undesirable results of significant and unreasonable economic, social, or environmental impacts occur"	See Multiple Comment Subject Area Response.	Leadership Counsel for Justice and Accountability

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Outreach (including DACs/SDACs)	not noted	The Madera Subbasin GSAs Are Responsible for the Disproportionate and Disparate Impacts That Its Policies and Activities Will Have on Disadvantaged Communities Belonging to Protected Groups [Residents in disadvantaged communities do not have the financial means to dig deeper wells and install drinking water treatment infrastructure...their critical drinking water needs must be considered and meaningfully protected by the GSP. The Madera Subbasin GSAs have not adequately done so...the current Draft GSP is likely to cause 63% of wells to go dry in the subbasin and puts domestic wells at risk of contamination from many unmonitored drinking water contaminations, with little funding allocated to help address drinking water impacts.]	Comment noted. See also Multiple Comment Subject Area Response	Leadership Counsel for Justice and Accountability
Outreach (including DACs/SDACs)	not noted	Inadequate Consideration of Public Input [Although staff has put forth observable effort into considering the interests of all beneficial users, some beneficial users of groundwater still have not been considered in the formation of the Draft GSP. For example, small, sustainable farms and socially disadvantaged farmers have not been incorporated into the public conversation surrounding SGMA or Plan proposals for the subbasin...the GSAs have incorporated input from large-scale agricultural interests significantly more than they have incorporated feedback from drinking water users]	See Multiple Comment Subject Area Response	Leadership Counsel for Justice and Accountability
Water Budget	not noted	The Draft GSP does not contain information on the methods, data, and assumptions used to estimate urban water use and urban pumping or what users are represented by the urban pumping totals reported	Information regarding urban pumping estimates has been added to Section 2.2.3.3 (Water Budget Components and Uncertainties).	Leadership Counsel for Justice and Accountability
Water Budget	not noted	The implementation and sustainability periods of the projected water budget use repeating periods of hydrology and water supply information, but the rationale for the periods used is not described.	Clarification of the rationale has been added to Section 2.2.3.2 (Water Budget Analysis Period).	Leadership Counsel for Justice and Accountability
Water Budget	not noted	The reported urban pumping exhibits more variability than would be expected in an urban environment, and the Draft GSP does not explain the reason for this variability	Information regarding urban pumping estimates has been added to Section 2.2.3.3 (Water Budget Components and Uncertainties).	Leadership Counsel for Justice and Accountability

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Water Budget	not noted	The water budget information presented in the draft GSP does not provide information needed to determine when sustainability is achieved and, it is not clear if the subbasin will have achieved sustainable conditions by the end of the implementation period in 2040 [Table 2-26 presents average annual values and shows an average annual decline in groundwater storage for the projected period (2040-2090) for the scenario without projects, but shows an average annual increase in storage over that time period for the scenario with projects]	Table 2-26 indicates that with the projects and management actions described in the plan completed by 2040, the subbasin will have achieved sustainable conditions. The average annual increase in storage over that period demonstrates that the subbasin is sustainable over the 2040 to 2090 sustainability period.	Leadership Counsel for Justice and Accountability
Water Budget	not noted	The Draft GSP is also missing an explanation of how the sustainable yield will be allocated to the seven GSAs in the subbasin	Specific allocation to each of the seven GSAs in the Madera Subbasin is not explicitly detailed in this GSP. The intent of this GSP, in coordination with the other GSPs in the subbasin, is to achieve sustainability for the entire subbasin. Furthermore, SGMA regulations do not require sustainable yield estimates to be represented for each GSA boundary. However, each of the seven GSA used agreed-upon methodologies and foundational data to develop information about 1) groundwater elevation; 2) groundwater extraction data; 3) surface water supply; 4) total water use; 5) changes in groundwater storage; 6) subbasin water budgets; and 7) subbasin sustainable yield. Projects and management actions identified by each of the seven GSAs, including those detailed in this GSP, collectively are expected to achieve the subbasins sustainability goals, and have been evaluated as if they were one complete set of actions for the subbasin.	Leadership Counsel for Justice and Accountability
Sustainable Management Criteria	not noted	The Draft GSP's Sustainable Management Criteria for Groundwater Levels are not Adequate: 1. The Proposed Undesirable Result for Groundwater Levels is Inadequate 2. The Proposed Measurable Objectives for Groundwater Levels are Inadequate 3. The Proposed Minimum Thresholds for Groundwater Levels are Inadequate	The SMC for groundwater levels need to be viewed in conjunction with the domestic well mitigation program. MOs are intended to represent where subbasin groundwater levels will be after sustainability is achieved, which makes GSP MOs consistent with GSP requirements. See also, Multiple Comment Subject Area responses.	Leadership Counsel for Justice and Accountability

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Quality	not noted	The Draft GSP Fails to Adequately Address Groundwater Quality: 1. The Proposed Minimum Threshold for Groundwater Quality is Inadequate 2. The Proposed Undesirable Result for Groundwater Quality is Inadequate 3. The Proposed Measurable Objectives for Groundwater Quality are Inadequate	The GSP is not intended nor required to be the primary means of addressing groundwater quality issues in the subbasin. That being said, the RMS groundwater quality monitoring program in the GSP is quite robust compared to GSP requirements. See also, Multiple Comment Subject Area response.	Leadership Counsel for Justice and Accountability
Sustainable Management Criteria	not noted	The Draft GSP does not include sustainable management criteria for subsidence, citing that, to date, subsidence has not impacted critical infrastructure	While this is true, the GSP does include procedures for adaptive management for subsidence.	Leadership Counsel for Justice and Accountability
Groundwater Levels and Groundwater Quality Related to Domestic Wells	not noted	The Monitoring Network is Inadequate With Respect to Groundwater Levels and Groundwater Quality (The GSA's monitoring network does not comply with SGMA regulations, and fails to capture drinking water impacts to disadvantaged communities and domestic wells. The GSAs have therefore not considered the interests of this beneficial user group and is likely to cause a disparate impact on protected groups who are dependent on domestic wells in the GSAs area.)	Areas designated and DACs and SDACs, along with domestic wells, are addressed in detail in the GSP (for example, see Figures 3-1 and 3-2). See also, Multiple Comment Subject Area response.	Leadership Counsel for Justice and Accountability
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	Current Projects and Management Actions are Inadequate	As described in Chapter 4 and 5 of the GSP, the projects and management actions included in the GSP were developed through a public process to ensure that the Subbasin meets sustainability objectives by 2040. Groundwater modeling performed for the GSP shows the Subbasin meeting sustainability objectives with the projects and management actions specified in the GSP.	Leadership Counsel for Justice and Accountability
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	Clearly Commit to a Drinking Water Protection Program for the Madera Subbasin	Drinking water protection is a goal of the domestic well mitigation program (described in Appendix 3D) that is currently being developed by the Madera County GSA Ad Hoc Committee in coordination with other GSAs. This program will be further developed through a stakeholder process as the GSP moves forward with implementation.	Leadership Counsel for Justice and Accountability

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	Recharge In or Near Disadvantaged Communities and Domestic Well Clusters	The timing and location of recharge activities will be assessed based on the suitability of available lands and contributions to Subbasin sustainability objectives.	Leadership Counsel for Justice and Accountability
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	Establish Pumping Buffer Zones That Protect Disadvantaged Communities and Clusters of Domestic Wells	The timing and location of recharge activities or other pumping-related projects will be assessed based on the suitability of available lands and contributions to Subbasin sustainability objectives.	Leadership Counsel for Justice and Accountability
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	Warning Against a Groundwater Market	In general, as described in GSP Chapter 4, the Subbasin is considering a range of demand management program options, including but not limited to a groundwater market.	Leadership Counsel for Justice and Accountability
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	Multi-benefit projects	In general, as described in GSP Chapter 4, the Subbasin is considering a range of projects that provide multiple benefits.	Leadership Counsel for Justice and Accountability
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	Funding of Projects and Management Actions	In general, as described in GSP Chapter 4 and 5 of the GSP, the GSAs are evaluating a range of financing options to pay for projects and management actions.	Leadership Counsel for Justice and Accountability

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Outreach (including DACs/SDACs)	not noted	Plan Implementation Section is Incomplete Because it Does not Contain Adequate Plans for Community Engagement	See Multiple Comment Subject Area Response	Leadership Counsel for Justice and Accountability
Sustainable Management Criteria; Projects and Management Actions	not noted	The Draft GSP threatens to infringe on water rights, conflicts with the reasonable and beneficial use doctrine, and conflicts with the public trust doctrine	The clearly stated goal of this GSP is "to implement a package of projects and management actions that will, by 2040, balance long-term groundwater system inflows with outflows" (Section 3.1). This GSP specifically describes Measurable Objectives (Section 3.2) to achieve this goal, as well as Minimum Thresholds (Section 3.3) to prevent the same undesirable results that underly the concerns stated in this comment.	Leadership Counsel for Justice and Accountability
Demand Management	not noted	Measurement – Section 4.4.4.3/4.2.3.3: The Draft GSPs identify several methods for measuring groundwater use that may be used in the basins. While simply identifying these tools is appropriate for the GSP, it will be useful for tools like remote-sensing measurement and analysis of ETAW to be implemented quickly so that bugs can be worked out and groundwater users can gain confidence in these systems as soon as possible.	See Multiple Comment Subject Area Response.	Madera Agricultural Water Association

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Demand Management	not noted	Rampdown – Section 4.4.4.2/4.2.3.2: The Draft GSPs identify a target for ramping down groundwater use of 2% per year for the first five years and 6% per year thereafter. While this is an appropriate goal, there are two clarifications that would be useful to include. First, it would be helpful to further explain that the annual rampdown targets apply to the Madera County GSA area as a whole and not to individual parcels or ownerships. Although the Draft GSP already indicates this is the case, highlighting this fact in the Executive Summary and in the relevant sections may help alleviate some confusion. Second, during the first few years of implementation, information and tools may not be available to provide specificity about whether these targets are being met. This is an expected challenge as not all the information needed to demonstrate these conditions is available. However, it may be useful to indicate this fact so that an inability to conclusively demonstrate planned reductions in the first year of implementation does not suggest the plan is inadequate. While actions will be taken to reduce demand immediately upon implementation of the GSPs, whether certain targets are hit may not be demonstrable for some time.	See Multiple Comment Subject Area Response.	Madera Agricultural Water Association
Demand Management	not noted	Allocations – Section 4.4.4.2/4.2.3.2: Implementing a groundwater allocation program may not be the only way to achieve the required demand reduction goals. Another option may be carefully managing access, consistent with property rights, and limiting the total available water without individual user allocations. Amending the Draft GSP to refer to “Allocation/Access” may clarify that approaches other than allocation may also be used to meet demand reduction goals.	See Multiple Comment Subject Area Response.	Madera Agricultural Water Association
Demand Management	not noted	Trading – Section 4.4.4.2/4.2.3.2: The Draft GSPs refer to a “water trading program” as a means of trading water credits. While market systems can add important flexibility to a system where available supply is limited, the details of the market system may end up being something other than a water trading program. Consider describing a “market system” generally to ensure that other types of market systems are also anticipated in the GSP.	See Multiple Comment Subject Area Response.	Madera Agricultural Water Association

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Demand Management	not noted	Easements – Section 4.4.4.2/4.2.3.2: Because the term “easements” can be understood in different ways, it would be helpful to use a more descriptive term to refer to voluntary programs to cease irrigating lands. Whether through easements or leases, irrigation abeyance agreements are a useful tool and should remain in the GSP. Find a good term to describe the range of such alternatives will help reduce confusion.	See Multiple Comment Subject Area Response.	Madera Agricultural Water Association
Demand Management	not noted	Fallowing – Section 4.4.4.2/4.2.3.2: The Draft GSPs appear to use the term fallowing to refer to ceasing to irrigate land that is currently irrigated. To the extent this term is used in the typical agronomic context, namely referring to land that has been plowed and left unseeded or is otherwise not in use, it is unnecessarily restrictive. As the GSP is implemented and land come out of irrigated agricultural production, much of that land may find other uses that do not require irrigation. Such land, for example, may be dryland farmed, transitioned to rangeland, converted to habitat, or be used for a solar array. Each of these new uses would cease irrigation, but would not technically be fallowing. Consider amending the Draft GSPs to refer to “land transition” or a similar term that indicates cessation of irrigation but anticipates a future economic use.	See Multiple Comment Subject Area Response.	Madera Agricultural Water Association
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	Planning vs. Prescribing: One of the key challenges in drafting a GSP is balancing between establishing a workable long-term strategy and providing near-term certainty through specific prescriptions. The reality is that the first step in the journey to groundwater sustainability is establishing and refining critical measurement and monitoring systems. While this means that certainty about some parameters is delayed, this is a necessary foundation to ensuring a fair and workable system is ultimately implemented. The Draft GSPs appropriately manage this balance by clearly identifying what is needed, how it will be obtained, and how it will be used to implement the management actions and projects that will achieve sustainability. The specific prescriptions and implementation of the tools is rightfully left to the implementation phase of the GSP. While this does leave some uncertainty at present, it is important that the tools and	Comment noted. No response needed.	Madera Agricultural Water Association

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
		prescriptions be based on the needed information and not hurriedly placed on a flawed foundation.		
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	Projects and Management Actions – Section 4: The Draft GSPs identify recharge, conveyance, and (for the Madera Subbasin) storage as projects, and demand management as a management action. These tools will be utilized to bring the basins into balance over the next twenty years. While these projects and management actions may be implemented by the GSAs, it would be useful to clarify in the Draft GSPs how these projects and management actions may be also implemented by other entities or individuals. This would allow others, in coordination with the GSAs and consistent with the GSPs, to implement projects and management actions that move us toward sustainability. In some cases, these entities may be able to implement these projects or management actions more quickly and efficiently than the GSAs.	Added text to GSP to indicate that entities or individuals can also implement projects and management actions.	Madera Agricultural Water Association
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	Recharge – Section 2.2.3.3 & Section 4 (Table 4-2): In discussing groundwater recharge, the Draft GSPs appropriately focus on Flood-MAR, recharge basins, and in lieu recharge. While these surface water diversion projects should remain the priority of the GSP, it may be useful for the GSP to anticipate inclusion of other types of projects and management actions that may not divert surface water but may contribute to the groundwater replenishment portfolio. Increasing consideration and study is being given to forest management, tillage practices, stormwater management, and other management practices that may increase the amount of precipitation infiltrating into the groundwater system. While these management practices are not sufficiently developed to be included in the projected budget, it would be helpful if the GSP also referenced groundwater replenishment practices that do not rely on diverted surface water.	Added text or emphasis that other projects may be considered in the future.	Madera Agricultural Water Association

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Water Budget	not noted	ETAW vs. AW: In discussing the Draft GSPs with stakeholders there is some confusion about the difference between the Evapotranspiration of Applied Water (ETAW) and Applied Water (AW). Although the Draft GSPs are not deficient in their explanation of this distinction, additional clarification, perhaps in the Executive Summary, would help the reader understand the difference between these terms and how they are used in the Draft GSPs.	Explanation added to GSP executive summary and water budget section.	Madera Agricultural Water Association
Subsurface Inflows	not noted	The Madera Subbasin draft GSP indicates there is approximately 69,400 AF of historical and current inflow with no project actions, the amount of inflow increases to 108,200 in 2040, which the Madera Subbasin identifies as their sustainability goal. With projects implemented and completed, the inflow is reduced to approximately 21,400 AF between 2040 and 2090. The GSP demonstrates that the Madera Subbasin will not achieve the sustainable yield or groundwater sustainability within SGMA's mandatory 20-year period. [Annual overdraft deficit is miscalculated when accounting for inflows, and GSP fails to address how the Subbasin will mitigate the overdraft deficit. The Madera Subbasin GSP does mention demand management beginning in year one, but details are being finalized. This could result in demand reduction of about 2%, but not enough to cover the total boundary flow.] The GSP infers the Madera Subbasin GSAs encroach on approximately 69,000 AF of water per year within NKGSA's boundary. [NKGSA intends to capture and recapture water that the Madera Subbasin indicates is flowing into the Madera Subbasin.]	The water balance and required projects/management actions for Madera Subbasin do not rely upon net subsurface inflows to reach sustainability. The GSP describes in detail how Madera Subbasin will achieve sustainability strictly based on changes to vertical inflows and outflows (i.e., addressing net recharge or shortage). Planned refinements of the model in 2025 will likely result in more accurate absolute values of net subsurface inflow. At this time, the magnitude of current model calculated inflows is likely conservative (i.e., overestimated), and it is more useful to utilize model results to understand that significant reductions in subsurface inflow are expected under sustainable subbasin conditions after 2040. See also, Multiple Comment Subject Area response.	North Kings GSA

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Water Budget	not noted	After attending the confined animal Ad Hoc Committee on October 3, 2019, I was concerned that the calculation of Dairy water use was not well developed in the Madera and Chowchilla Basin GSPs. Provost & Pritchard Consulting Group has been working on understanding Dairy use of groundwater for several years. We would like to share our methodology with the County to demonstrate how the consumptive use of dairies has been handled in the past and in other GSPs. Dairy water budgeting parameters, calculations, and data sources have been based on field calculations, canal turnout and water well measurements, annual dairy reports and milk production. Generally, about 9 gallons per cow each day is exported from the dairy as milk and another 7 to 10 is excreted as urine, sweat and solids; equating to 0.01 to 0.02 Acre Foot (AF) per cow each year. Wash water varies by operation and is reported in dairy reports as outflow to lagoons; generally, about 72 gallons/cow each day which equates to about 0.08 AF per cow each year. The total water used in the dairy facility ranges from 80 to 90 gallons per cow each day, or 0.09 to 0.1 AF/cow each year. [See letter for detailed methodology]	Respectfully, we do not see anything in the Provost & Pritchard (P&P) memo that is different than we've discussed and considered in development of the Madera Subbasin GSP. We have used ~70 gallons/cow in other work, so their value is consistent with our expectations. Dairy water is included in the Madera Subbasin GSP "Land Use System" agricultural land water balance. Almost all of the dairy water ends up being applied to crops (89% in the P&P memo water budget). Methodologies to estimate applied water requirements based on ET analysis accommodate the source(s) of water. If water used by a dairy is pumped, then the ET method will calculate the correct groundwater pumping. See clarifications in: Section 2.1.1 and Section 2.2.3.3, under "Land Use Data".	Provost & Pritchard
GW model	not noted	The GSP relies too heavily on a numerical groundwater model that has not been calibrated and therefore does not accurately reflect boundary conditions with the Delta Mendota Subbasin. In addition, the numerical model used has projected water levels to decline significantly in the Delta-Mendota Subbasin by the year 2040. This is contradictory to SJREC GSP which will maintain historic water levels through 2040 in order to maintain sustainability.	The numerical groundwater model was extensively calibrated as described in the groundwater model documentation in Appendix 6E. The model does not indicate significant declines in groundwater levels in the Delta-Mendota Subbasin by the year 2040. We note that this comment makes reference to the SJREC GSP, which has not yet been made available for public review.	San Joaquin River Exchange Contractors GSA
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	The Madera GSP should be updated to mitigate land subsidence in the areas closest to the Delta-Mendota Subbasin. A successful mitigation program is being implemented by the Triangle T Water District in cooperation with the member agencies of the SJREC GSA. Other areas in western Madera County should be held to a similar standard and immediately reduce extractions from the lower aquifer at or below the sustainable yield.	Demand management program is planned to begin with GSP implementation, extent of the program is designed to remain within the subbasins sustainable yield, which is defined based on the sustainability goals of the Subbasin that includes land subsidence.	San Joaquin River Exchange Contractors GSA

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	The GSP for the Exchange Contractor GSP calls for keeping water levels in the future from declining below 2015 levels. In contrast, the GSP for the Madera Subbasin allows continuing water level declines through almost 2040. This will result in more groundwater outflow from the Delta Mendota Subbasin into the Madera Subbasin which will negatively impact our subbasin.	Review of detailed groundwater modeling results indicates that net subsurface inflows will decrease in both the Implementation Period and the following Sustainability Period due to implementation of projects and management actions in Madera Subbasin.	San Joaquin River Exchange Contractors GSA
Water Budget	not noted	For the storage change calculations in the unconfined or upper aquifer, instead of over reliance on the water budget, a better method is evaluating unconfined water-level changes and specific yields. For the confined or lower aquifer, compaction of fine-grained layers, as reflected by the amount of land subsidence, is a better approach.	The GSP includes calculations of groundwater storage change using multiple methods, including by specific yields and water level changes.	San Joaquin River Exchange Contractors GSA
Subsurface Inflows	not noted	The groundwater flow estimates were developed from the groundwater model, which is not the preferred approach. This approach relies on values for a multitude of parameters, some of which are poorly known. The preferred approach is to use suitable water-level elevation maps and transmissivity values from pump tests for both the upper and lower aquifer.	There are multiple methods of calculating groundwater flow that may be considered valid for a given subbasin. DWR has recommended that a groundwater model be used for evaluating sustainability, groundwater flows and other related parameters of interest. See also Multiple Comment Subject Area response.	San Joaquin River Exchange Contractors GSA
Subsidence	not noted	The plan asserts in Section 3.2.3 and 3.3.3.1 that "No significant impacts to infrastructure has been noted in the Plan areas…" and therefore the Land Subsidence analysis and proposed actions were minimized. However, there was no discussion of the subsidence along the Eastside Bypass which the California Department of Water Resources has determined the flood carrying capacity has been significantly decreased by about 50% in the area near the Fresno River, nor the collapsed wells due to subsidence in the vicinity due to subsidence.	It is not clear if the comment is referencing an area or impacts within Madera Subbasin. It appears that the referenced infrastructure impacts occurred outside of Madera Subbasin. See also Multiple Comment Subject Area response.	San Joaquin River Exchange Contractors GSA

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Subsurface Inflows	not noted	The "net groundwater flow" (one value) should be divided into flow at each of the three subbasin boundaries, also between the upper and lower aquifers in each case. As presented, one cannot readily check the groundwater flow value. There is also downward groundwater flow throughout most of the subbasin (from the upper aquifer to the lower aquifer). This also needs to be determined but wasn't discussed in the plan.	These values are quantified, but they are not required. Given the uncertainty in the calculation of subsurface groundwater flows (regardless of calculation method), the absolute value of groundwater flows to/from each subbasin is of limited value. Rather the relative change in groundwater flows across subbasin boundaries under future sustainable basin conditions is more useful to evaluate. See also Multiple Comment Subject Area response.	San Joaquin River Exchange Contractors GSA
Groundwater Quality	not noted	This GSP did not include a regional water quality concern of the northeasterly flow of high TDS groundwater associated with overdraft in the Madera Subbasin. Declining water levels in the upper aquifer of the Madera Subbasin has increased the migration of high TDS groundwater into the Delta-Mendota Subbasin.	The comment raises concerns about flow of high TDS groundwater into Delta-Mendota Subbasin due to historical overdraft in Madera Subbasin, but provides no evidence or analysis to support the comment. It is not clear how Madera Subbasin groundwater levels are impacting flow of high TDS groundwater into Delta-Mendota Subbasin that is occurring at a location far removed from the Madera Subbasin/Delta-Mendota Subbasin boundary. Furthermore, the natural flow of groundwater under pre-development conditions is similar to the current groundwater flow direction in the referenced high TDS area. The source of this TDS water is likely naturally occurring, and the movement of this groundwater from its origin towards the northeast is the natural flow direction towards the river independent of Madera Subbasin groundwater pumping. Additional data/analyses (such as development of a numerical groundwater flow model) would need to be developed and presented to demonstrate how/if this natural flow of groundwater is significantly influenced by groundwater pumping in the distant Madera Subbasin.	San Joaquin River Exchange Contractors GSA

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Subsurface Inflows/Groundwater quality/Subsidence	not noted	Your plan sets the minimum thresholds for Chronic Lowering of Groundwater Levels, and provides for the continued lowering of groundwater levels through almost 2040. As defined, this poses an immediate risk to the SJREC GSA and the Delta-Mendota Subbasin. Intentional decline in water levels in the Madera Subbasin will directly impact the Delta-Mendota Subbasins infrastructure, water supply, and for the following sustainability indicators: a) chronic lowering of groundwater levels, b) reduction of groundwater storage, c) land subsidence, and d) degraded water quality. a. Chronic lowering of groundwater levels: the SJREC GSP is managing groundwater levels to maintain historic levels. If the Madera Subbasin intends to lower the water levels across the subbasin boundary, inherently more groundwater will flow out of the Delta-Mendota Subbasin inducing a groundwater imbalance and overdraft in the Delta-Mendota Basin. b. Reduction of groundwater storage: As described above lowering water levels will increase the lateral groundwater outflow from the Delta-Mendota Subbasin. The results of increased outflow will result in a reduction in groundwater storage in the Delta-Mendota Subbasin. c. Land subsidence: this GSP plans to use water levels as a proxy for land subsidence. It should be noted that the proposed water level minimum thresholds will have very significant impacts to the Delta-Mendota Subbasin d. Degraded water quality: Lowering water levels in the Madera Subbasin will exacerbate the problem of migrating high TDS water into the SJREC GSA. This problem is not discussed in the GSP and should be evaluated to ensure regional sustainability.	It is not clear how Madera Subbasin groundwater level MTs pose an immediate risk to Delta-Mendota Subbasin, as the subbasin is intended to be managed in the future to avoid hitting MTs. There is no "intentional decline" in water levels within Madera Subbasin; rather, a modest temporary decline in water levels is anticipated within Madera Subbasin (given the time needed to implement projects and management actions) that is not expected to significantly impact groundwater levels in Delta-Mendota Subbasin. We anticipate only very modest impacts on net subsurface inflows during the Implementation Period, that will evolve into significantly reduced net subsurface net inflows during the sustainability period. The Delta-Mendota Subbasin water budget and sustainability will be enhanced by reduced net outflows to Madera Subbasin related to implementation of the Madera Subbasin GSP. Also see multiple comment subject area responses.	San Joaquin River Exchange Contractors GSA
Subsurface Inflows	not noted	There has consistently been groundwater flows in both the upper and lower aquifers from the Delta-Mendota Subbasin to the Madera Subbasin. Based on natural (pre-pumping) conditions, all of these flows have been induced by pumping in the Madera Subbasin.	While SGMA does not require restoration of pre-2015 groundwater conditions, analyses conducted for the Madera GSP indicate significant reductions in net subsurface inflow as the subbasin moves toward and achieves sustainability. Also see multiple comment subject area responses.	San Joaquin River Exchange Contractors GSA

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Description of general plans and other land use plans relevant to GDEs and their relationship to the GSP (23 CCR §354.8	2-1	The GSP states "The Madera Subbasin … contains no considerable state land or federal land" and provides a brief description of these lands as a footnote. Other than State preserves and parks, protected lands that could contain aquatic, riparian, and other potentially groundwater-dependent habitat are not identified. Please identify all state park land, wildlife preserves, wetlands, open space, mitigation areas, and local parks with potentially groundwater-connected aquatic resources and habitat.	The identification of potential GDEs is included in the GSP regardless of land ownership or management.	The Nature Conservancy
Description of general plans and other land use plans relevant to GDEs and their relationship to the GSP (23 CCR §354.8	2-9 to 2-11	The GSP states (p. 2-10): "Limitations on surface water deliveries will limit operational flexibility by reducing surface water supplies available for conjunctive use programs." The limitations are not defined and warrant further description, either in this section or in Section 2.1.2.4, to more specifically identify potential effects on the flows of interconnected surface waters and potential stress to the groundwater system. Please ensure that description of the surface water monitoring system clarifies the limitations and please specify whether these limitations could affect the surface water conditions of any GDEs or instream habitat in ISWs that may be present in the area.	Comment noted.	The Nature Conservancy
Description of general plans and other land use plans relevant to GDEs and their relationship to the GSP (23 CCR §354.8	2-9 to 2-11	This section describes the types of monitoring performed by federal, state and local entities of surface water inflows and outflows. The monitoring stations for flows are listed in Table 2-3 and other recording stations for flow or irrigation releases are listed in Table 2-4. Please explain the relationship of existing stream flow monitoring to the protection of ISWs and GDEs.	Added explanation to Section 2.1.2.2: "These monitoring stations are important for monitoring surface water available to interconnected surface water (ISW) habitats and groundwater dependent ecosystems (GDEs)."	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Description of general plans and other land use plans relevant to GDEs and their relationship to the GSP (23 CCR §354.8	2-14 to 2-15	The Madera County General Plan includes restrictions on development in "areas with sensitive environmental resources" (Policy 1.A.5). This section should include a discussion of General Plan goals and policies related to the protection and management of GDEs and aquatic resources that could be affected by groundwater withdrawals. Please include a discussion of how implementation of the GSP may affect and be coordinated with General Plan policies and procedures regarding the protection of wetlands, aquatic resources and other GDEs and ISWs.	Added description to Section 2.1.3.1	The Nature Conservancy
Description of general plans and other land use plans relevant to GDEs and their relationship to the GSP (23 CCR §354.8	2-14 to 2-15	This section should identify Habitat Conservation Plans (HCPs) or Natural Community Conservation Plans (NCCPs) within the Subbasin and if they are associated with critical, GDE or ISW habitats. Please identify all relevant HCPs and NCCPs within the Subbasin and address how GSP implementation will coordinate with the goals of these HCPs or NCCPs.	Added description to Section 2.1.2.1. The PG&E San Joaquin Valley Operations & Maintenance Habitat Conservation Plan overlaps with Madera Subbasin. No NCCPs overlap with the Madera Subbasin (https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=68626&inline).	The Nature Conservancy
Description of general plans and other land use plans relevant to GDEs and their relationship to the GSP (23 CCR §354.8	2-14 to 2-15	Please refer to the Critical Species Lookbook (https://groundwaterresourcehub.org/sgma-tools/the-critical-species-lookbook/) to review and discuss the potential groundwater reliance of critical species in the basin. Please include a discussion regarding the management of critical habitat for these aquatic species and its relationship to the GSP.	See the discussion of the Potential GDE Units in Section 2.2.2.6 for information on special status species. Also see the discussion of the GDE Monitoring Program in section 3.5.2.5 and the GDE Appendix 2.B for more information on special species and management of critical habitat.	The Nature Conservancy
Description of general plans and other land use plans relevant to GDEs and their relationship to the GSP (23 CCR §354.8	2-15 to 2-16	Madera County has an online well permitting system that includes agricultural wells, observation/monitoring wells, community water supply wells, and individual domestic water supply wells. Please include a discussion of how future well permitting will be coordinated with the GSP to assure achievement of the Plan's sustainability goals.	Added description to Section 2.1.3.4	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Description of general plans and other land use plans relevant to GDEs and their relationship to the GSP (23 CCR §354.8	2-15 to 2-16	The State Third Appellate District recently found that Counties have a responsibility to consider the potential impacts of groundwater withdrawals on public trust resources when permitting new wells near streams with public trust uses (ELF vs. SWRCB and Siskiyou County, No. C083239). Compliance of well permitting programs with this requirement should be stated in the GSP.	Added description to Section 2.1.3.4	The Nature Conservancy
Hydrogeologic Conceptual Model (23 CCR §354.14)	2-27	In the Madera Subbasin, the base of the usable aquifer corresponds with the base of fresh water, defined as having “total dissolved solids of less than 1,000 milligrams/liter (mg/L) or conductivity of less than 1,600 µmhos/cm.” The text states, “In general, the aquifer base is controlled mostly by the base of freshwater provided in Figure 2-18 except in the far eastern portions of the subbasin” where the depth of the basement complex is shallower. As noted on page 9 of DWR's Hydrogeologic Conceptual Model BMP (https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_HCM_Final_2016-12-23.pdf) "the definable bottom of the basin should be at least as deep as the deepest groundwater extractions. Thus, groundwater extraction well depth data should also be included in the determination of the basin bottom. Properly defining the bottom of the basin will prevent the possibility of extractors with wells deeper than the basin boundary from claiming exemption from SGMA due to their well residing outside the vertical extent of the basin boundary.	Additional text was added to the GSP in response to this comment.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Hydrogeologic Conceptual Model (23 CCR §354.14)	2-27	The cross sections in Chapter 2 (Figures 2-24 through 2-34) clearly show the base of freshwater and the top of the basement rocks. However, they do not include a graphical representation of the manner in which shallow groundwater may interact with ISWs or GDEs that would allow the reader to understand this topic. Please include an example near-surface cross section that depicts the conceptual understanding of shallow or perched stream, riparian and other GDE interactions at different locations.	The referenced cross sections do show recent groundwater levels for the Upper Aquifer, which demonstrate a clear lack of surface water - groundwater connection throughout the subbasin. The depth to shallow groundwater, including the perched/mounded shallow groundwater levels along the San Joaquin River, are further illustrated in Figures 2-71 and 2-72. Regional aquifer and perched groundwater levels are discussed in detail in Section 2.2.2.1 on pages 2-32 through 2-35. Surface water - groundwater interaction and GDEs are discussed in Sections 2.2.2.5 and 2.2.2.6 on pages 2-40 through 2-42. Considerable discussion and graphics have been devoted to this topic in the GSP. Potential for interconnection between surface water and groundwater will be further evaluated for the 5-year update report due in 2025 using data collected over the next five years.	The Nature Conservancy
Hydrogeologic Conceptual Model (23 CCR §354.14)	2-27	The extent and depth of the Corcoran Clay layer is shown in Figure 2-15. “Where the Corcoran Clay aquitard exists, the aquifer system is subdivided into an upper unconfined aquifer above the Corcoran Clay and a lower confined aquifer below the Corcoran Clay. In the central and eastern portions of the subbasin where the Corcoran Clay does not exist, the aquifer system is generally considered to be semiconfined with discontinuous clay layers interspersed with more permeable coarse-grained units” (p. 2-29). Please confirm that only wells with screened intervals in the unconfined aquifer are being used to compare with surface water and to identify and confirm potential GDEs.	The analysis of interconnected surface water and GDEs was based upon Upper Aquifer well data, including SJRRP monitoring well data.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Dependent Ecosystems	2-42 to 2-48, and App 2.B	The GSP states (p. 2-42): "GDEs may also occur in areas where regional groundwater levels are deeper than 30 feet but shallower perched groundwater exists atop bedrock or another type of aquitard; however, these types of GDEs would generally not be impacted by pumping of groundwater supply wells." The GSP discounts the perched water zones as derived from surface water, and therefore they were not considered in evaluation of GDEs. The GSP should provide clear evidence of hydraulic disconnection where shallow groundwater is considered perched or identify hydraulic connection as a data gap. In addition, the GSP should consider perched water as a shallow aquifer, because even though it may not be pumped at present, it could be in the future. Groundwater in the perched water zones may provide water supply to GDEs and ISWs. Please explicitly enumerate the principal aquifer(s) and intervening aquitards, their relationship to each other, and their role in supplying groundwater to all beneficial uses and users of groundwater (including environmental).	Perched groundwater is discussed in the GSP, and available data clearly show the lack of hydraulic connection between perched zones and the regional aquifer where groundwater pumping occurs. It is not reasonable to conclude that perched zones will be pumped in the future for water supply, as there is insufficient aquifer thickness and pumping capacity in perched aquifers.	The Nature Conservancy
Groundwater Dependent Ecosystems	2-42 to 2-48, and App 2.B	The text states (p. 2-42): "A DTW cutoff of 30 feet was used in the initial screening of potential GDEs. The use of a 30-foot DTW criterion to identify potential GDEs is based on reported maximum rooting depths of California phreatophytes and is consistent with guidance provided by The Nature Conservancy (Rohde et al. 2018) for identifying potential GDEs." We have the following comments regarding this sentence and on the methodology for identifying GDEs in the Subbasin. [see bulleted list in next 4 entries for details]	See Multiple Comment Subject Area Response. A DTW cutoff of 30 feet was used as one of the primary criteria in the initial screening of potential GDEs. It was not used as a stand-alone criterion for exclusion of potential GDEs. Edits made in Section 2.2.2.6 to further explain and clarify.	The Nature Conservancy
Groundwater Dependent Ecosystems	2-42 to 2-48, and App 2.B	[Continued from above] o 30-ft criteria from TNC Guidance: In TNC's GDE Guidance, the depth criterion of 30 feet is presented as a criterion for inclusion, not a standalone criterion for exclusion. In other words, if groundwater is within 30 feet of the ground surface, then a GDE can be identified. If it is not, then further analysis must be conducted (see Appendix III of the GDE Guidance, Worksheet 1, for other indicators of GDEs).	See Multiple Comment Subject Area Response. Where DTW was greater than 30 feet, other criteria such as river hydrology (flow permanence and gaining vs. losing reaches) and dominant vegetation were used to determine whether potential GDEs should be considered as final GDEs. Screening of potential GDEs also included field evaluation of potential GDEs where initial uncertainty was high. Edits made in Section 2.2.2.6 to further explain and clarify.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Dependent Ecosystems	2-42 to 2-48, and App 2.B	[Continued from above] o 30-ft as maximum rooting depths of California phreatophytes: Please use care when considering rooting depths of vegetation. While Valley Oak (Quercus lobata) have been observed to have a max rooting depth of ~24 feet (https://groundwaterresourcehub.org/gde-tools/gde-rooting-depths-database-for-gdes/), rooting depths are likely to spatially vary based on the local hydrologic conditions available to the plant. Also, max rooting depths do not take capillary action into consideration, which will vary with soil type and is an important consideration since woody phreatophytes generally do not like to have their roots submerged in groundwater for extended periods of time, and hence can access groundwater at deeper depths. In addition, while it is likely to be true that shallow water availability is necessary to support the recruitment of saplings, hydraulic lift of groundwater to shallow depths has been observed in Quercus spp.	Comment noted. Our analysis considered all available data on vegetation rooting depth and the importance of capillary action, as well as recent published research indicating variability in rooting depth according to local topography and groundwater conditions.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Dependent Ecosystems	2-42 to 2-48, and App 2.B	[Continued from above] o Use of depth to water maps from 2014 and 2016: ▪ 2016 is after the SGMA benchmark date of January 1, 2015. Please rely on groundwater condition data prior to the SGMA benchmark date. ▪ We highly recommend using depth to groundwater data from multiple seasons and water year types (e.g., wet, dry, average, drought) to determine the range of depth to groundwater around NC dataset polygons. Please refer to Attachment D of this letter for best practices for using local groundwater data to verify whether polygons in the NC Dataset are supported by groundwater in an aquifer. If insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons in the GSP until data gaps are reconciled in the monitoring network. While depth to groundwater levels within 30 feet are generally accepted as being a proxy for confirming that polygons in the NC dataset are connected to groundwater, it is highly advised that seasonal and interannual groundwater fluctuations in the groundwater regime are taken into consideration. Utilizing groundwater data from one or two points in time can misrepresent groundwater levels required by GDEs, and inadvertently result in adverse impacts to the GDEs. Based on a study we recently submitted to Frontiers in Environmental Science Journal, we've observed riparian forests along the Cosumnes River to experience a range in groundwater levels between 1.5 and 75 feet over seasonal and interannual timescales. Seasonal fluctuations in the regional water table can support perched groundwater near an intermittent river that seasonally runs dry due to large seasonal fluctuations in the regional water table. While perched groundwater itself cannot directly be managed due to its position in the vadose zone, the water table position within the regional aquifer (via pumping rate restrictions, restricted pumping at certain depths, restricted pumping around GDEs, well density rules) and its interactions with surface water (e.g., timing and duration) can be managed to prevent adverse impacts to ecosystems due to changes in groundwater quality and quantity under SGMA.	See Multiple Comment Subject Area Response. The 2014 and 2016 DTW data were the most accurate and recent DTW data available for the Madera Subbasin. While the 2016 data represent conditions after the 2015 SGMA baseline, the use of shallow groundwater data from both years was deemed appropriate because it provided a more conservative (i.e., more inclusive) indicator of potential GDEs than the use of a data from a single year. Omitting 2016 data as suggested by TNC would reduce the number and extent of potential GDEs. Edits made in Section 2.2.2.6 to justify the use of both 2014 and 2016 data.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Dependent Ecosystems	2-42 to 2-48, and App 2.B	[Continued from above] Please provide more details on how depth to groundwater contour maps were developed (Figures 2-70 and 2-71): ▪ Are the wells used for interpolating depth to groundwater sufficiently close (<5km) to NC Dataset polygons to reflect local conditions relevant to ecosystems? ▪ Are the wells used for interpolating depth to groundwater screened within the surficial unconfined aquifer and capable of measuring the true water table? ▪ Is depth to groundwater contoured using groundwater elevations at monitoring wells to get groundwater elevation contours across the landscape? This layer can then be subtracted from land surface elevations from a Digital Elevation Model (DEM)5 to estimate depth-to-groundwater contours across the landscape. This will provide much more accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found. Depth to groundwater contours developed from depth to groundwater measurements at wells assumes that the land surface is constant, which is a poor assumption to make. It is better to assume that water surface elevations are constant in between wells, and then calculate depth to groundwater using a DEM of the land surface to contour depth to groundwater.	See Multiple Comment Subject Area Response	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Identifying and Mapping GDEs (23 CCR §354.16)	2-42 to 2-48, and App 2.B	Please further explain how NC Dataset polygons adjacent to the San Joaquin River were retained or removed as potential GDEs. On Appendix 2.B, Figure 1 polygons are shown as removed based on depth to groundwater greater than 30 feet, but the groundwater depth contours (Figures 2-71 and 2-72) do not show enough detail to make this distinction and subsequent determination. Please refer to specific well hydrographs that were used to analyze particular reaches of the San Joaquin River.	As described in Appendix 2.B, polygons classified as GDE indicators (iGDEs) in DWR's Natural Communities Commonly Associated with Groundwater dataset (NC Dataset) were evaluated for inclusion as GDEs based on multiple factors; primarily vegetation type and maximum rooting depth, surface water hydrology, and depth to groundwater (DTW). Potential GDEs were retained for further analysis if the underlying DTW in either winter/spring 2014 or winter/spring 2016 was equal to or shallower than 30 feet, which corresponds with the maximum rooting depth of California phreatophytes. Where DTW was greater than 30 feet, other criteria, primarily river hydrology, were used to determine whether potential GDEs should be subject to further analysis. Some iGDE polygons along the San Joaquin River were removed based on evidence that the San Joaquin River in the subbasin is in a losing hydrological condition (i.e., loses water to the shallow groundwater system) and DTW greater than 30 feet. Hydrographs for wells MCE RMS-9, MID RMS-17, and MCS RMS-5 are shown in Appendix 2.B and generally provide evidence supporting the inclusion of iGDE polygons near these locations as potential GDEs, despite the conclusion that infiltration from the San Joaquin River very likely provides a substantial contribution to the shallow groundwater in these areas.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Identifying and Mapping GDEs (23 CCR §354.16)	2-42 to 2-48, and App 2.B	The GSP states (p. 2-45): "The adjacent San Joaquin River contains Essential Fish Habitat (EFH) for the endangered Chinook salmon which is partially dependent on riparian inputs to provide important salmon habitat elements including shade, overhead cover, nutrients, and woody material for instream cover and habitat complexity," and further states (p. 25 of Appendix 2.B): "the riparian vegetation community of the San Joaquin River Riparian Potential GDE Unit fulfills several essential ecosystem functions or provides important habitat elements, such as large wood and riparian shade, on which both semiaquatic species of the GDE unit and aquatic species of the San Joaquin River depend for completing essential life behaviors". Please consider retaining all NC Dataset polygons adjacent to the San Joaquin River due to the essential ecosystem function that the riparian vegetation community performs for the critical habitat of the Chinook salmon in the San Joaquin River.	We acknowledge the important role of riparian vegetation along the San Joaquin River in providing habitat elements and ecosystem functions for special-status salmonids and other aquatic and riparian species. As such, the riparian vegetation community along the San Joaquin River should be monitored, protected, and enhanced to the maximum extent possible. NC Dataset polygons (iGDE polygons) were retained if there was evidence that they are connected to groundwater. Because evidence indicates that much of the riparian vegetation is reliant on infiltration of surface water from the San Joaquin River, not all riparian vegetation iGDE polygons were retained as GDEs for further analysis. While groundwater pumping from the regional aquifer is unlikely to affect riparian vegetation along the San Joaquin River, monitoring to evaluate its ecological condition is included in the GSP. As described in GSP Section 3.5.2.5, groundwater level monitoring being conducted for the overall GSP includes three RMS wells adjacent to the San Joaquin River Riparian potential GDE Unit along the San Joaquin River in the southern Plan area, and one RMS well near the Madera Canal Equalization Reservoir in close proximity to the Fresno River Riparian GDE Unit. Reconnaissance-level biological surveys were conducted in May 2019 and additional monitoring will be conducted every five years to document ecological condition of each GDE unit, including the Sumner Hill potential GDE Unit.	The Nature Conservancy
Identifying and Mapping GDEs (23 CCR §354.16)	2-42 to 2-48, and App 2.B	As shown on Appendix 2.B, Figure 1, it appears that there is one potential GDE unit in light green on the far western border of the Subbasin. Please describe further and clarify if this is indeed a polygon from the NC Dataset that was kept as a potential GDE.	There is no potential GDE unit in light green ("kept") at that location on Appendix 2.B, Figure 1. The shading at that location is light blue, indicating DTW greater than 30 feet in either 2014 or 2016. This has been verified using the source data and GIS-derived mapping layer.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Identifying and Mapping GDEs (23 CCR §354.16)	2-42 to 2-48, and App 2.B	TNC acknowledges and appreciates the comprehensive evaluation of the four GDE Units identified in the GSP following our guidance, including analyzing hydrologic conditions, ecological conditions, providing an inventory of species and ecological value, along with concurrent field studies and reconnaissance. We also appreciate the use of TNC's GDE Pulse to examine NDVI and NDMI trend data for the GDE polygons within the GDE Units.	Comment noted.	The Nature Conservancy
Identifying and Mapping GDEs (23 CCR §354.16)	2-42 to 2-48, and App 2.B	The Sumner Hill GDE Unit is located on an unnamed tributary of the San Joaquin River and includes riparian vegetation and a freshwater wetland. The source of water to the wetland is unknown and may be an intermittent tributary to the San Joaquin River. This potential GDE was considered to have a high ecological value because it supports special status species and habitat. The GSP states (p. 2-48): "Reconnaissance level biological assessments, aerial photograph analysis, and NDVI/NDMI data indicate adverse impacts are not likely occurring in the Sumner Hill Potential GDE Unit (Appendix 2.B)." Please obtain groundwater data before concluding that there are no adverse impacts to the GDE Unit and make plans to address this data gap in the Monitoring section of the GSP.	Lack of shallow groundwater data near the Sumner Hill Potential GDE Unit is acknowledged as a data gap in the GSP. While the GSP does not include installation of a monitoring well in this GDE unit, the GSP's GDE Monitoring Program (Section 3.5.2.3) includes monitoring every five years to document the ecological condition of the unit. Surface geology maps indicates this Potential GDE Unit essentially overlies bedrock or is an area with very shallow depths to bedrock, which likely accounts for the potential presence of shallow groundwater in this drainage.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Surface Water-Groundwater Interactions	2-40	The text states (p. 2-40): "review of historical regional aquifer groundwater levels compared to stream thalweg (deepest portion of stream channel) elevations conducted for this study indicate that surface water – groundwater interactions are not a significant issue (i.e., regional groundwater levels are relatively far below creek thalweg elevations) along Berenda Creek, Dry Creek, the Fresno River, and Cottonwood Creek in Madera Subbasin." Please note that ISWs are best estimated by first determining which reaches are completely disconnected from groundwater. This approach would involve comparing groundwater elevations with a land surface Digital Elevation Model that could identify which surface waters have groundwater consistently below surface water features, such that an unsaturated zone would separate surface water from groundwater. Groundwater elevations that are always deeper than 50 feet below the land surface can be used to identify the above ground reaches as disconnected surface waters. As shown in Figures 2-71 and 2-72, depth to groundwater is greater than 100 feet in 2014 and 2016 across much of the Subbasin. However, areas in upstream reaches of the Fresno River and San Joaquin River show depths to groundwater within 20-30 feet in 2014. Please provide further evidence, such as cross-sections or corresponding hydrographs, to show the relationship between the river channel and the depth to groundwater at wells near the Fresno River and San Joaquin river to improve ISW mapping. Where data gaps exist regarding the existence of ISWs, make plans to reconcile them in the Monitoring section.	See Multiple Comment Subject Area Response	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Surface Water-Groundwater Interactions	2-40	Figures 2-71 and 2-72 present depth to shallow groundwater for 2014 and 2016. Please further describe how these figures were developed, specifically noting the following best practices for developing depth to groundwater contours presented in Attachment D. Ensure that the first step is contouring groundwater elevations, and the subtracting this layer from land surface elevations from a DEM to estimate depth to groundwater contours across the landscape. This will provide much more accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found. Depth to groundwater contours developed from depth to groundwater measurements at wells assumes that the land surface is constant, which is a poor assumption to make.	See Multiple Comment Subject Area Response	The Nature Conservancy
Surface Water-Groundwater Interactions	2-40	The regulations [23 CCR §351(o)] define interconnected surface waters (ISW) as "surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted". "At any point" has both a spatial and temporal component. Even short durations of interconnections of groundwater and surface water can be crucial for surface water flow and supporting environmental users of groundwater and surface water. ISWs can be either gaining or losing. The defining feature of disconnected surface waters is that groundwater is consistently below surface water features such that an unsaturated zone always separates surface water from groundwater, not whether the reach is gaining or losing. To improve ISW mapping, please reconcile data gaps (shallow monitoring wells, stream gauges, and nested/clustered wells) along surface water features in the Monitoring Network section of the GSP.	See Multiple Comment Subject Area Response	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Surface Water-Groundwater Interactions	2-40	The GSP states (p. 2-40): "It is likely that seepage from the San Joaquin River is the source of water that combined with the presence of shallow clay layers that serves to maintain shallow groundwater levels at these locations." Please provide estimates of current and historical surface water depletions for or the San Joaquin River, quantified and described by reach, season, and water year type. Provide a discussion of the expected effect of the SJRRP on flows, GDEs and ISWs along the San Joaquin River.	See Multiple Comment Subject Area Response	The Nature Conservancy
Measurable Objectives (23 CCR §354.30)	3-5	The description of Measurable Objectives (in this section of the text, or Appendix 2.B) does not explain how GDEs were considered. Please include GDEs in this section and explain how the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	Several RMS locations specific to identified GDE Units were assigned MO/MT and included in the overall RMS network. Thus, GDEs were specifically and directly incorporated in the RMS network being used to demonstrate subbasin sustainability.	The Nature Conservancy
Measurable Objectives (23 CCR §354.30)	3-5	The Sumner Hill and Friant Riparian GDE Units do not have nearby monitoring wells that monitor hydrologic conditions. Please specifically address the data gap with respect to these GDE Units or refer to a later section of the GSP.	There is extensive discussion in the GSP regarding groundwater levels and GDEs, and specific RMS sites were selected to represent GDEs. See response to previous comment on Sumner Hill Potential GDE Unit above. See Multiple Comment Subject Area Response Section regarding ISW.	The Nature Conservancy
Measurable Objectives (23 CCR §354.30)	3-12	The description of Measurable Objectives does not consider how water quality needs of GDEs were considered. Please include a discussion about GDEs and water quality and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	As stated in the GSP, it is expected that drinking water standards are also protective of GDEs.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Surface Water-Groundwater Interactions	3-15	The GSP fails to establish measurable objectives or minimum thresholds for this sustainability indicator. The GSP states (p. 3-15): “Thus, the connection between regional groundwater and streams was broken prior to 2015, and the surface water depletion sustainability criteria is not applicable to the Plan area.” However, the existence of riparian GDEs along the streams in the basin has been identified in Appendix 2.B, and their connection to groundwater is assumed. Their occurrence in the riparian zone means that these GDEs should be considered a beneficial user of groundwater that could be affected by chronic groundwater level decline as discussed above, as well as beneficial users of surface water that could be depleted by groundwater extraction. A more detailed discussion of the known facts regarding these surface-groundwater interactions in the riparian zone should be provided. In addition, a more detailed discussion regarding specific data gaps should also be included.	See Multiple Comment Subject Area response.	The Nature Conservancy
Measurable Objectives (23 CCR §354.30)	3-15	There is a need to evaluate and discuss potential effects on beneficial uses of surface and groundwater. This is necessary, at a minimum, so that the nature of the data gaps can be understood. In addition, the applicable state, federal and local standards for the protection of aquatic, riparian and other protected habitats should be discussed. Please refer to Attachment C for a list of freshwater species in Madera Subbasin that may be exist within ISWs. We recommend that after identifying which freshwater species exist in your basin, especially federal and state listed species, that you contact staff at the Department of Fish and Wildlife (DFW), United States Fish and Wildlife Service (USFWS) and/or National Marine Fisheries Services (NMFS) to obtain their input on the groundwater and surface water needs of the organisms on the freshwater species list. Because effects to plants and animals are difficult and sometimes impossible to reverse, we recommend erring on the side of caution to preserve sufficient groundwater conditions to sustain GDEs and ISWs. Please refer to the Critical Species Lookbook to review and discuss the potential groundwater reliance of critical species in the basin.	Edits made in Section 3.2.5 referring to Appendix 2.B.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Measurable Objectives (23 CCR §354.30)	3-15	The SJRRP identifies instream flow needs for salmon in multiple reaches which form the southern border of the Subbasin (http://www.restoresjr.net/about/overviewmap/). Please include instream flow requirements in this section and set measurable objectives and interim milestones that will help achieve the sustainability goal as it pertains to the environment	The ecological basis of the SJRRP's restoration flow schedule is described in the Fisheries Management Plan (Exhibit E: Ecological Goals of the Restoration Flows, available at: http://www.restoresjr.net/?wpfb_dl=861). The Ecological Goals document describes the flow-related needs of each Chinook salmon life stage as well as riparian vegetation recruitment and maintenance and other functions. We are not aware of any quantitative instream flow needs for salmon that have been established or documented by the SJRRP. The GSP has been revised in Section 3.2.5 to include discussion of potential adverse effects on instream flow, aquatic species, and riparian vegetation that could result from depletion of surface water.	The Nature Conservancy
Minimum Thresholds (23 CCR §354.28)	3-18 to 3-26	For the discussion of GDE susceptibility to changes in groundwater conditions (p. 3-25 to 3-26), please present or refer to specific hydrologic data or figures to back up claims of low susceptibility to impacts related to groundwater management and to allow the reader to more readily follow the discussion.	References to hydrologic data, including well hydrographs where available, have been added to the GSP in Section 3.3.1 (p. 3-25 to 3-26). There are no hydrologic data for the Fresno River Riparian or Sumner Hill potential GDE units.	The Nature Conservancy
Minimum Thresholds (23 CCR §354.28)	3-18 to 3-26	The Friant Riparian and the Sumner Hill GDE Units do not have wells nearby. While the likelihood of impacts due to pumping is considered low in these areas, the groundwater levels should be monitored; thus, new wells are recommended for installation in these areas. Please include proposed monitoring wells for the Friant Riparian and the Sumner Hill GDE Units as representative monitoring sites (RMS) for minimum thresholds.	Recommendation noted. The GSP's GDE Monitoring Program (Section 3.5.2.5) includes monitoring every five years to document the ecological condition of these potential GDE units. In the Fresno River Riparian Potential GDE Unit (as well as the Friant Riparian and San Joaquin River Riparian Potential GDE units), biological data will be analyzed in conjunction with hydrological data to assess potential ecological effects related to changes in groundwater levels and the relative degree of influence on GDE conditions exerted by streamflows and groundwater levels. Installation of monitoring wells in the Friant Riparian and Sumner Hill Potential GDE Units is not currently proposed. See also response to comment above on Sumner Hill Potential GDE Unit.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Minimum Thresholds (23 CCR §354.28)	3-18 to 3-26	Until monitoring wells are available in GDE Units Friant Riparian and Sumner Hill, consideration should be given to establishing minimum thresholds based on species or ecosystem response as measured by biological monitoring or remote sensing.	Without evidence of a link between groundwater conditions and the ecological condition of these potential GDE units, establishment of minimum thresholds in the GSP based on ecological response or other factors is not appropriate or justified.	The Nature Conservancy
Minimum Thresholds (23 CCR §354.28)	3-30 to 3-33	The Minimum Thresholds do not consider water quality needs of GDEs. The GSP states (p. 3-33): "Protection of municipal and domestic beneficial uses is also protective of all other groundwater beneficial uses." Please provide evidence or basis for the statement that protection of municipal and domestic beneficial uses is also protective of all other groundwater beneficial uses including environmental uses. Include a discussion about GDEs and water quality and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	In general, meeting municipal and domestic water quality MO/MT is expected to be protective of GDEs. It should also be noted that the GSP is not responsible for existing constituent levels or ongoing non-GSP related activities that may result in increasing constituent concentrations. As described in the GSP, there are many other agencies/programs devoted to monitoring and protection of groundwater quality, with which the GSAs plan to coordinate.	The Nature Conservancy
Surface Water-Groundwater Interactions	3-34	Minimum Thresholds for depletion of surface water were not developed for the Subbasin because the GSP determined that surface water was no longer connected to groundwater. GDEs are often adjacent to streams or associated with riparian corridors where ISWs exist, even if only seasonally or are discontinuous along a longitudinal profile. GDEs have been identified along parts of Fresno and San Joaquin Rivers. The San Joaquin River "contains Essential Fish Habitat (EFH) for Chinook salmon which is partially dependent on riparian inputs to provide important salmon habitat elements including shade, overhead cover, nutrients, and woody material for instream cover and habitat complexity" (p. 2-45). Following the discussion presented above for Checklist Item 26 (Measurable Objectives), please include a discussion of Sustainable Management Criteria for ISWs, including Minimum Thresholds, in the GSP. Please cite data gaps regarding ISWs and make plans to reconcile them in the Monitoring Section of the GSP.	See Multiple Comment Subject Area Response	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Dependent Ecosystems and Surface Water-Groundwater Interactions	3-45	Per the GSP Regulations (23 CCR §354.34 (a) and (b)), monitoring must address trends in groundwater and related surface conditions (emphasis added). For this section to provide the appropriate context and help assure integration of GSP implementation with other ongoing regulatory programs, please describe jurisdictions related to aquatic resources, interconnected surface waters (ISWs), instream flow requirements, and groundwater-dependent ecosystems (GDEs) that could be affected by groundwater withdrawals.	There is extensive discussion in the GSP regarding groundwater levels and GDEs, and specific RMS sites were selected to represent GDEs. See Multiple Comment Response Section regarding ISW.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Interconnected Surface Waters (ISWs) (23 CCR §354.16)	3-39	Per the GSP Regulations (23 CCR §354.34 (a) and (b)), monitoring must address trends in groundwater and related surface conditions (emphasis added). Groundwater level monitoring alone may be insufficient to establish a linkage between groundwater extraction and potentially resulting impacts to environmental resources associated with GDEs and ISWs. The cause-effect relationship between groundwater levels and the biological responses that could result in significant and unreasonable impacts to ISWs and GDEs depends on a number of complicated factors, and this relationship is not characterized or discussed. The Monitoring Network section currently does not address future needs for ISW monitoring. In this section, please describe monitoring for ISWs as described below: In addition to the need for additional shallow monitoring wells in the upper aquifer to map GDEs, there is also a need to enhance monitoring of stream flow and vertical groundwater gradients by installing more stream gauges and clustered/nested wells near streams, rivers or wetlands. Ideally, co-locating stream gauges with wells that can monitor groundwater levels in both the upper and lower aquifers would enhance understanding about where ISWs exist in the basin and whether pumping is causing depletions of surface water or impacts on beneficial users of surface water and groundwater. Please provide sufficient detail for the investigation and monitoring program including stream gauges, screened intervals and frequency of monitoring, in order to describe monitoring of both the extent of ISWs and the quantity of surface water depletions from ISWs.	There is extensive discussion in the GSP regarding groundwater levels and GDEs, and specific RMS sites were selected to represent GDEs. See Multiple Comment Subject Area Response Section regarding ISW.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Monitoring Network (23 CCR §354.34)	3-41 to 3-45	The proposed wells to be used for monitoring groundwater levels are shown in Figure 3-1 and include 11 wells in the Upper Aquifer and 22 wells in the Lower Aquifer. At present the Upper Aquifer wells are located in the southwestern part of the Madera GSA. Several of the monitoring wells are missing well construction information. Four composite wells are listed in Table 3-11 (p. 3-44). Please describe how the missing well construction information will be obtained, or how data from the wells will be used if it cannot be obtained. Please indicate how the composite wells will be used and whether the proposed nested wells will replace them.	The RMS network in the GSP had to be selected based upon existing available wells. The limited number (4) of composite wells are located outside of the Corcoran Clay area to try to fill spatial data gaps. Locations outside the Corcoran Clay area do not have as well-defined Upper and Lower Aquifers as occur within the Corcoran Clay area, so use of composite wells outside the Corcoran Clay area is less problematic. Nested monitoring well data will be used to both supplement the RMS network (after sufficient water level datasets are able to be obtained), and further refine our understanding of existing RMS locations with unknown well construction.	The Nature Conservancy
Monitoring Network (23 CCR §354.34)	3-53, App 2.B. Section 5	The GSP states (p. 3-53): “Biological data will be analyzed in conjunction with hydrological data, where available, to assess potential ecological effects related to changes in groundwater levels and the relative degree of influence on GDE conditions exerted by streamflows and groundwater levels associated with each potential GDE.” Appendix 2.B refers to an adaptive management framework to facilitate improvements in the monitoring program. Please further describe how adaptive management will facilitate improvements in the monitoring program and refine projects and management actions.	The GDE appendix states the following on this topic: "Biological monitoring data should be evaluated as part of an adaptive management framework to facilitate improvements in the monitoring program and refinement of projects and management actions or implementation of new actions to avoid adverse impacts to GDEs." Adaptive management could include a variety of actions such as adjustments to demand management strategies, new or expanded recharge projects, increased frequency of biological monitoring, and installation of new wells to monitor shallow GW in the Friant, Sumner Hill, and Fresno River Potential GDE units.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Monitoring Network (23 CCR §354.34)	3-55	The Friant Riparian Potential GDE Unit does not have any wells or monitoring points nearby and the true depth to groundwater is unknown. "Part of the GSP Implementation Plan will be to further investigate existing wells in this area for verifying presence of shallow groundwater (i.e., less than or equal to 30 feet bgs) and possible inclusion of a well as a representative monitoring station (RMS), if necessary (p. 19 of Appendix 2.B). If there are no appropriate existing wells to obtain current groundwater depth data for this GDE Unit, it is recommended to install one or more shallow wells to verify the presence of shallow groundwater.	Comment noted.	The Nature Conservancy
Monitoring Network (23 CCR §354.34)	3-55	The Sumner Hill Potential GDE Unit is located on an unnamed tributary of the San Joaquin River and includes riparian vegetation and a freshwater wetland. This potential GDE has a shallow depth to bedrock and is close to the Madera Canal, but no groundwater data are available. If there are no appropriate existing wells to obtain current groundwater depth data for this GDE Unit, it is recommended to install one or more shallow wells to verify the presence of shallow groundwater.	Comment noted.	The Nature Conservancy
Notice & Communication	2-21	In Table 2-5 (p. 2-21), please expand the stakeholder list associated with the Environmental and Ecosystem Uses category to include the appropriate agencies and list of environmental groups. Although environmental agencies and environmental groups are listed as one of the beneficial users of groundwater in the Subbasin, no specific uses are given.	The Environmental and Ecosystem category of interest in Table 2-4 has been expanded with the names of specific groups.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Dependent Ecosystems	2-20	The types and locations of environmental uses, species and habitats supported, instream flow requirements, and other designated beneficial environmental uses of surface waters that may be affected by groundwater extraction in the Subbasin should be specified. To identify environmental users, please refer to the following: o The NC Dataset (https://gis.water.ca.gov/app/NCDatasetViewer/) which identifies the potential presence of groundwater dependent ecosystems in this basin o The list of freshwater species located in the Madera Subbasin in Attachment C of this letter. Please take particular note of the species with protected status. o Lands that are protected as open space preserves, habitat reserves, wildlife refuges, etc. or other lands protected in perpetuity and supported by groundwater or interconnected surface waters should be identified and acknowledged.	See Multiple Comment Subject Area Response	The Nature Conservancy
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	4-1 to 4-52	The Madera Subbasin includes GDEs and ISWs that are beneficial uses and users of groundwater, and may include potentially sensitive resources and protected lands. Environmental beneficial users and uses of groundwater should be considered in establishing project priorities. In addition, consideration should be given to multi-benefit projects that can address water quantity as well as providing environmental benefits or benefits to disadvantaged communities. Please include environmental benefits and multiple benefits as criteria for assessing project priorities.	Edits made in Section 4. See comment in Section 4 intro (pg. 4-1) and text on pg. 4-7 which provides an example of benefits of recharge basins.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	4-1	This section identifies many important projects; the descriptions of benefits for these projects only identifies benefits to water level and storage. Because maintenance or recovery of groundwater levels, or construction of recharge facilities, may have potential environmental benefits in many cases it would be advantageous to demonstrate multiple benefits from a funding and prioritization perspective. o For the projects already identified, please consider stating how ISWs and GDEs will benefit or be protected, or what other environmental benefits will accrue. o If ISWs will not be adequately protected by those listed, please include and describe additional management actions and projects targeted for protecting ISWs. o Recharge ponds, reservoirs and facilities for managed stormwater recharge can be designed as multiple-benefit projects to include elements that act functionally as wetlands and provide a benefit for wildlife and aquatic species. In some cases, such facilities have been incorporated into local Habitat Conservation Plans (HCPs) and Natural Community Conservation Plans (NCCPs), more fully recognizing the value of the habitat that they provide and the species they support. For projects that construct recharge ponds, please consider identifying if there is habitat value incorporated into the design and how the recharge ponds can be managed as multiple-benefit projects that have a benefit to environmental users. o For examples of case studies on how to incorporate environmental benefits into groundwater projects, please visit our website: https://groundwaterresourcehub.org/case-studies/recharge-case-studies/	In addition to the proposed projects/management actions in the GSP, the San Joaquin River Restoration Program will provide a major source of new water to support GDEs along the San Joaquin River and will reduce diversions available for irrigation. Edits made in Section 4.1.1.5.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	4-45	The GSP states (p. 4-45): "Based on preliminary estimates, approximately 500 acres of Arundo exists in concentrated stretches of Berenda, Cottonwood, and Dry Creeks. Details on acreage of infestation, water use, the potential for reduction, and the cost would be developed before a removal/control plan is prepared." We appreciate the citing of TNC's literature review of Arundo evapotranspiration studies and recognizing Arundo removal as a potential project for the Subbasin.	Comment noted.	The Nature Conservancy
Sustainability Goal (23 CCR §354.24)	3-3	The sustainability goal does not specifically mention beneficial uses or users of groundwater, including environmental users. It states "the six sustainability indicators, established measurable objectives, and minimum thresholds will ensure that no undesirable results of significant and unreasonable economic, social, or environmental impacts occur…" Please rephrase the Sustainability Goal to specifically call out beneficial uses and users of groundwater including environmental users. Please state how the sustainability of environmental uses will be protected. In addition, a statement about any intention to address pre-SGMA impacts should be included.	Comment noted. The sustainability goal was discussed in public meetings and incorporates feedback received by GSAs from stakeholders during public meetings.	The Nature Conservancy
Sustainability Goal (23 CCR §354.24)	3-3	Because potential GDEs have been identified along the Fresno and San Joaquin Rivers, please include these surface waters in the Sustainability Goal.	The sustainability goal and GSP primarily relate to groundwater and surface waters impacted by groundwater pumping after 2015. Fresno and San Joaquin River surface waters do not fit in these categories and are not assigned SMC or included specifically in the sustainability goal.	The Nature Conservancy
Undesirable Results (23 CCR §354.26)	3-34 to 3-35	This section only describes undesirable results relating to human beneficial uses of groundwater and neglects environmental beneficial uses that could be adversely affected by chronic groundwater level decline. Please add "potential adverse impacts to GDEs" to the list of potential undesirable results presented in Table 3-8 (p. 3-35).	This section, in particular Table 3-8, describes undesirable results in terms of physical groundwater parameters. How these groundwater parameters relate to beneficial uses of groundwater are described in other sections. The relation to environmental beneficial uses is described in the sections and appendix that describe the GDE analysis completed.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Undesirable Results (23 CCR §354.26)	3-35	The GSP states (p. 3-36): “The undesirable result for groundwater levels is defined as more than 30 percent of RMS exceeding their minimum thresholds for the same two consecutive Fall readings. The 30 percent criterion was selected to balance the interest of beneficial use with the practical aspect of groundwater management uncertainty. Given a total of 37 RMS sites, a total of 12 or more of the initial RMS would need to exceed MTs as defined above to constitute an undesirable result for chronic lowering of groundwater levels.” The use of 30 percent to define an undesirable result does not allow for the occurrence of low water levels in one area, such as near a GDE, to be an Undesirable Result, which may impact an environmental beneficial use. Please consider the use of separate management areas for the GDE Units, so that Sustainable Management Criteria protective of GDEs can be established for the GDE Units. Please elaborate on how the exceedance criteria would be applied in a way that is protective of significant and unreasonable harm to GDEs.	The use of Management Areas for small areas of Potential GDEs is not appropriate. GDEs are not one of the six sustainability indicators designated under SGMA and GSP regulations. However, GDEs were considered in detail in the GSP and specific GDE RMS sites are included in the Plan.	The Nature Conservancy
Groundwater Quality	3-38	This section describes undesirable results in terms of meeting drinking water standards, including arsenic, but does not discuss degradation of water quality that may impact GDEs. Any potential undesirable results from degradation of water quality that may impact GDEs and freshwater species in the area should be discussed in this section	Arsenic is included as one of the key constituents for which MT and MO have been set. The GSP accounts for arsenic regardless of the mechanism by which the concentrations may increase, provided that increase in concentrations is caused by GSP projects/management actions.	The Nature Conservancy
Interconnected Surface Waters (ISWs) (23 CCR §354.16)	3-39	The Fresno and San Joaquin Rivers were connected historically but are not considered connected under current conditions. The GSP states (p. 3-39): “The Fresno River and the San Joaquin River are adjacent to, but not a part of, the Fresno River Riparian potential GDE Unit and the Friant Riparian and San Joaquin River Riparian potential GDE units, respectively. Both rivers are in a net-losing condition, with surface flow likely contributing directly to the shallow groundwater systems that support the vegetation in these GDE units.” The analysis for potential depletion of ISWs in Section 3.4.5 should include all beneficial users of surface water that could be affected by groundwater withdrawals, including environmental users.	The GSP analysis determined there are no ISW in Madera Subbasin; thus, beneficial users of surface water would not be affected by groundwater pumping.	The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Undesirable Results (23 CCR §354.26)	3-39	The GSP states (p. 2-47) that for the San Joaquin River Riparian Potential GDE Unit, “the adjacent San Joaquin River contains Essential Fish Habitat (EFH) for Chinook salmon which is partially dependent on riparian inputs to provide important salmon habitat elements including shade, overhead cover, nutrients, and woody material for instream cover and habitat complexity (PFMC 2014).” Further, the GSP states (p. 3-39): “However, the shallow groundwater system underlying the portion of the San Joaquin River that supports the San Joaquin River Riparian Potential GDE Unit does have at least the potential (albeit quite muted) to be affected by regional groundwater pumping.” These statements illustrate the need to develop Sustainable Management Criteria for ISWs. Following the discussion presented above for Checklist Item 26 (Measurable Objectives), please include a discussion of Sustainable Management Criteria for ISWs, including Undesirable Results, in the GSP. Please cite data gaps regarding ISWs and make plans to reconcile them in the Monitoring Section of the GSP.	The GSP analysis determined there are no ISW in Madera Subbasin; thus, beneficial users of surface water would not be affected by groundwater pumping. These GSP statements are saying that shallow perched/mounded groundwater is within 30 feet of ground surface (therefore, a potential GDE Unit is present), but groundwater is disconnected from surface water.	The Nature Conservancy
Water Budget	2-49 to 2-56	In the Land Surface System component of the water budget, ET is split into ET of applied water and ET of precipitation (Table 2-11, p. 2-54). ET of groundwater (ETg) is not included. Please include ETg in the water budget, or explain where it is included.	ET of applied groundwater is included in ETaw. For irrigators without access to surface water supplies, ETaw is equal to ETg. ET of shallow groundwater extracted by native and riparian vegetation is minimal in the Madera Subbasin. This is commented near Figure 2-89 and Table 2-24.	The Nature Conservancy
Water Budget	2-61 to 2-64	Please clarify how the Integrated Water Flow Model Demand Calculator (IDC) model of the root zone budget was used to differentiate ET among the agricultural, urban, and native vegetation land uses. Please explain how any native vegetation present in GDEs was handled in the water budget process.	Clarification of the IDC model procedures is provided in Section 2.2.3.3 (Water Budget Components and Uncertainties) and Appendix 2.F.i.	The Nature Conservancy

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Water Budget	2-77	The GSP states (p. 2-84): "…for native lands, groundwater extraction by riparian vegetation was considered to be negligible because of the depth to groundwater in the subbasin." Because there are GDEs in the Madera Subbasin, please quantify the evapotranspiration from groundwater by riparian vegetation. Please revise the text and budget as necessary.	Evapotranspiration from groundwater by riparian vegetation is included in the evapotranspiration of native vegetation. Riparian vegetation is not included in the list of water use sectors requiring separate quantification by the GSP regulations. The GSP regulations require that outflow be quantified by water use sector defined 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.	The Nature Conservancy
Language/copy edit	5-11	I would remove the word "all" in "comply with all of the requirements"	GSP revised accordingly.	Mark Hutson
Language/copy edit	not noted	Implementation of all projects. Remove "all." In short - remove the words all, shall, will, etc. These words are strong assertions and can be left out. This would apply to all chapters.	GSP revised accordingly.	Mark Hutson
Language/copy edit	not noted	I believe it is very important to strongly state in this chapter and others, that as knowledge, technology + management practices adapt and change, that the methodology of projects will adapt. This area of operation is so new, what we think is right may be wrong, and vice-versa. Please leave a wide area to maneuver within the GSP as GSAs become more knowledgeable. They need to be nimble and not constrained by a plan that may become obsolete.	Added paragraph in Section 4 and in Executive Summary on page 18.	Mark Hutson
Edits to plan	not noted	Update Fig. 1.1 & 1.6 & 1.8 & 1.14 to reflect recent annexation to Root Creek and removal from MID.	All figures with GSA boundaries are updated to reflect the changes in GSA boundaries.	Madera County Water
Edits to plan	1-8	Update 1.3, 1.3, Page 8 with new MADCO Supervisor Board meeting dates	Updated Section 1.3.1.3 to reflect the range of dates and times when the Madera County Board of Supervisors convenes as the Madera County GSA (typically the first or second Tuesday of each month, per the Madera County calendar).	Madera County Water

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Edits to plan	not noted	I'm trying to read and refer to tables and figures as I read. Can I suggest that they be placed closer to the narrative that refers to them? Where is figure 2-55? There are numerous figures that are referred to in Chapter 2 that I cannot find.	Many large maps in Chapter 2 are packaged together separately in a pdf document at the end of the GSP (due to file size constraints in hosting the GSP online). These figures are indicated in the List of Figures under the Table of Contents.	Bill Diedrich
Demand Management	not noted	CPF was pleased to see that the Draft GSP included recharge and conveyance projects. We recommend that the Madera Subbasin Coordination Committee make supply augmentation its top priority. CPF commends the Madera Irrigation District in particular for considering ways to encourage growers to participate in augmentation. Incentives such as additional extraction rights would be an excellent method of increasing landowner support for and participation in supply projects. But we are concerned that the Madera County GSA appears to be emphasizing a "substantial demand management" program that contemplates reducing irrigated acreage by 50% without explaining specifically how that would be done. Although the Draft GSP sets out principles for developing any demand management program such as minimizing economic impact, maintaining established water rights, and incentivizing investment in water supply infrastructure, it was unclear how those were applied to choose the demand management goals and how they would be applied in the future. The public will need to have meaningful opportunities to participate in the development of any demand management measures, which should include adequate time to evaluate supporting information and submit written comments. That is especially important in light of the finding (at Draft GSP page 4-45) that demand management will have direct economic costs of $53 .9 million per year and additional indirect costs that currently are unknown. And we would expect all the Subbasin GSAs to do their best to ameliorate such impacts by adopting implementation measures that are cost-effective.	See Multiple Comment Subject Area response.	California Poultry Federation

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Riparian Water Rights	1-9, 1-10	I am a landowner. My property is within both the Madera County GSA and the Madera Irrigation District GSA. Portions of my property in both of said GSAs receives riparian water-rights deliveries from the Fresno River. I noticed that riparian rights to the Fresno River for these GSAs were not mentioned in the draft of Chapter 1 of the Madera Subbasin Groundwater Sustainability Plan. The riparian water-rights holders along the Fresno River use thousands of acre-feet of riparian water rights water annually and this water is a critical part of the groundwater sustainability of the Madera Subbasin. There may even be additional riparian landowners who are not aware that they have surface water rights to riparian water. The more riparian water-rights water that is used, the better! Can these important riparian water-rights please be included in the next draft of Chapter 1 of the Madera Subbasin Groundwater Sustainability Plan? Please let me know if you have any questions, points of clarification, or if there is someone else, I need to contact with regard to the above.	GSP revised accordingly.	Anonymous
Riparian Water Rights	1-9	There are significant riparian deliveries to landowners within the Madera County GSA who hold riparian water rights to the Fresno River. For example see the attached pages documenting riparian diversions by one landowner diverting over 1,000 acre feet per year. There are many other land owners diverting riparian water from the Fresno River. Please update the attached highlighted paragraph to acknowledge the voluminous Fresno River riparian water diversions.	GSP revised accordingly.	Anonymous

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Demand Management	not noted	Road 20 Farm and Food Commons Fresno are against the potential of a land retirement policy for the implementation of demand reduction. Both Road 20 Farm and Food Commons Fresno are opposed to the potential measure because we acknowledge the potential for this measure to harm or cease our operations entirely. Additionally, are agricultural operations and management provide both a positive economic impact on the local community, as well as contribute greatly to the biological diversity and ecosystem health of Madera County. Road 20 Farm employs over 25 people, and based on the economic multiplier effect, contribute approximately 2.5-3 million to the local economy. Environmental benefits of our farm and land management include providing crucial habitat for pollinators, as well as increasing the biological diversity of Madera county based on our crop and flora diversity, and regenerative practice	See Multiple Comment Subject Area response.	Food Commons Fresno/Road 20 Farm
Minimum Thresholds (23 CCR §354.28)	xv	Comment on Chapter One of the GSP -Madera Subbasin - Section -List of Abbreviations: The list should appear with the abbreviation first, followed by the definition i.e.; ET - evapotranspiration Reason: If a person is looking up the meaning of an abbreviation, they would not look it up by the meaning -they don't know what that is. (it is currently written -definition/meaning first}	GSP revised accordingly.	Jeannie Habben
Water Budget	App. 3D, page 5	Looking at Appendix 3 page 5. Just wondering how they calculated an annual domestic well mitigation program cost of $277,000. The annual administrative cost is purported to be $150,000 plus $5,000 per well. This would leave only $127,000 for wells ($277,000 less $150,000). At $30,000 per well ($25,000 plus $5,000 admin fee) this would leave enough for only enough reimbursement for about 4 wells yet there is supposed to be enough to reimburse for 12 wells per year. (240 impacted wells divided by a 20 year implementation period) Do I have my math right? This does not look right! I think 12 wells per year is a little light! Talked to my well driller Horner and Sons and he drills 2 wells per week for 100 per year.	The database used to estimate the number of wells that would be impacted was obtained from DWR. The analysis acknowledges that this database is missing some wells, however, it was the best source found to be available. To better understand the number of wells that may need to be replaced, the GSAs are applying for a grant to complete an inventory of domestic wells.	James Paul Provenzano

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Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	How do you propose to change types of crops grown by market mechanisms?	The GSP does not propose to change crops that will be grown. Cropping decisions will continue to be made by individual growers.	Sarb Johal
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	The plan itself is heavily dependent on the purchase of available surface water and the construction of water recharge facilities. There is substantial risk of either the cost of water increases above a reasonable economic threshold or is simply not available. In recent years the amount of available surface water available for farming and recharge has been cut due to reallocations to environmental purposes. The plan also requires the construction of recharge facilities. These could quite possibly be delayed or face hurdles (environmental, economic, or governmental) that are quite literally impossible to overcome. In short there is a lot of uncertainty of the ability to implement this part of the plan.	The following text has been added to the GSP: The GSAs have prioritized implementing projects that provide additional surface water supply, thereby reducing groundwater pumping. The GSAs also are committed to adaptive management of projects and management actions. As projects are implemented and monitored, the project timelines and volume of demand management necessary will be reviewed. If adjustments are needed to meet the sustainability objective, first project timelines will be evaluated and adjusted. The key point being that demand management will be adjusted if needed due to a shortfall of purchased or project water.	James Paul Provenzano
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	ES-3	Figure ES-1 shows RCWD GSA boundaries incorrectly: This map and all other maps in the GSP should reflect the current RCWD GSP boundary.	All figures with GSA boundaries are updated to reflect the changes in GSA boundaries.	Root Creek Water District
Edits to plan	ES-7	The sustainable yield of 441,800 af doesn't match Figure ES-4	Figures has been updated to reflect sustainable yield estimates.	Root Creek Water District
Edits to plan	ES-10	Table ES-3 Lowering of groundwater levels: The MO and MT are set via the model. The model is based upon data from wells. The RCWD GSP are based upon observed water levels and extending the trends into the future recognizing the implementation of projects.	Comment noted with one correction: The Madera Subbasin MO and MT are set by a combination of observed and numerical model results. The RCWD MO and MT are set by a combination of observed and analytical model results.	Root Creek Water District

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Minimum Thresholds (23 CCR §354.28)	ES-10	The GSA's intend to mitigate for potential impacts to domestic wells caused by further decline in groundwater levels: The RCWD GSA has implemented and is operating projects and does not intend to participate in mitigating impacts to wells in adjacent GSAs.	Comment noted with this observation: the Madera Subbasin GSP has/will implement projects/management actions, but recognizes some additional groundwater level declines will occur prior to stabilization and potential rebound of groundwater levels. The domestic well mitigation program is intended to address Implementation Period declines. The RCWD GSP also shows Implementation Period groundwater level declines for the same reasons they are expected to occur in the remainder of the subbasin.	Root Creek Water District
Minimum Thresholds (23 CCR §354.28)	ES-13	Figure ES-5 – there are limited monitor wells in Southeast Madera basin bounded by State Highways 99 and 145: The RWCD GSA encourages installation of additional monitor wells at the border of the GSA's as well as in the Madera Ranchos as well as between the Madera Ranchos and State Highway 41 North of RCWD GSA.	Comment noted.	Root Creek Water District
Minimum Thresholds (23 CCR §354.28)	ES-13	Figure ES-5 – The monitor system proposed in Southeast Madera County does not propose discrete sampling by zone. The proposed monitoring program is spatially and temporally inadequate. One area of considerable interest is the level change within the Madera Ranchos. No proposed monitor well is proposed and many of the wells proposed are composite or are of unknown construction.	The RMS network in the GSP had to be selected based upon existing available wells. The limited number (4) of composite wells are located outside of the Corcoran Clay area to try to fill spatial data gaps. Locations outside the Corcoran Clay area do not have as well-defined Upper and Lower Aquifers as occur within the Corcoran Clay area, so use of composite wells outside the Corcoran Clay area is less problematic. Nested monitoring well data will be used to both supplement the RMS network (after sufficient water level datasets are able to be obtained), and further refine our understanding of existing RMS locations with unknown well construction. It is anticipated that other wells (both new and existing) may be added to the network, and GSAs would encourage well owners in data gap areas to come forward to offer their wells for inclusion in the RMS network (for wells with known construction data and preferably some water level history).	Root Creek Water District

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Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	ES-14	Table ES-4 RCWD tabulation of surface supplies: See the attached information taken from the RCWD GSA proposed GSP for more information. See Attachment 1 to this communication.	Table ES-4 contains the projects that RCWD provided to the joint GSP for modeling. Based on review of the RCWD GSP and this comment, it appears that RCWD added project(s) that are not included in the calibrated numerical model. A footnote has been added to Table ES-4 and the table in chapter 4 acknowledging this.	Root Creek Water District
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	ES-15	Table ES-5 RCWD tabulation of total surface water supplies	Table ES-5 contains the total surface supply of the projects that RCWD provided to the joint GSP for modeling. Based on review of the RCWD GSP and this comment, it appears that RCWD added project(s) that are not included in the calibrated numerical model. A footnote has been added to Table ES-5 and the table in chapter 4 acknowledging this.	Root Creek Water District
Edits to plan	1-4	Figure 1-1 Map incorrect – RCWD GSA boundaries	All figures with GSA boundaries are updated to reflect the changes in GSA boundaries.	Root Creek Water District
Hydrogeologic Conceptual Model (23 CCR §354.14)	not noted	Figure 2-47 Spring 1988 Contour Map: It is noted that this Figure documents a northwesterly groundwater flow direction similar to the groundwater flow direction found on Figure 3-22 in the RCWD GSP.	Comment noted.	Root Creek Water District
Hydrogeologic Conceptual Model (23 CCR §354.14)	not noted	Figure 2-48 Spring 2014 Contour Map: This map appears to have more data points than the 1988 map but much fewer than in an area of the Madera Ranchos. Compared to Figure 3-23 in the RCWD GSP, it appears that the location of the depression in the Southeast is located more to the west under the Madera Ranchos.	Comment noted.	Root Creek Water District
Hydrogeologic Conceptual Model (23 CCR §354.14)	not noted	Figure 2-49 Spring 2016 Contour Map: It appears that there is even less data when compared to other maps to prepare this map in the Southeast portion of Madera County.	Comment noted.	Root Creek Water District

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Hydrogeologic Conceptual Model (23 CCR §354.14)	not noted	Figure 2-53 Hydrograph shows level data from 2000 to present: The hydrograph for well id 11S20E31P001M is in the same proximate area as RCWD well 130 as shown on Figure 3-21 in the RCWD GSP which indicates a depth to water of approximately 275 feet in 1998 and continuing this trend to a depth of about 295 feet presently. The recovery shown in well P1M would be expected to be in a shallower well.	Upon further review of the water level spreadsheet associated with this well, notes made regarding various measurements, and additional recent data, the hydrograph for this well will be further evaluated and likely revised in upcoming annual and/or 5-year reports.	Root Creek Water District
Hydrogeologic Conceptual Model (23 CCR §354.14)	not noted	Figure 2-56 Change shows ground water level rise in southeast Madera basin: As suggested in the document the groundwater elevation rise shown in the Southeast area south of State Highway 145 is from a lack of data and interpolations on data.	Comment noted. This area will be evaluated further in upcoming annual and/or 5-year reports.	Root Creek Water District
Hydrogeologic Conceptual Model (23 CCR §354.14)	2-33	Paragraph 1 – identifies local depression in southeast: When looking at more specific data in the Southeast region it appears that the groundwater depressions are further east than noted on the maps.	Comment noted.	Root Creek Water District
Sustainable Management Criteria	3-5	Sustainable Management Criteria: As stated in the paragraph on measurable objectives (MO) the MO were developed based upon a model with average hydrology with implementation of projects. Since this is a layered model it is important to note that at varying depth or layers in the model that vary different water elevations can be realized. In the Southeastern Madera area as well, there were fewer wells to calibrate the model. Using historical data over a long period of time will provide significant insight into the realization of sustainability.	Comment noted with the following observations: the MO were developed based upon observed data and numerical model results. Additional data will be available for refinement of the model during the 5-year update.	Root Creek Water District
Monitoring Network (23 CCR §354.34)	3-55	Data Gaps – elevations – lower aquifer and extreme eastern portions of basin: The data gaps mentioned earlier are identified. No plan to fill this data gap is offered.	The GSAs will encourage existing well owners to offer their wells for inclusion in the RMS network, and seek funding opportunities for new well installations.	Root Creek Water District

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Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	4-3	Table 4-1: RCWD is currently purchasing water from partners outside the basin and should be added in this category.	GSP revised accordingly.	Root Creek Water District
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	4-4	Table 4-2: See Attachment 1 to this communication.	Table 4-2 contains the projects that RCWD provided to the joint GSP for modeling. Based on review of the RCWD GSP and this comment, it appears that RCWD added project(s) that are not included in the calibrated numerical model. A footnote has been added to Table ES-4 and the table in chapter 4 (4-2) acknowledging this.	Root Creek Water District
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	4-51	Section 4.7.1 Distribution of Purchased Water for In-Lieu Storage: Since completion over 16,000 af has been delivered through the system. The Madera SB GSP indicates only 8,000AF.	GSP revised accordingly.	Root Creek Water District
Minimum Thresholds (23 CCR §354.28)	not noted	Figure 3A-1 Elevation of Minimum Thresholds: Comparison with RCWD GSP shows in general range but RCWD GSP shows slightly lower levels	Comment noted.	Root Creek Water District
Measurable Objectives (23 CCR §354.30)	not noted	Figure 3A-3 Elevation of Measurable Objectives: Comparison with RCWD GSP shows in general range but RCWD GSP shows lower levels	Comment noted.	Root Creek Water District
Minimum Thresholds (23 CCR §354.28)	not noted	Appendix 3 – Hydrograph MC-RMS-5: It should be noted that this well is shallow adjacent to the SJR and should be used discretely and may not be reflective of shallow groundwater levels.	Comment noted - please provide any well construction data that may be available.	Root Creek Water District

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Subsurface Inflows	not noted	The Madera Subbasin draft GSP indicates there is approximately 69,400 AF of historical and current inflow with no project actions, the amount of inflow increases to 108,200 in 2040, which the Madera Subbasin identifies as their sustainability goal. With projects implemented and completed, the inflow is reduced to approximately 21,400 AF between 2040 and 2090. The GSP demonstrates that the Madera Subbasin will not achieve the sustainable yield or groundwater sustainability within SGMA's mandatory 20-year period. [Annual overdraft deficit is miscalculated when accounting for inflows, and GSP fails to address how the Subbasin will mitigate the overdraft deficit. The Madera Subbasin GSP does mention demand management beginning in year one, but details are being finalized. This could result in demand reduction of about 2%, but not enough to cover the total boundary flow.] The GSP infers the Madera Subbasin GSAs depends on approximately 69,000 AF of water per year within NKGSA's boundary. [NKGSA intends to capture and recapture water that the Madera Subbasin indicates is flowing into the Madera Subbasin.]	The water balance and required projects/management actions for Madera Subbasin do not rely upon net subsurface inflows to reach sustainability. The GSP describes in detail how Madera Subbasin will achieve sustainability strictly based on changes to vertical inflows and outflows (i.e., addressing net recharge or shortage). Planned refinements of the model in 2025 will likely result in more accurate absolute values of net subsurface inflow. At this time, the magnitude of current model calculated inflows is likely conservative (i.e., overestimated), and it is more useful to utilize model results to understand that significant reductions in subsurface inflow are expected under sustainable subbasin conditions after 2040. See also, Multiple Comment Subject Area response.	Fresno Irrigation District
Water Budget	not noted	An overview of the Gunner Ranch West Project (Project), a development project, is presented. The project includes a groundwater plan for long-term groundwater sustainability within portions of the subbasin that the Project overlies. The Project is referenced in other comments.	Comment noted. GSP edits in Madera County and City of Madera water budget Appendices.	McCormick, Barstow, Sheppard, Wayte & Carruth LLP, on behalf of Gunner Family
Undesirable Results (23 CCR §354.26)	not noted	The Project overlays a portion of the subbasin that the GSP identifies as a more stable area. The GSP describes the disparate and disconnected nature of the Madera County GSA territory, but makes no distinction or difference regarding the range of undesirable results or triggers for such results within the subbasin. This is inconsistent with other aspects of the GSP (e.g. separate water budgets for each of the GSAs). The separate water budgets should allow the GSP to identify more local minimum thresholds and measurable objectives for undesirable results, but that approach is not used for the GSP.	The MO/MT for each RMS site are specific to that location and well.	McCormick, Barstow, Sheppard, Wayte & Carruth LLP, on behalf of Gunner Family

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Management Areas	not noted	The GSP does not make use of separately defined management areas within the Madera County GSA territory, despite the disparate qualities of the underlying geology. The CCR and DWR's GSA BMP document describe forming these separate management areas. Failure to incorporate distinct management areas within the Madera County GSA territory creates arbitrary treatment of overlying lands that have dissimilar hydrogeology.	Formation of management areas under SGMA is optional and not required. GSA and consultant team review of Basin Setting conditions led to a determination that management areas were not necessary. Regardless of the management area decision, MO/MT for each RMS site are different for each RMS.	McCormick, Barstow, Sheppard, Wayte & Carruth LLP, on behalf of Gunner Family
Demand Management	not noted	The Project includes a reasonably established Project Sustainable Yield regarding groundwater use, which is a critical component of the Project's ultimate success. The demand management programs and strategies described do not adequately consider the Project because of failure to specify establishment of any specific "credits" that are part of the regulation, failure to adopt distinct management areas within the GSA territory, because of the limited evaluation of agricultural land classes (which does not adequately address development entitled lands), and potential conflicts with Madera County's General Plan. The demand management strategies have the potential to apply arbitrary and unnecessary regulatory impositions on land owners.	See Multiple Comment Subject Area Response and GSP edits in Madera County and City of Madera water budget Appendices.	McCormick, Barstow, Sheppard, Wayte & Carruth LLP, on behalf of Gunner Family
Minimum Thresholds (23 CCR §354.28)	References pages 3-36	Presents concern about adequacy of GSP to protect Valley Children's Hospital's Beneficial Uses of Groundwater, on which it is fully reliant. Undesirable result of "30 percent of wells below minimum threshold for two consecutive fall measurements" has potential to impact Valley Children's Hospital's water supply; the GSP should change undesirable results to prevent impacts to drinking water supply.	Comment noted.	Valley Children's Hospital
Monitoring Network (23 CCR §354.34)	References pages 53-54	Presents concern about adequacy of GSP to protect Valley Children's Hospital's Beneficial Uses of Groundwater, on which it is fully reliant. The proposed "representative monitoring sites" used to monitor sustainable management criteria in the vicinity of the Valley Children's Hospital campus (MCE-RMS-9, MCE-RMS-7, MCE-RMS-4) are not representative of the hospital's wells. Valley Children's Hospital is willing to include their wells in the representative monitoring network to address this issue.	Comment noted.	Valley Children's Hospital

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Demand Management	not noted	The draft GSP's proposed "Demand Management" and "Demand Reduction" is vague and needs to be clarified. It is unclear whether the program applies only to Madera County's GSA area or to all GSAs within the Madera Subbasin. It is also unclear on whether Demand Management will apply to agricultural users or all beneficial users. If applied to all beneficial users, it could create substantial hardship for the Hospital.	See Multiple Comment Subject Area Response	Valley Children's Hospital
Edits to plan	not noted	Valley Children's Hospital is located in between the Madera County GSA area, Root Creek Water District, and North Kings Subbasin and could be affected by GSPs and groundwater management in all three areas. The Hospital suggests that Madera County review and comment on neighboring GSPs and take a leading role in coordination within the Madera Subbasin and with neighboring GSAs to implement SGMA in a manner that protects all beneficial users.	Comment noted. Madera County is currently taking an active, leading role in coordinating SGMA-compliance and GSP implementation subbasin-wide.	Valley Children's Hospital

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Levels Related to Domestic Wells	not noted	Water Level Monitoring Network & Sustainable Mgmt. Criteria: The draft GSP does not include a thorough analysis of impacts to key beneficial users in the subbasin (domestic well users and members of DACs). The GSP should describe how the proposed approach to developing MOs/MTs is protective of the diverse drinking water users in the subbasin. The GSP should explain how the proposed monitoring network is adequate to monitor conditions for these sensitive beneficial users. The GSP should explicitly describe any future RMS wells and identify the proposed locations, and when assessing the monitoring network data gaps, the GSP should consider the locations of beneficial users, including DACs, small water systems, and domestic wells. Given that the subbasin is in critical overdraft, the GSP should explain how the projected additional water level declines of over 64 feet on average and over 100 feet (up to 130 feet at the MTs) near groundwater-dependent communities reliant on domestic wells will result in sustainable conditions for beneficial users. It is recommended that the impacts to groundwater gradients at the proposed MOs and MTs be analyzed and described in the GSP, as well as impacts to drinking water wells.	A thorough analysis of anticipated impacts is provided in the GSP, including hydrographs for RMS locations included in Appendix 3. However, the impact evaluation has to consider also the proposed domestic well mitigation program described in Appendix 3. See also the Multiple Comment Subject Area response.	Self-Help Enterprises

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Levels Related to Domestic Wells	not noted	Water Level Monitoring Network & Sustainable Mgmt. Criteria (Domestic Well Mitigation Program): The draft GSP does not include a thorough analysis of impacts to key beneficial users in the subbasin (domestic well users and members of DACs). Without more specific and clear details about the domestic well mitigation program, the public cannot assess the adequacy of this program to address the needs of the communities or provide productive and meaningful comments on such plan. The draft GSP does not present the results of the domestic well impact analysis in a clear and transparent manner, illustrating for example, 1) where the likely impacted wells are located, 2) what communities are most affected (including DACs), 3) an estimate of the size of the population that relies on these domestic wells, or 4) if the creation a new or expanded community water system could address some or all of the population affected by the loss of domestic wells. The analysis appears to significantly underrepresent the likely impacts of the proposed GSP on domestic well users. The GSP should present a thorough, robust, and transparent analysis, supported by maps, that identifies: (1) which domestic wells are likely to be impacted at the MTs and at the MOs, and (2) the location of the likely impacted wells with respect to DACs and other communities and systems dependent on groundwater. The domestic well mitigation program should assess the number of domestic wells that will be impacted under projected conditions and lay out a clear and proactive plan so that the potentially affected domestic well users do not lose access to drinking water when water levels decline, but an UR is not yet triggered. *Note: Nine key considerations for the program are detailed at the end of the comment letter.*	The results of an analysis of domestic well impacts using the current database can yield different results depending on the thresholds and assumptions used in the analysis. A primary difference in the analysis conducted for the GSP vs. the analysis conducted by SHE is that the SHE analysis includes no time factor. For example, the SHE analysis of domestic well impacts related to the MO (570 wells) does not consider that MOs at each RMS site were already exceed historically, so essentially no wells will go dry in the future at MO levels that have not already gone dry. The GSP domestic well analysis is intended to address domestic well impacts during the Implementation Period. It should also be noted that developing an accurate analysis of domestic wells is affected by limitations in the current database. The current database from DWR has missing well construction data , does not have individual well depths/screen intervals but rather just a summary of minimum, maximum, and average construction characteristics by section, provides no information on age of wells and current status (i.e., active, inactive, destroyed), and likely is biased towards older shallower wells (many of which may already have been abandoned/destroyed/replaced), and does not include many recently installed deeper wells. The County recently applied for a Prop 68 Grant to conduct a domestic well inventory to provide a better database for incorporation in the domestic well mitigation program. See also the Multiple Comment Subject Area response.	Self-Help Enterprises

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Quality	not noted	Water Quality Monitoring Network & Sustainable Mgmt. Criteria: Several clarifications or improvements are recommended for the water quality SMCs and monitoring network presented in the draft GSP. Because multiple constituents are present above MCLs and because they present a clear risk to drinking water beneficial users of the subbasin and thus do not represent sustainable conditions, the GSAs should include these constituents in its monitoring program and establish MOs and MTs for these constituents. Also, it is not clear what the GSAs intend to use as water quality MTs, and thus how sustainability for water quality is defined for the subbasin. Lastly, the draft GSP should include a description and map of the location of known groundwater contamination plumes and sites per 23 CCR § 354.16. It appears that the community water systems in the subbasin are generally well represented by this network, but that limited monitoring will be conducted in areas with high densities of domestic well users, which may constitute significant data gaps in the monitoring network. Additional sampling taps to fill this data gap are described in the GSP, but it is not clear based on the information presented in the draft GSP (1) how many additional sampling taps will be added to the network, (2) where these wells will be located, and (3) whether these wells will be included as groundwater quality RMS wells and evaluated with respect to MTs/MOs.	See Multiple Comment Subject Area response.	Self-Help Enterprises

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Water Budget	not noted	Water Budget: The description of the water budget in the draft GSP is not fully transparent, and it is not clear how drinking water users will be protected when sustainable yield allocations are implemented. The GSP should include information on the methods used to estimate urban pumping including reported data (if any), population estimates used, per capita water use estimates used, and the areas and users of the subbasin represented by the urban pumping water budget component. The GSP should include information on how the changes in urban pumping were determined for the projected water budget and how these changes may impact small community water systems and domestic well users. The reported urban pumping exhibits more variability than would be expected in an urban environment. The GSP should provide information on the cause of this variability so the public can determine if it is reasonable. The GSP should also discuss how the urban water demands presented in historical the water budget related to the historical water demands reported by the City of Madera in its Urban Water Management Plans. The GSP should include additional details on the how the hydrologic and water supply periods used for the projected water budget were selected and why the selected period are anticipated to be representative of future conditions. It is also recommended that the GSP clearly present the water budget results for the intended conditions in 2040 so that the public may evaluate whether sustainable conditions will be achieved by 2040. The GSP should include information on how the sustainable yield will be allocated to the GSAs and how it will impact the water budget in these GSAs. The GSP should also clearly identify how the allocation of sustainable yield will be protective of drinking water users, including domestic well users and small public water systems.	Information used to develop urban pumping estimates has been added to Section 2.2.3.3 (Water Budget Components and Uncertainties). Groundwater pumping records from City of Madera were used when available. Measurable Objectives and Minimum Thresholds have been established to protect domestic wells (see Table 3-8). Furthermore, the domestic well mitigation program described in Appendix 3.D provides one further plan for protecting domestic well users affected during the GSP implementation period. The projected with projects groundwater model simulation indicates that the schedule for project implementation together with the domestic well mitigation program results in Measurable Objective values (i.e., groundwater levels, groundwater storage, and water quality) that avoid Minimum Thresholds and associated undesirable results for the 2040-2090 projected period. Additional detail has been added to Section 2.2.3.2 describing the selection of the projected water budget period. The sustainable yield is specified for the basin, as required by the GSP Regulations (23 CCR Section 354.18(b)(7)).	Self-Help Enterprises

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Hydrogeologic Conceptual Model (23 CCR §354.14)	2-7	The GSP should include a more detailed description of the region's diverse groundwater users and DACs' dependence on groundwater for drinking water purposes. Besides listing DACs present within the GSAs boundaries, the GSP should provide a more comprehensive description of the domestic, irrigation, and public supply wells that includes the average well-depth for each group and the amount of groundwater that domestic and public supply wells are dependent on (we recommend this information to be included on page 2-7 of the draft GSP).	Maps of wells in the subbasin are updated to identify SDACs and DACs in the subbasin. Average well depths are included in the Ch. 3 figures, and can be cross-referenced with SDACs and DACs.	Self-Help Enterprises
Description of Plan Area	not noted	The draft GSP should include a map naming and indicating the location of public water systems serving SDACs and/or DACs as well as domestic well communities (we recommend the map to be included on subsection 2.1.1 of the draft GSP or adding that information on figures 2-5, 2-6, and 2-7).	Comment noted. GSP regulations do not require the map described.	Self-Help Enterprises
Outreach (including DACs/SDACs)	App. 2.C.c	The GSP should include and describe the methods the Agency shall follow to inform the public about the progress on implementing the Plan, including the status of projects and actions, per 23 CCR § 354.10. The GSP should update the Engagement Matrix (Appendix 2.C.c) and provide details about the implementation of each of the communication methods outlined in the GSP.	See Multiple Comment Subject Area response. The Engagement Matrix has been updated.	Self-Help Enterprises
Hydrogeologic Conceptual Model (23 CCR §354.14)	not noted	The draft GSP should include a description of the groundwater level conditions in and around S/DACs and show whether groundwater levels in these communities have led to dry wells or a decrease in water production. Specific recommendations are: Provide the locations and depths of all domestic and public supply wells in the GSA area using the best available information. Utilize our Focused Technical Review paired with the Madera Subbasin Water Budget to develop a more detailed description of the historical and currently known groundwater challenges impacting drinking water supplies. Include a description of the impacts experienced during the 2012-2016 drought. Include a discussion of the historical fall groundwater elevation contour maps and how pumping patterns may have and is currently influencing groundwater conditions.	The GSP provides this well information and DAC/SDAC locations in various figures in Sections 1 and 2 and Appendices 2 and 3. In addition to existing wells and other information; the County had met in person and held multiple conference calls with Leadership Council to receive and discuss concerns related to DAC/SDACs. One outcome of these discussions was moving locations of two nested monitoring well locations to the communities of Fairmead and La Vina per the request of LC. Information obtained from these and other new nested well locations installed specifically in SDAC areas, along with existing wells, will provide substantial additional information during GSP implementation in DAC/SDAC areas.	Self-Help Enterprises

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Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	Recharge Projects: The draft GSP should provide more information regarding how the risks of inadvertent drinking water impacts associated with projects, in particular on-farm recharge projects, will be evaluated and monitored as a part of each identified project and management action.	In Section 4, the description of on-farm recharge projects also includes a description of how these projects will be monitored.	Self-Help Enterprises
Demand Management	not noted	Demand Management Program: The draft GSP should present in a clear and transparent manner that is sufficient for the reader to understand the scope of precautions and assumptions being considered for drinking water use and users for the development of the demand management program, in particular for the allocation framework and the groundwater market.	See Multiple Comment Subject Area Response	Self-Help Enterprises
Management Areas	not noted	Water Banking and Recharge: Where possible, GSPs should identify management areas that may benefit form additional recharge and banking and develop incentives for public or private investment to expand recharge and banking capacity.	Formation of management areas under SGMA is optional and not required. GSA and consultant team review of Basin Setting conditions led to a determination that management areas were not necessary. Regardless of the management area decision, MO/MT for each RMS site are different for each RMS.	Wonderful Citrus
Data Management System	not noted	GSAs should develop a coordinated, basin-wide data management system (DMS). The DMS should also include, or be capable of interfacing with, a groundwater market platform.	Consider adding interfacing mechanism between the DMS and a groundwater market platform. Existing plans for DMS are described in GSP Ch. 5.	Wonderful Citrus
Demand Management	not noted	If pumping restrictions are required to achieve sustainability, they should be implemented with the most gradual ramp-down possible while still avoiding undesirable results. Should allocation of native yield be a necessary management action, the GSAs should use a stakeholder-driven process to develop a methodology of allocation that is consistent with the various legal considerations drawn from case law.	Acknowledged. See also Multiple Comment Subject Area Response	Wonderful Citrus

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Edits to plan	not noted	We request that the MVWC be specifically identified in the early chapter(s) of the GSP, as a distinct entity within the County GSA's area along with the included agencies. We provide the following summary text for inclusion in the plan. "Madera Valley Water Company is located in the County of Madera north of the City of Madera and was constructed in 1956. Located north of Avenue 17 between Road 26 and Road 27. It encompasses approximately 1,600 acres. The population served is estimated at 8,900. The majority of the connections are residential. The lot sizes range from ¼ acre to 1 acre. There are approximately 50 commercial properties which consist mainly of small retail stores, restaurants, offices, and several gas stations. The water system has 5 wells ranging in depth of 543 feet to 770 feet and a 1.5-million-gallon elevated water storage tank. Each of the wells has a liquid chlorination unit for emergency chlorination. There are approximately 40 miles of pipeline in the system."	There are a number of individual agencies within the County GSA, and they do not have individual descriptions. This could be added to an update or an annual report, but needs to be done for all individual agencies at that time.	Madera Valley Water Company
Monitoring Network	not noted	Because MVWC serves 8,900 residents has been impacted in the last 3-5 years with unprecedented declines in water levels we believe that at least one SGMA-specific monitoring well should be included in or immediately adjacent to our service area.	Recommendation noted. The GSP's Monitoring Network includes monitoring wells in the vicinity of MVWC. A RMS well for water levels (MID RMS-16) is located very near to MVWC and has been historically monitored as part of the CASGEM program.	Madera Valley Water Company
Subsidence	not noted	Having already experienced infrastructure issues due to subsidence to date, and anticipating additional engineering projects may be required in response to additional subsidence, MVWC believes that subsidence is an undesired result of increased groundwater usage that needs to be specifically addressed in greater detail in the GSP.	The GSP does include procedures for adaptive management for subsidence. See also Multiple Comment Subject Area Response.	Madera Valley Water Company
Groundwater Quality	not noted	The GSP should address the impacts of the lowering groundwater levels on groundwater quality in greater detail and identify the possible mitigation of groundwater quality issues over the planning horizon of the GSP.	The GSP is not intended nor required to be the primary means of addressing groundwater quality issues in the subbasin. See also, Multiple Comment Subject Area response.	Madera Valley Water Company

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Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	Although it is stated in the GSP that agricultural pumping is the dominant use of groundwater in the Basin, MVWC understands that we have to do our part to reduce groundwater usage. We have recently successfully received recognition as a disadvantaged community (DAC) from the state, which will allow us to pursue additional funding sources for future projects. We are currently pursuing state funding sources to implement flow meter installation for each connection in our service area. We anticipate that once we establish water use for each residence, we can pursue potential management actions such as conservation programs and tiered rate structures that will result in a decrease in per capita groundwater consumption in our service area. We anticipate that these actions will result in a decrease of at least 30% in our annual groundwater pumping volume. This project should be included in the GSP.	Comment noted. Projects not submitted during the project submittal time period cannot be included in the GSP due to the need to review and write up the project. This project will be considered for addition during the five year update.	Madera Valley Water Company
Edits to plan	not noted	MVWC provided more than 30 years of data to the GSA consulting team for use in the GSP development, but we see no evidence in the plan that it was considered or utilized. Will there be an appendix or some acknowledgement that our data was used in the development of the plan	Data provided by MVWC during the preliminary data collection and analysis work for Madera Subbasin include annual system production values for 1996-2016 and sporadic water level measurements for their wells indicated by year (no measurement date or other time of year provided) between 1996 and 2017. Because of the lack of indication of measurement date on the provided water level data, these data were difficult to incorporate into the GSP analyses. One MVWC well is included as an identified RMS well being monitored by other programs (Division of Drinking Water) for groundwater quality (Well ID 1010010-007), and a separate RMS well for water levels (MID RMS-16) is located very near to MVWC and has been historically monitored as part of the CASGEM program.	Madera Valley Water Company
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	The GSP utilizes estimates for much of the pumping data collection. The GSP should include a policy or at least a discussion of having all non-de minimis wells metered to ensure accuracy of the pumping data and for potential use to generate revenue to pay for recharge projects based on actual use.	The GSP discusses in Chapter 5 that each GSA is responsible to develop a budget and funding mechanism. The Madera County GSA recently passed a fee structure to pay for the GSA's activities.	Madera Valley Water Company

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	The GSP should include a policy or at least a discussion on how basin-wide or multi agency projects would be planned and developed to include all stake holders, including small agencies and DAC's, to ensure that recharge or other mitigation projects are effective and economically feasible.	Stakeholder engagement in GSP development and implementation is discussed in Chapters 2, 4, and 5. The GSAs decided to implement projects by GSA. Each project implemented by an individual GSA also benefits the subbasin and the coordination and administrative effort is less when a project is implemented by a single GSA. Each GSA is responsible ensure that the recharge or other mitigation projects they are implementing are effective and economically feasible.	Madera Valley Water Company
Plan Implementation	not noted	Recommend that the implementation chapter include more detail on how the GSP would be implemented and include policy statements regarding implementation such as those discussed in these comments.	The GSP will be implemented through project implementation at the GSA level and coordination and review by all GSAs that each GSA is completing the projects they are responsible for on time.	Madera Valley Water Company
Hydrogeologic Conceptual Model (23 CCR §354.14)	not noted	The draft GSP states that the comments from representatives of DACs are considered, and examples of DACs are listed in the Table 2-5 Stakeholder Engagement Chart for GSP Development. However, the draft GSP does not provide a detailed description of how the DACs were identified, the names and locations of all of the communities, or any further details of the population in the communities or how they use groundwater. Without this information, it is not clear how the GSP can identify and consider the needs of these DAC beneficial users. It is recommended the GSP provide a map of all DAC areas.	Maps of wells in the subbasin are updated to identify SDACs and DACs in the subbasin. Average well depths are included in the Ch. 3 figures, and can be cross-referenced with SDACs and DACs.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Stakeholders	not noted	The GSP should modify the stakeholder list associated with the Environmental and Ecosystem Uses category to include the appropriate agencies and list of environmental \groups.	Comment acknowledged, stakeholder list updated	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Monitoring Network	not noted	Providing maps of the monitoring network overlaid with location of DACs, domestic wells, community water systems, GDEs, and any other sensitive beneficial users will allow the reader to evaluate the adequacy of the network to monitor conditions near these beneficial users.	Maps of wells in the subbasin are updated to identify SDACs and DACs in the subbasin. Average well depths are included in the Ch. 3 figures, and can be cross-referenced with SDACs and DACs.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Groundwater Levels Related to Domestic Wells	not noted	Based on the information presented in the draft GSP, it is not clear how representative the monitoring network is for domestic well users. The GSP should therefore explain how the proposed monitoring network is adequate to monitor conditions for these sensitive beneficial users	A thorough analysis of anticipated impacts is provided in the GSP, including hydrographs for RMS locations included in Appendix 3. However, the impact evaluation has to consider also the proposed domestic well mitigation program described in Appendix 3. See also the Multiple Comment Subject Area response.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Monitoring Network	3-47	The draft GSP proposes “a potential for future addition of up to 21 monitoring wells from the 2019 nested well installation program” but does not identify the location of these potential wells on maps (Section 3.5.1.1).The GSP should explicitly describe any future representative monitoring wells and identify the proposed locations and depths. When assessing the monitoring network data gaps, the GSP should consider the locations of beneficial users, including DACs, small water systems, and domestic wells.	Proposed nested monitoring well locations were shown in the GSP on various maps, including Figures 3-1 and 3-2. Two of the seven nested well site locations were changed based on recommendations from Leadership Council. The final depths and screen intervals could only be determined after results for pilot hole drilling are obtained at each site. However, the domestic well depths at each location are one of the key criteria reviewed for designing each nested well. All of the nested wells were located within or immediately adjacent to SDAC areas.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Conditions	not noted	The GSP should provide clear evidence of hydraulic disconnection where shallow groundwater is considered perched or identify hydraulic connection as a data gap. In addition, the GSP should consider perched water as a shallow aquifer, because even though it may not be pumped at present, it could be in the future.	Perched groundwater is discussed in the GSP, and available data clearly show the lack of hydraulic connection between perched zones and the regional aquifer where groundwater pumping occurs. Perched aquifers lack sufficient permeability and aquifer thickness to allow for pumping for water supply purposes.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Groundwater Dependent Ecosystems	not noted	Areas with depth to groundwater greater than 30 feet can serve as a water source to some plants, e.g. oak trees, in the dry part of the year. The depth criterion of 30 feet is presented as a criterion for inclusion, not a standalone criterion for exclusion. In other words, if groundwater is within 30 feet of the ground surface, then a GDE can be identified. If it is not, then further analysis must be conducted.	See Multiple Comment Subject Area Response. Comment noted. Where DTW was greater than 30 feet, other criteria such as river hydrology (flow permanence and gaining vs. losing reaches) and dominant vegetation were used to determine whether potential GDEs should be considered as final GDEs. Screening of potential GDEs also included field evaluation of potential GDEs where initial uncertainty was high. Edits made in Section 2.2.2.6 to further explain and clarify.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Groundwater Conditions	2-43	Figures 2-71 and 2-72: the GSP should provide more details on how depth to groundwater contour maps were developed.	GSP revised to describe contouring process.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Dependent Ecosystems	not noted	The GSP uses depth to water maps from 2014 and 2016; 2016 is after the SGMA benchmark date of January 1, 2015. It should focus on groundwater condition data prior to the SGMA benchmark date instead. The GSP should use depth to groundwater data from multiple seasons and water year types (e.g., wet, dry, average, drought) to determine the range of depth to groundwater around NC dataset polygons. It should refer to TNC's guidance on Identifying GDEs Under SGMA (https://groundwaterresourcehub.org/public/uploads/pdfs/TNC_NC dataset_BestPracticesGuide_2019.pdf) for best practices for developing depth to groundwater contours. If insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons in the GSP until data gaps are reconciled in the monitoring network.	The GSP was revised to describe contouring process. Additional description and rationale for using groundwater levels for 2014 and 2016 was added to the GSP. The depth to groundwater contouring presented in the draft GSP was conducted as requested in this comment. Also see Multiple Comment Subject Area Response.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Groundwater Dependent Ecosystems	not noted	The GSP should further explain how NC Dataset polygons adjacent to the San Joaquin River were retained or removed as potential GDEs. On Appendix 2.B, Figure 1 polygons are shown as removed based on depth to groundwater greater than 30 feet, but the groundwater depth contours (Figures 2-71 and 2-72) do not show enough detail to make this distinction. The GSP should also consider retaining all NC Dataset polygons adjacent to the San Joaquin River due to the essential ecosystem function that the riparian vegetation community performs for the critical habitat of the Chinook salmon. As shown on Appendix 2.B, Figure 1, it appears that there is one potential GDE unit in light green on the far western border of the Subbasin. The GSP should describe further and clarify if this is indeed a polygon from the NC Dataset that was kept as a potential GDE. It is recommended that the GSP should obtain groundwater data before concluding that there are no adverse impacts to the GDE Unit and make plans to address this data gap in the Monitoring section of the GSP.	Comment acknowledged. There is no potential GDE unit in light green ("kept") at that location on Appendix 2.B, Figure 1. The shading at that location is light blue, indicating DTW less than or equal to 30 feet in either 2014 or 2016. This has been verified using the source data and GIS-derived mapping layer. Also see Multiple Comment Subject Area Response.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Surface Water – Groundwater Interaction	not noted	ISWs are best estimated by first determining which reaches are completely disconnected from groundwater. This approach would involve comparing groundwater elevations with a land surface DEM that could identify which surface waters have groundwater consistently below surface water features, such that an unsaturated zone would separate surface water from groundwater. Groundwater elevations that are always deeper than 50 feet below the land surface can be used to identify the above ground reaches as disconnected surface waters. The GSP should provide further evidence, such as a cross-sections or corresponding hydrographs, to show the relationship between the river channel and the depth to groundwater at wells near the Fresno River and San Joaquin river to improve ISW mapping. Where data gaps exist regarding the existence of ISWs, make plans to reconcile them in the Monitoring section. It should also provide estimates of current and historical surface water depletions for the San Joaquin River, quantified and described by reach, season, and water year type. Provide a discussion of the expected effect of the San Joaquin River Restoration Program (SJRRP) on flows, GDEs and ISWs along the San Joaquin River. To improve ISW mapping, it should reconcile data gaps (shallow monitoring wells, stream gauges, and nested/clustered wells) along surface water features in the Monitoring Network section of the GSP to address the temporal connectedness of ISWs with groundwater.	See Multiple Comment Subject Area Response.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Water Budget	not noted	Given the uncertainties of climate change, it is appropriate to analyze the impacts of climate change for a range of scenarios (e.g., a mild effects scenario and a high (worst case) effects scenario). Therefore, it is recommended the GSP also includes the DWR-provided 2070 climate change factors to represent a high climate change scenario.	The GSP considers climate change as a sensitivity model run and analysis, and uses a specific set of climate change parameters specified by DWR. The intent is to show the magnitude of effects on groundwater due to a given reasonably foreseeable scenario of potential climate change impacts on precipitation, evapotranspiration, and surface water supply. The GSP does not evaluate multiple potential climate change scenarios because there are an endless number of possibilities for future climate change. Ultimately, the GSAs will have to do adaptive management and adjust the projects and the amount of demand management to address the climate change that actually occurs. This is now reinforced in the Executive Summary (ES-2, Water Budget section).	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Water Budget	not noted	The GSP also does not provide specifics on drinking water demands separated by large urban water systems, domestic well users, or community water systems in the historical, current or future water budgets. This information should be provided for full transparency of the assumptions, data, and results of the water budgets.	Information used to develop urban pumping estimates has been added to Section 2.2.3.3 (Water Budget Components and Uncertainties). This includes information on drinking water demands.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Water Budget	not noted	The GSP should include information on the methods used to estimate urban pumping including reported data (if any), population estimates used, per capita water use estimates used, and the areas and users of the subbasin represented by the urban pumping water budget component. The GSP should include information on how the changes in urban pumping were determined for the projected water budget and how these changes may impact small community water systems and domestic well users. The GSP should also discuss how the urban water demands presented in historical the water budget related to the historical water demands reported by the City of Madera in its Urban Water Management Plans.	Information used to develop urban pumping estimates has been added to Section 2.2.3.3 (Water Budget Components and Uncertainties). Groundwater pumping records from City of Madera were used when available. Information regarding projected water budget development is also described in Chapter 2.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Identifying and Mapping GDEs (23 CCR §354.16)	not noted	Due to the presence of GDEs in the Madera Subbasin, the GSP should quantify the evapotranspiration from groundwater by riparian vegetation. It should also include ET of groundwater in the water budget or explain where it is included	Water use for native vegetation is included. SGMA does not require riparian vegetation to be accounted for separately from native vegetation. ET of groundwater is included in ET of applied water.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Management Areas	not noted	Tables 1-1 and 1-6 identify that management areas are discussed in Section 2.2.4. However, Section 2.2.4 does not appear to be included in the GSP and there is no other section discussing management areas. Therefore, it is assumed that the GSAs have not identified any management areas.	Section 2.2.4 Management Areas had been added to the GSP. Formation of management areas under SGMA is optional and not required. GSA and consultant team review of Basin Setting conditions led to a determination that management areas were not necessary. Regardless of the management area decision, MO/MT for each RMS site are different for each RMS.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Management Areas	not noted	If management areas are defined in the future, care should be taken so that they and the associated monitoring network are designed to adequately assess and protect against impacts to all beneficial users, including GDEs and DACs.	Comment acknowledged.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Levels Related to Domestic Wells	not noted	There are no upper aquifer or composite RMS wells located in the northern, central or southeastern portions of the subbasin, indicating that current monitoring network lacks adequate coverage for domestic wells in those areas, including those in the communities of Fairmead and Chowchilla (both DACs), Storey, Lake Madera Country Estates, and the area north of Madera. Therefore, based on the information presented in the draft GSP, it is not clear how representative the monitoring network is for domestic well users. The GSP should therefore explain how the proposed monitoring network is adequate to monitor conditions for these sensitive beneficial users.	A thorough analysis of anticipated impacts is provided in the GSP, including hydrographs for RMS locations included in Appendix 3. However, the impact evaluation has to consider also the proposed domestic well mitigation program described in Appendix 3. The RMS network will be expanded in the future with new nested monitoring wells and other potential well locations. See also the Multiple Comment Subject Area response.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Monitoring Network	not noted	The GSP should discuss whether there are data gaps in the monitoring networks for DACs and provide maps showing the monitoring network in relation to locations of the DACs and GDEs, so that the public may review the adequacy of the monitoring network to monitor for impacts to these beneficial users.	Maps of wells in the subbasin are updated to identify SDACs and DACs in the subbasin. Average well depths are included in the Ch. 3 figures, and can be cross-referenced with SDACs and DACs.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Undesirable Results (23 CCR §354.26)	not noted	Based on the presented information, domestic well uses are considered under URs and for the development of water level MOS and MTs, but DAC members are not explicitly considered. More detail and specifics regarding DAC members, including those that rely on smaller community drinking water systems, not only domestic wells, is necessary to demonstrate that these beneficial users were adequately considered	Nested monitoring wells are being installed and are anticipated to be added to the RMS network in the future. See also other responses to similar comments above.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Levels Related to Domestic Wells	not noted	If water levels reach the MOs, water levels would increase by an average of approximately 22 feet across all RMS wells in the subbasin compared to current conditions (2016), with localized water decreases as much as 72 feet below current conditions. At the MTs, water levels at the RMS wells would decrease by an average of approximately 64 feet from current conditions. In several communities, this decline is estimated to be over 100 feet from current conditions (COM RMS-2, MCE RMS-2, MWD RMS-1, COM RMS-1). Given that the subbasin is in critical overdraft, the GSP should explain how the projected additional water level declines of over 64 feet on average and over 100 feet near groundwater-dependent communities will result in sustainable conditions for beneficial users.	See Multiple Comment Subject Area Response.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Groundwater Quality	not noted	The draft GSP sets the MTs for water quality constituents as the MCLs or the recent concentration plus 20 percent when existing or historical concentrations already exceed the MCL. However, Table 3-7 shows the MT values for all wells as MCLs, and includes a note that "Values will be confirmed and/or adjusted as needed based on results from initial sampling for constituents. If existing levels exceed the MCL, then the MT is set at the existing concentration plus 20 percent" even for the existing RMS wells. This appears to be inconsistent with the MT methodology described in Section 3.3. Therefore, it is not clear what the GSAs intend to use as water quality MTs, and thus how sustainability for water quality is defined for the subbasin.	The GSP is not intended nor required to be the primary means of addressing groundwater quality issues in the subbasin. That being said, the RMS groundwater quality monitoring program in the GSP is quite robust compared to GSP requirements. See also, Multiple Comment Subject Area response.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Groundwater Dependent Ecosystems	not noted	The draft GSP defines the undesirable result for groundwater levels is defined as more than 30 percent of RMS exceeding their minimum thresholds for the same two consecutive Fall readings. The use of 30 percent to define an undesirable result does not allow for the occurrence of low water levels in one area, such as near a GDE, to be an Undesirable Result, which may impact an environmental beneficial use.	See Multiple Comment Subject Area Response.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Levels Related to Domestic Wells	not noted	The GSP should present a thorough, robust, and transparent analysis, supported by maps, that identifies: (1) which domestic wells are likely to be impacted at the MTs and at the MOs, and (2) the location of the likely impacted wells with respect to DACs and other communities and systems dependent on groundwater; (3) how small water system production wells will be affected by MOs and MTs; and (4) clearly identify the increased well operation costs for domestic well users and public water systems associated with water level MOs and MTs.	See Multiple Comment Subject Area Response and updates to: Ch. 3 maps, Appendix 3.D.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Groundwater Quality	not noted	The GSP should similarly analyze the potential impacts of setting minimum thresholds that exceed water quality objectives on domestic wells and community water systems.	See Multiple Comment Subject Area response.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Groundwater Levels Related to Domestic Wells	not noted	The draft GSP should include more detailed information about the potential impacts on sensitive drinking water users, such as 1) where the likely impacted wells are located, 2) what communities are most affected (including DACs), 3) an estimate of the size of the population that relies on these domestic wells, or 4) if the creation a new or expanded community water system could address some or all of the population affected by the loss of domestic wells.	See Multiple Comment Subject Area Response and updates to: Ch. 3 maps, Appendix 3.D.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Dependent Ecosystems	3-37	The GSP should add "potential adverse impacts to GDEs" to the list of potential undesirable results presented in Table 3-8 and consider the use of separate management areas for the GDE Units, so that Sustainable Management Criteria protective of GDEs can be established for the GDE Units. It should also elaborate on how the exceedance criteria (30% of RMSs) for chronic lowering of groundwater levels would be applied in a way that is protective of significant and unreasonable harm to GDEs.	See Multiple Comment Subject Area Response.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Groundwater Dependent Ecosystems	not noted	The GSP should also discuss any potential undesirable results from degradation of water quality that may impact GDEs and freshwater species in the area.	See Multiple Comment Subject Area Response.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Groundwater Levels Related to Domestic Wells	App. 3.D.	The draft GSP states that a temporary domestic well mitigation program is under consideration to address groundwater level declines that are expected to occur during the GSP implementation period. Appendix 3D of the draft GSP presents an economic analysis of the effects of implementing the GSP, including estimated costs to replace domestic wells that will be dewatered "with [Sustainable Groundwater Management Act] SGMA" and "without SGMA." According to the draft GSP, 87 domestic wells will be impacted prior to 2020, 43 more will be impacted under GSP implementation, and an additional 185 domestic wells would be impacted if the GSP was not implemented (i.e., if there were no changes as a result of SGMA). The draft GSP does not, however, present the results of this impact analysis in a clear and transparent manner, illustrating for example, 1) where the likely impacted wells are located, 2) what communities are most affected (including DACs), 3) an estimate of the size of the population that relies on these domestic wells, or 4) if the creation a new or expanded community water system could address some or all of the population affected by the loss of domestic wells. Several of these aspects are listed as potential mitigation measures under Section 3.2.4 of Appendix 3D and thus are important not only for the public to understand and review, but for the GSAs to understand in the development of their domestic well mitigation program.	See Multiple Comment Subject Area Response and updates to Appendix 3.D.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	The likely benefits and impacts to DAC members by the proposed projects and management actions are not clearly identified in the GSP. A discussion should be added for each project or management action to clearly identify the benefits to DAC drinking water users and potential impacts to the water supply. For all potential impacts, the project/management action should include a clear plan to monitor for, prevent, and/or mitigate against such impacts.	This information is generally provided in the GSP by comparison of data in Appendix 3 to maps showing DAC areas.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy

Comment Category/ General Topic	GSP Page	Comment	Response	Organization or Commenter
Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)	not noted	The GSP should evaluate any potential impacts of projects and management actions on groundwater levels near surface water bodies.	The hydrographs in Appendix 3 provide the requested information.	Clean Water Action/Clean Water Fund, Local Government Commission, Audubon California, American Rivers, The Nature Conservancy

4 DOCUMENTATION OF COMMENTS RECEIVED

All comments received are included in this section exactly as they were received.

Stephanie Anagnoson

From: Madera County Water <website@maderacountywater.com>
Sent: Tuesday, April 2, 2019 1:40 PM
To: MCwater
Subject: New submission from Contact Us

Follow Up Flag: Follow up
Flag Status: Flagged

Name

Al Solis

Email

al@soldevelopment.com

Phone

(559) 709-0805

Message

Chapter 1 suggestions

Update Fig. 1.1 & 1.6 & 1.8 & 1.14 to reflect recent annexation to Root Creek and removal from MID.

Update 1.3,1.3, Page 8 with new MADCO Supervisor Board meeting dates

Meta

http://www.maderacountywater.com/maps/madera-subbasin/ 96.67.196.153 Mozilla/5.0 (Windows NT 6.1; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/73.0.3683.86 Safari/537.36

7/23/19

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637

93637-354800

MADERA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN (GSP) COMMENT FORM

Please complete the following information to provide comments on the draft Madera Subbasin GSP. Type or print legibly for your comments to be considered.

Please return this form to (hand delivery, mail, or email accepted):

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637
Email: MaderaGSPComments@maderacounty.com

Date Submitted: 7/16/2019

Submitted By: Anonymous

Address: NA

Phone Number / Email: NA

APNs: NA

Located in Groundwater Sustainability Agency (GSA):
☐ Madera County ☐ MID ☐ City of Madera ☐ MWD ☒ Other NA

Affiliation: ☐ Irrigated Ag ☐ Non-Irrigated Ag ☐ Rural Residential
☐ Disadvantaged Community Member ☐ Agency/Government ☒ Other NA

Chapter No. / Page No. of GSP: 1/8

Comments: There are significant riparian deliveries to landowners within the Madera County GSA who hold riparian water rights to the Fresno River. For example see the attached pages documenting riparian diversions by one landowner diverting over 1,000 acre feet per year. There are many other landowners diverting riparian water from the Fresno River.

Please update the attached highlighted paragraph to acknowledge the voluminous Fresno River riparian water diversions.

Chapter No. / Page No. of GSP:

Comments:

Chapter No. / Page No. of GSP:

Comments:

Chapter No. / Page No. of GSP:

Comments:

1.3.1.3 Madera County GSA

Madera County (MC) GSA was formed on January 27, 2017 and manages approximately 177,800 acres of the Madera Subbasin, representing the largest jurisdictional area within the subbasin (Figure 1-6). As of 2015, the majority of this area is comprised of agricultural land (48%) or native vegetation (39%). The remaining area is primarily developed land (includes urban, semi-agricultural, and industrial land) (12%), though some water surface exists (1%).

In 2015, irrigated agricultural land represented over 82,000 acres in MC GSA. Much of this area is used for cultivating orchard crops (primarily almonds and pistachios) and grapes (Figure 1-7). Surface water supplies available for agriculture in MC GSA is limited to riparian deliveries to individual water rights users along the San Joaquin River and a small volume of Central Valley Project (CVP) supply received under contract with the U.S. Bureau of Reclamation (Reclamation). Thus, agricultural water demand in MC GSA is primarily fulfilled by groundwater.

The Board of Directors for MC GSA is the Madera County Board of Supervisors. As the Board of Directors, the Board of Supervisors meets on the first Tuesday of each month at the end of the 10 a.m. Board of Supervisors Meeting. These meetings are open to the public (200 West Fourth Street, Madera, CA, 93637) and are recorded and available for public viewing on the Madera County website (maderacounty.com). Madera County GSA also has an Advisory Committee that meets bimonthly and provides feedback to the Board of Supervisors on SGMA-related matters. Members of the committee also serve as ambassadors in their communities regarding water issues.

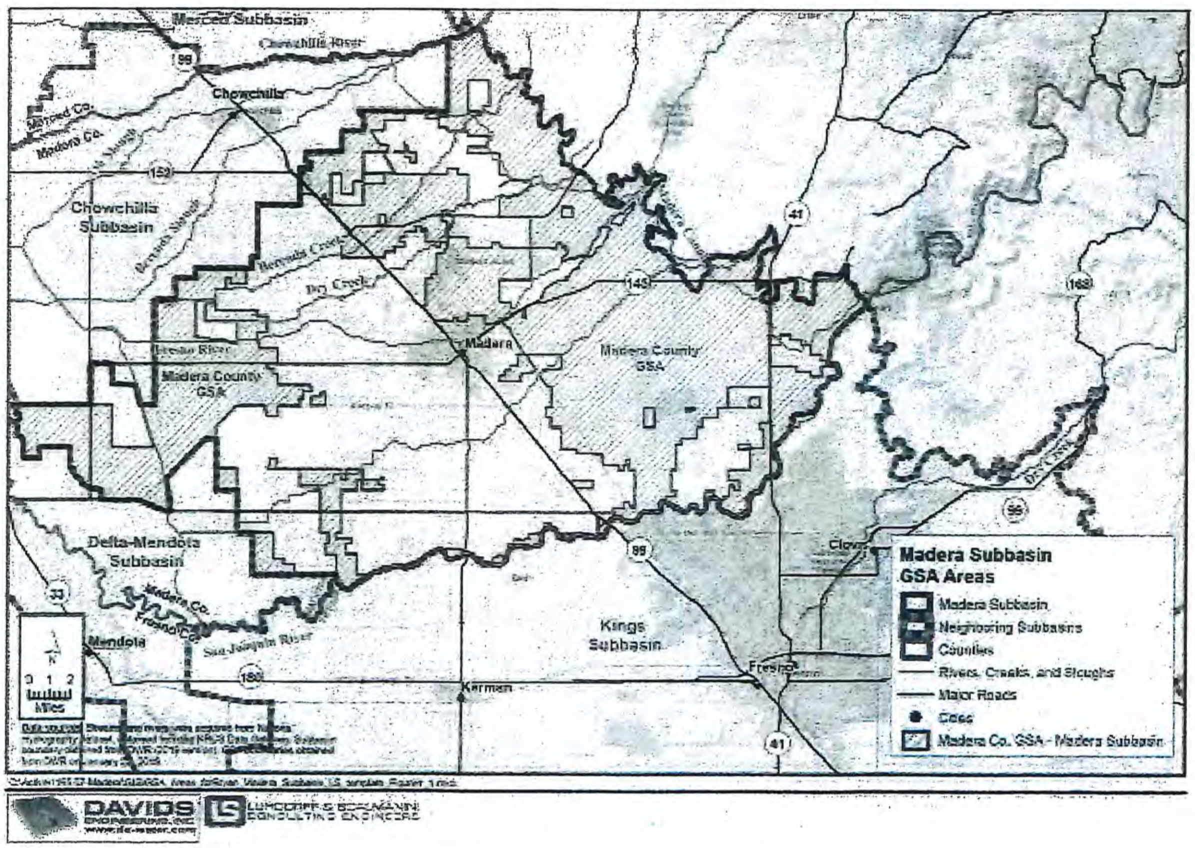
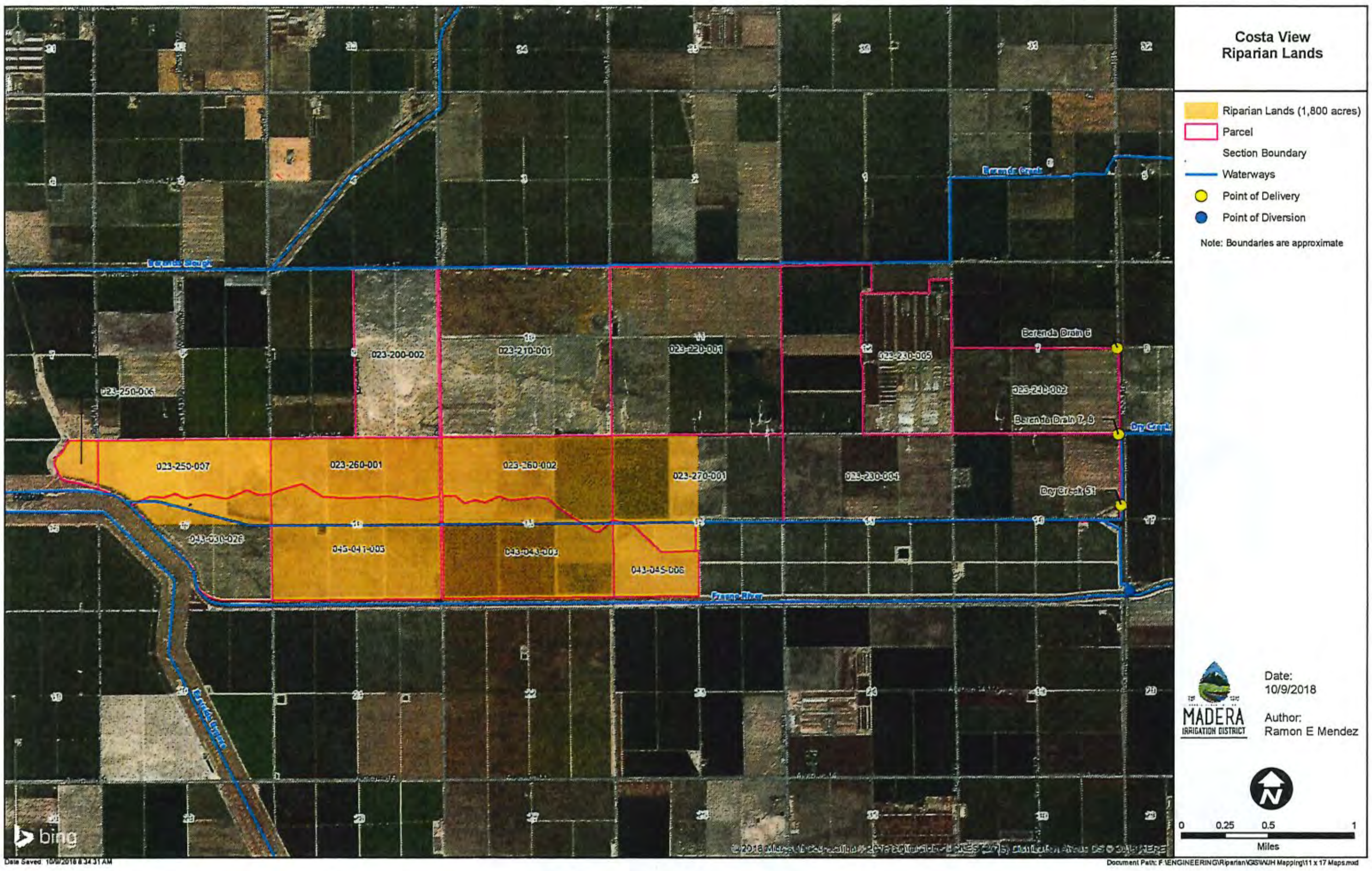


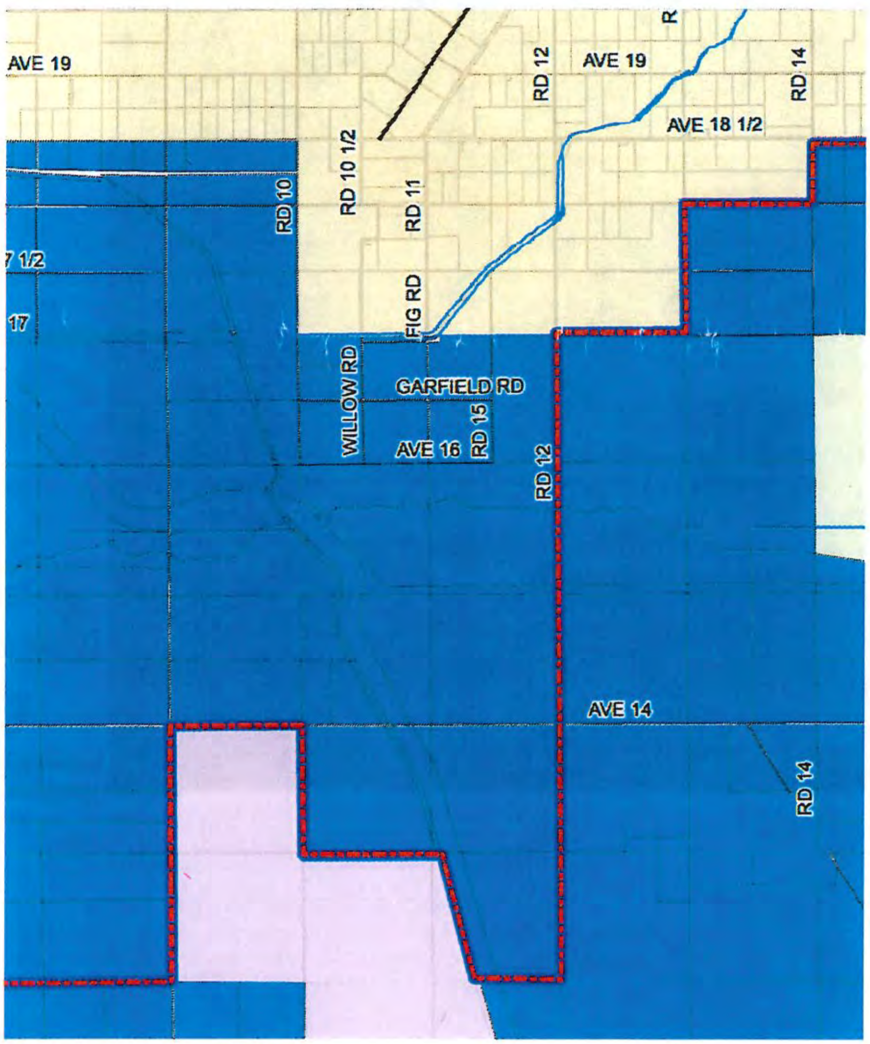
Figure 1-6. Madera County GSA Map.


Costa View
Riparian Lands
Riparian Lands (1,800 acres)
Parcel
Section Boundary
Waterways
Point of Delivery
Point of Diversion
Note: Boundaries are approximate
MADERA
IRRIGATION DISTRICT
Date:
10/9/2018
Author:
Ramon E Mendez
0 0.25 0.5 1
Miles

MADERA COUNTY

Groundwater Sustainability Agencies

April 4, 2017



[SUMMARY OF FINAL SUBMITTED VERSION]

SUPPLEMENTAL STATEMENT OF WATER DIVERSION AND USE FOR 2018

Primary Owner: COSTA VIEW FARMS #2, A CA GEN PARTNERSHIP
Statement Number: S005005
Date Submitted: 06/27/2019

1. Water is used under	Riparian Claim Pre-1914 Claim
2. Year diversion commenced	1903

3. Purpose of Use	
Irrigation	

Irrigated Crops			
	Multiple Crops	Area Irrigated (Acres)	Primary Irrigation Method
Alfalfa	No	961	Surface (example: flood)
Almonds and Other Nuts	No	948.20	Low-volume (example: micro-sprinkler, drip)
Corn	Yes	1666	
Grains (wheat, oat)	No	2994	Surface (example: flood)
Pasture	No	160	Surface (example: flood)

4. Changes in Method of Diversion

Special Use Categories	
C1. Are you using any water diverted under this right for the cultivation of cannabis?	No

5. Maximum Rate of Diversion	
Month	Rate of Diversion
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	

6. Amount of Water Diverted and Used			
Month	Amount directly diverted (Acre-Feet)	Amount diverted or collected to storage (Acre-Feet)	Amount beneficially used (Acre-Feet)
January	0	0	0
February	0	0	0

March	0	0	0
April	438.64	0	438.64
May	1065.09	0	1065.09
June	0	0	0
July	0	0	0
August	0	0	0
September	0	0	0
October	0	0	0
November	0	0	0
December	0	0	0
Total	1503.73	0	1503.73
Type of Diversion	Direct Diversion Only		
Comments			

Water Transfers	
6d. Water transfered	No
6e. Quantity transfered (Acre-Feet)	
6f. Dates which transfer occurred	/ to /
6g. Transfer approved by	

Water Supply Contracts	
6h. Water supply contract	No
6i. Contract with	
6j. Other provider	
6k. Contract number	
6l. Source from which contract water was diverted	
6m. Point of diversion same as identified water right	
6n. Amount (Acre-Feet) authorized to divert under this contract	
6o. Amount (Acre-Feet) authorized to be diverted in 2018	
6p. Amount (Acre-Feet) projected for 2019	
6q. Exchange or settlement of prior rights	
6r. All monthly reported diversion claimed under the prior rights	
6s. Amount (Acre-Feet) of reported diversion solely under contract	

7. Water Diversion Measurement	
a. Required to measure as of the date this report is submitted	Yes
b. Is diversion measured?	Yes
c. An alternative compliance plan was submitted to the division of water rights on	
d. A request for additional time was submitted to the division of water rights on	

Measurement ID number	M014140
This Device/Method was used to measure water during the current reporting period	Yes
M1. Briefly describe the measurement device or method	lift pump
M2. Nickname	Pump 11-5R
M3. Type of device / method	Flow meter (propeller)
M4. Device make	McCrometer
M5. Serial number	18-05565
M6. Model number	M0312
M7. Approximate date of installation	11/01/2018

M8. Additional info	
M9. Approximate date the measuring device was last calibrated or the measurement method was updated	05/22/2018
M10. Estimated accuracy of measurement	100.3%
M11. Description of calibration method	Volumetric
M12. Describe the maintenance schedule for the device/method	
Information for the person who last calibrated the device or designed the measurement method	
M13. Name	Robert Galusha
M14. Phone number	(951) 652-6811
M15. Email	customerservice@mccrometer.com
M16. Qualifications of the individual	
M17. License number and type for the qualified individual above and/or any other relevant explanation	ID #176785
M18. Type of data recorder device / method	Analog register (flow meter)
M19. Data recorder device make	McCrometer
M20. Data recorder serial number	18-05565
M21. Data recorder model number	M0312
M22. Data recorder units of measurement	Acre-Feet
M23. Frequency of data recording	
M24. Additional data recorder info	
M25. I am required to report my diversion or storage data by telemetry as of the date this report is submitted	No
M26. I report my diversion or storage date by telemetry to the following website	

Measurement Attachments

Measurement ID Number	File Name	Description	Size
No attachments			

Measurement Data Files

Measurement ID Number	File Name	Description	Size
No data files			

8. Conservation of Water

a.	Are you now employing water conservation efforts?	Yes
	Describe any water conservation efforts you have initiated	Costa View Farms implements land leveling of the fields so that the water can be used more efficiently across acres of crops. Costa View Farms also puts return drains in the fields and moves the water to re-use it on different fields within the riparian place of use. Additionally, Costa View Farms uses drip and tape line irrigation to conserve water.
b.	Amount of water conserved	
	I have data to support the above surface water use reductions due to conservation efforts.	No

9. Water Quality and Wastewater Reclamation

a.	Are you now or have you been using reclaimed water from a wastewater treatment facility,	No

	desalination facility, or water polluted by waste to a degree which unreasonably affects such water for other beneficial causes?	
b.	Amount of reduced diversion	
	Type of substitute water supply	
	Amount of substitute water supply used	
	I have data to support the above surface water use reductions due to the use of a substitute water supply	

10. Conjuctive Use of Surface Water and Groundwater		
a.	Are you now using groundwater in lieu of surface water?	No
b.	Amount of groundwater used	
	I have data to support the above surface water use reductions due to the use of groundwater.	

Additional Remarks
Please note that the surface water was measured by a combination of the measurement device identified in this report and through measurements by Madera Irrigation District's (MID's) watermaster. There was a new meter installed in November 2018, and that and MID's measurements are being used for 2019 diversions. However, MID is controlling how much water Costa View Farms receives and we do not agree with their numbers. We believe we should be receiving more riparian water for the 4,005 irrigated riparian acres.

Attachments		
File Name	Description	Size
No Attachments		

Contact Information of the Person Submitting the Form	
First Name	Lauren
Last Name	Layne
Relation to Water Right	Other: Legal Counsel
The information in the report is true to the best of his/her knowledge and belief	Yes

[SUMMARY OF FINAL SUBMITTED VERSION]

SUPPLEMENTAL STATEMENT OF WATER DIVERSION AND USE FOR 2017

Primary Owner: COSTA VIEW FARMS #2, A CA GEN PARTNERSHIP
Statement Number: S005005
Date Submitted: 06/15/2018

1. Water is used under	Riparian Claim Pre-1914 Claim
2. Year diversion commenced	1903

3. Purpose of Use	
Irrigation	

Irrigated Crops			
	Multiple Crops	Area Irrigated (Acres)	Primary Irrigation Method
Alfalfa	No	548	Surface (example: flood)
Almonds and Other Nuts	Yes	950	Low-volume (example: micro-sprinkler, drip)
Corn	Yes	1432	Surface (example: flood)
Grains (wheat, oat)	Yes	1592	Surface (example: flood)
Pasture	Yes	160	Surface (example: flood)

4. Changes in Method of Diversion

Special Use Categories	
C1. Are you using any water diverted under this right for the cultivation of cannabis?	No

5-6. Maximum Rate of Diversion for each Month and Amount of Water Diverted and Used				
Month	Rate of diversion (CFS)	Amount directly diverted (Acre-Feet)	Amount diverted or collected to storage (Acre-Feet)	Amount beneficially used (Acre-Feet)
January		77.02	0	77.02
February		109.84	0	109.84
March		197.26	0	197.26
April		382.17	0	382.17
May		205.14	0	205.14
June		641.04	0	641.04
July		0	0	0
August		0	0	0
September		0	0	0
October		0	0	0
November		0	0	0
December		0	0	0
Total		1612.47	0	1612.47
Type of Diversion	Direct Diversion Only			

Comments	

Water Transfers	
6d. Water transfered	No
6e. Quantity transfered (Acre-Feet)	
6f. Dates which transfer occurred	/ to /
6g. Transfer approved by	

Water Supply Contracts	
6h. Water supply contract	No
6i. Contract with	
6j. Other provider	
6k. Contract number	
6l. Source from which contract water was diverted	
6m. Point of diversion same as identified water right	
6n. Amount (Acre-Feet) authorized to divert under this contract	
6o. Amount (Acre-Feet) authorized to be diverted in 2017	
6p. Amount (Acre-Feet) projected for 2018	
6q. Exchange or settlement of prior rights	
6r. All monthly reported diversion claimed under the prior rights	
6s. Amount (Acre-Feet) of reported diversion solely under contract	

7. Water Diversion Measurement	
a. Required to measure as of the date this report is submitted	Yes
b. Is diversion measured?	My diversion is measured by a watermaster assigned to the following service area: Madera Irrigation District
c. An alternative compliance plan was submitted to the division of water rights on	
d. A request for additional time was submitted to the division of water rights on	

8. Conservation of Water		
a.	Are you now employing water conservation efforts?	Yes
	Describe any water conservation efforts you have initiated	Costa View Farms implements land leveling of the fields so that the water can be used more efficiently across acres of crops. Costa View Farms also put return drains in the fields and moves the water to re-use it on different fields within the place of use. Additionally, Costa View Farms uses drip and tape line irrigation to conserve water.
b.	Amount of water conserved	
	I have data to support the above surface water use reductions due to conservation efforts.	

9. Water Quality and Wastewater Reclamation		
a.	Are you now or have you been using reclaimed water from a wastewater treatment facility, desalination facility, or water polluted by waste to a degree which unreasonably affects such water for other beneficial causes?	No

b.	Amount of reduced diversion	
	Type of substitute water supply	
	Amount of substitute water supply used	
	I have data to support the above surface water use reductions due to the use of a substitute water supply	

10. Conjuctive Use of Surface Water and Groundwater		
a.	Are you now using groundwater in lieu of surface water?	No
b.	Amount of groundwater used	
	I have data to support the above surface water use reductions due to the use of groundwater.	

Additional Remarks
Please note in Section 4 that since there is not a category for Sudan Grass, that crop is listed as "pasture." Statement of Diversion and Use S021430 is no longer necessary as that information is included in this Statement of Diversion and Use S005005.

Attachments		
File Name	Description	Size
No Attachments		

Contact Information of the Person Submitting the Form	
First Name	Lauren
Last Name	Layne
Relation to Water Right	Other: Legal Counsel
The information in the report is true to the best of his/her knowledge and belief	Yes

MADERA COUNTY

EST. 1920 MADERA IRRIGATION DISTRICT

MADERA WATER DISTRICT GROUNDWATER SUSTAINABILITY AGENCY

MADERA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN (GSP) COMMENT FORM

Please complete the following information to provide comments on the draft Madera Subbasin GSP. Type or print legibly for your comments to be considered.

Please return this form to (hand delivery, mail, or email accepted):

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637
Email: MaderaGSPComments@maderacounty.com

Date Submitted: ____________________

Submitted By: ____________________

Address: ____________________

Phone Number / Email: ____________________

APNs: ____________________

Located in Groundwater Sustainability Agency (GSA):
☐ Madera County ☐ MID ☐ City of Madera ☐ MWD ☐ Other ____________

Affiliation: ☐ Irrigated Ag ☐ Non-Irrigated Ag ☐ Rural Residential
☐ Disadvantaged Community Member ☐ Agency/Government ☐ Other ____________

Chapter No. / Page No. of GSP: ____________________

Comments: ____________________

____

____

FRESNO CA 937
WED 07 AUG 2019 PM

USA FOREVER

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637

RECEIVED
AUG 14 2019
BY:____________

MADERA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN (GSP) COMMENT FORM

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Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637
Email: MaderaGSPComments@maderacounty.com

Date Submitted: 7/16/2019

Submitted By: Anonymous

Address: NA

Phone Number / Email: NA

APNs: NA

Located in Groundwater Sustainability Agency (GSA):
☐ Madera County ☐ MID ☐ City of Madera ☐ MWD ☒ Other NA

Affiliation: ☐ Irrigated Ag ☐ Non-Irrigated Ag ☐ Rural Residential
☐ Disadvantaged Community Member ☐ Agency/Government ☒ Other NA

Chapter No. / Page No. of GSP: 1/8

Comments: There are significant riparian deliveries to landowners within the Madera County GSA who hold riparian water rights to the Fresno River. For example see the attached pages documenting riparian diversions by one landowner diverting over 1,000 acre feet per year. There are many other landowners diverting riparian water from the Fresno River.

Please update the attached highlighted paragraph to acknowledge the voluminous Fresno River riparian water diversions. ____

____

____

Chapter No. / Page No. of GSP: ____

Comments: ____

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Chapter No. / Page No. of GSP: ____

Comments: ____

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Chapter No. / Page No. of GSP: ____

Comments: ____

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1.3.1.3 Madera County GSA

Madera County (MC) GSA was formed on January 27, 2017 and manages approximately 177,800 acres of the Madera Subbasin, representing the largest jurisdictional area within the subbasin (Figure 1-6). As of 2015, the majority of this area is comprised of agricultural land (48%) or native vegetation (39%). The remaining area is primarily developed land (includes urban, semi-agricultural, and industrial land) (12%), though some water surface exists (1%).

In 2015, irrigated agricultural land represented over 82,000 acres in MC GSA. Much of this area is used for cultivating orchard crops (primarily almonds and pistachios) and grapes (Figure 1-7). Surface water supplies available for agriculture in MC GSA is limited to riparian deliveries to individual water rights users along the San Joaquin River and a small volume of Central Valley Project (CVP) supply received under contract with the U.S. Bureau of Reclamation (Reclamation). Thus, agricultural water demand in MC GSA is primarily fulfilled by groundwater.

The Board of Directors for MC GSA is the Madera County Board of Supervisors. As the Board of Directors, the Board of Supervisors meets on the first Tuesday of each month at the end of the 10 a.m. Board of Supervisors Meeting. These meetings are open to the public (200 West Fourth Street, Madera, CA, 93637) and are recorded and available for public viewing on the Madera County website (maderacounty.com). Madera County GSA also has an Advisory Committee that meets bimonthly and provides feedback to the Board of Supervisors on SGMA-related matters. Members of the committee also serve as ambassadors in their communities regarding water issues.

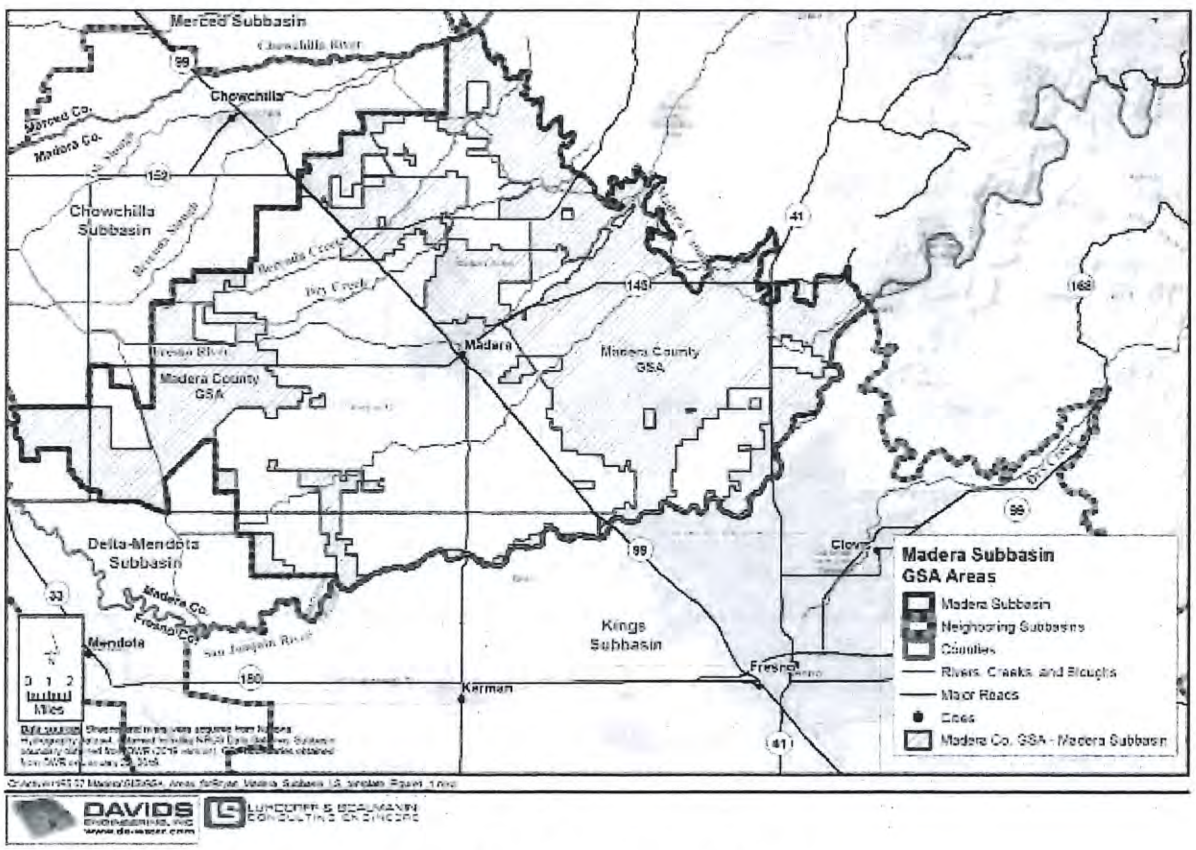
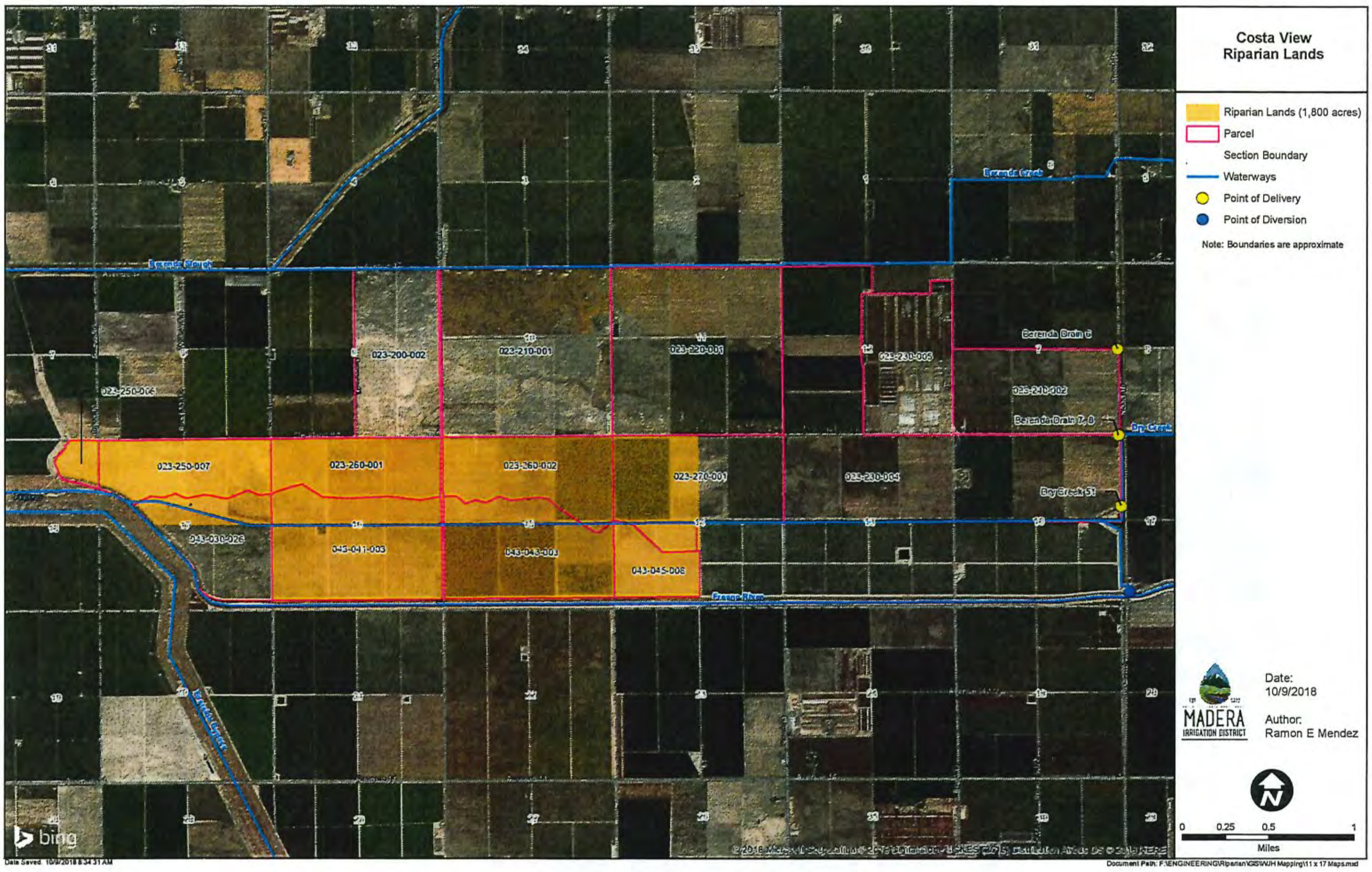


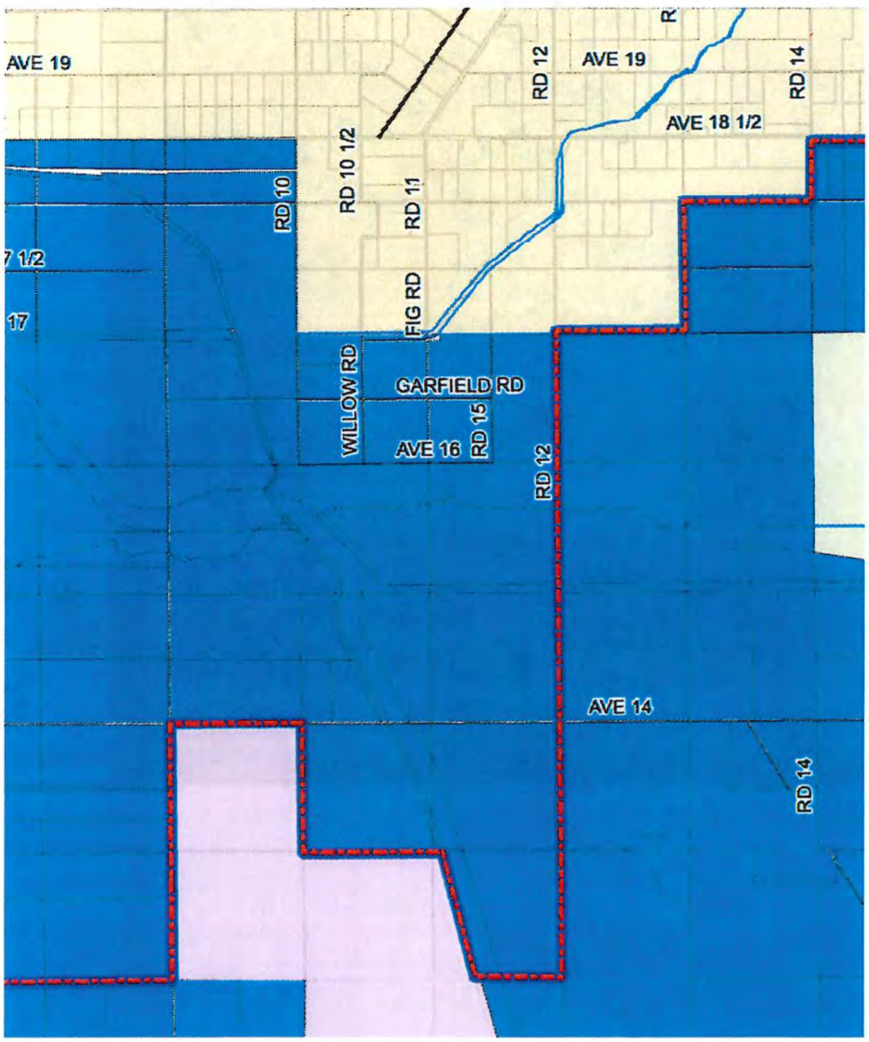
Figure 1-6. Madera County GSA Map.


Costa View
Riparian Lands
Riparian Lands (1,800 acres)
Parcel
Section Boundary
Waterways
Point of Delivery
Point of Diversion
Note: Boundaries are approximate
023-200-002
023-210-001
023-220-001
023-230-005
023-240-002
023-250-007
023-260-001
023-260-002
023-270-001
023-230-004
043-041-003
043-043-003
043-045-008
Date:
10/9/2018
Author:
Ramon E Mendez
MADERA
IRRIGATION DISTRICT
0
0.25
0.5
1
Miles

MADERA COUNTY

Groundwater Sustainability Agencies

April 3, 2017



[SUMMARY OF FINAL SUBMITTED VERSION]

SUPPLEMENTAL STATEMENT OF WATER DIVERSION AND USE FOR 2018

Primary Owner: COSTA VIEW FARMS #2, A CA GEN PARTNERSHIP
Statement Number: S005005
Date Submitted: 06/27/2019

1. Water is used under	Riparian Claim Pre-1914 Claim
2. Year diversion commenced	1903

3. Purpose of Use	
Irrigation	

Irrigated Crops			
	Multiple Crops	Area Irrigated (Acres)	Primary Irrigation Method
Alfalfa	No	961	Surface (example: flood)
Almonds and Other Nuts	No	948.20	Low-volume (example: micro-sprinkler, drip)
Corn	Yes	1666	
Grains (wheat, oat)	No	2994	Surface (example: flood)
Pasture	No	160	Surface (example: flood)

4. Changes in Method of Diversion

Special Use Categories	
C1. Are you using any water diverted under this right for the cultivation of cannabis?	No

5. Maximum Rate of Diversion	
Month	Rate of Diversion
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	

6. Amount of Water Diverted and Used			
Month	Amount directly diverted (Acre-Feet)	Amount diverted or collected to storage (Acre-Feet)	Amount beneficially used (Acre-Feet)
January	0	0	0
February	0	0	0

March	0	0	0
April	438.64	0	438.64
May	1065.09	0	1065.09
June	0	0	0
July	0	0	0
August	0	0	0
September	0	0	0
October	0	0	0
November	0	0	0
December	0	0	0
Total	1503.73	0	1503.73
Type of Diversion	Direct Diversion Only		
Comments			

Water Transfers	
6d. Water transfered	No
6e. Quantity transfered (Acre-Feet)	
6f. Dates which transfer occurred	/ to /
6g. Transfer approved by	

Water Supply Contracts	
6h. Water supply contract	No
6i. Contract with	
6j. Other provider	
6k. Contract number	
6l. Source from which contract water was diverted	
6m. Point of diversion same as identified water right	
6n. Amount (Acre-Feet) authorized to divert under this contract	
6o. Amount (Acre-Feet) authorized to be diverted in 2018	
6p. Amount (Acre-Feet) projected for 2019	
6q. Exchange or settlement of prior rights	
6r. All monthly reported diversion claimed under the prior rights	
6s. Amount (Acre-Feet) of reported diversion solely under contract	

7. Water Diversion Measurement	
a. Required to measure as of the date this report is submitted	Yes
b. Is diversion measured?	Yes
c. An alternative compliance plan was submitted to the division of water rights on	
d. A request for additional time was submitted to the division of water rights on	

Measurement ID number	M014140
This Device/Method was used to measure water during the current reporting period	Yes
M1. Briefly describe the measurement device or method	lift pump
M2. Nickname	Pump 11-5R
M3. Type of device / method	Flow meter (propeller)
M4. Device make	McCrometer
M5. Serial number	18-05565
M6. Model number	M0312
M7. Approximate date of installation	11/01/2018

M8. Additional info	
M9. Approximate date the measuring device was last calibrated or the measurement method was updated	05/22/2018
M10. Estimated accuracy of measurement	100.3%
M11. Description of calibration method	Volumetric
M12. Describe the maintenance schedule for the device/method	
Information for the person who last calibrated the device or designed the measurement method	
M13. Name	Robert Galusha
M14. Phone number	(951) 652-6811
M15. Email	customerservice@mccrometer.com
M16. Qualifications of the individual	
M17. License number and type for the qualified individual above and/or any other relevant explanation	ID #176785
M18. Type of data recorder device / method	Analog register (flow meter)
M19. Data recorder device make	McCrometer
M20. Data recorder serial number	18-05565
M21. Data recorder model number	M0312
M22. Data recorder units of measurement	Acre-Feet
M23. Frequency of data recording	
M24. Additional data recorder info	
M25. I am required to report my diversion or storage data by telemetry as of the date this report is submitted	No
M26. I report my diversion or storage date by telemetry to the following website	

Measurement Attachments

Measurement ID Number	File Name	Description	Size
No attachments			

Measurement Data Files

Measurement ID Number	File Name	Description	Size
No data files			

8. Conservation of Water

a.	Are you now employing water conservation efforts?	Yes
	Describe any water conservation efforts you have initiated	Costa View Farms implements land leveling of the fields so that the water can be used more efficiently across acres of crops. Costa View Farms also puts return drains in the fields and moves the water to re-use it on different fields within the riparian place of use. Additionally, Costa View Farms uses drip and tape line irrigation to conserve water.
b.	Amount of water conserved	
	I have data to support the above surface water use reductions due to conservation efforts.	No

9. Water Quality and Wastewater Reclamation

a.	Are you now or have you been using reclaimed water from a wastewater treatment facility,	No

	desalination facility, or water polluted by waste to a degree which unreasonably affects such water for other beneficial causes?	
b.	Amount of reduced diversion	
	Type of substitute water supply	
	Amount of substitute water supply used	
	I have data to support the above surface water use reductions due to the use of a substitute water supply	

10. Conjuctive Use of Surface Water and Groundwater		
a.	Are you now using groundwater in lieu of surface water?	No
b.	Amount of groundwater used	
	I have data to support the above surface water use reductions due to the use of groundwater.	

Additional Remarks
Please note that the surface water was measured by a combination of the measurement device identified in this report and through measurements by Madera Irrigation District's (MID's) watermaster. There was a new meter installed in November 2018, and that and MID's measurements are being used for 2019 diversions. However, MID is controlling how much water Costa View Farms receives and we do not agree with their numbers. We believe we should be receiving more riparian water for the 4,005 irrigated riparian acres.

Attachments		
File Name	**Description**	**Size**
No Attachments		

Contact Information of the Person Submitting the Form	
First Name	Lauren
Last Name	Layne
Relation to Water Right	Other: Legal Counsel
The information in the report is true to the best of his/her knowledge and belief	Yes

[SUMMARY OF FINAL SUBMITTED VERSION]

SUPPLEMENTAL STATEMENT OF WATER DIVERSION AND USE FOR 2017

Primary Owner: COSTA VIEW FARMS #2, A CA GEN PARTNERSHIP
Statement Number: S005005
Date Submitted: 06/15/2018

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2. Year diversion commenced	1903

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	Multiple Crops	Area Irrigated (Acres)	Primary Irrigation Method
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Almonds and Other Nuts	Yes	950	Low-volume (example: micro-sprinkler, drip)
Corn	Yes	1432	Surface (example: flood)
Grains (wheat, oat)	Yes	1592	Surface (example: flood)
Pasture	Yes	160	Surface (example: flood)

4. Changes in Method of Diversion

Special Use Categories	
C1. Are you using any water diverted under this right for the cultivation of cannabis?	No

5-6. Maximum Rate of Diversion for each Month and Amount of Water Diverted and Used				
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May		205.14	0	205.14
June		641.04	0	641.04
July		0	0	0
August		0	0	0
September		0	0	0
October		0	0	0
November		0	0	0
December		0	0	0
Total		1612.47	0	1612.47
Type of Diversion	Direct Diversion Only			

Comments	

Water Transfers	
6d. Water transfered	No
6e. Quantity transfered (Acre-Feet)	
6f. Dates which transfer occurred	/ to /
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Water Supply Contracts	
6h. Water supply contract	No
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6l. Source from which contract water was diverted	
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7. Water Diversion Measurement	
a. Required to measure as of the date this report is submitted	Yes
b. Is diversion measured?	My diversion is measured by a watermaster assigned to the following service area: Madera Irrigation District
c. An alternative compliance plan was submitted to the division of water rights on	
d. A request for additional time was submitted to the division of water rights on	

8. Conservation of Water		
a.	Are you now employing water conservation efforts?	Yes
	Describe any water conservation efforts you have initiated	Costa View Farms implements land leveling of the fields so that the water can be used more efficiently across acres of crops. Costa View Farms also put return drains in the fields and moves the water to re-use it on different fields within the place of use. Additionally, Costa View Farms uses drip and tape line irrigation to conserve water.
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a.	Are you now or have you been using reclaimed water from a wastewater treatment facility, desalination facility, or water polluted by waste to a degree which unreasonably affects such water for other beneficial causes?	No

b.	Amount of reduced diversion	
	Type of substitute water supply	
	Amount of substitute water supply used	
	I have data to support the above surface water use reductions due to the use of a substitute water supply	

10. Conjuctive Use of Surface Water and Groundwater		
a.	Are you now using groundwater in lieu of surface water?	No
b.	Amount of groundwater used	
	I have data to support the above surface water use reductions due to the use of groundwater.	

Additional Remarks
Please note in Section 4 that since there is not a category for Sudan Grass, that crop is listed as "pasture." Statement of Diversion and Use S021430 is no longer necessary as that information is included in this Statement of Diversion and Use S005005.

Attachments		
File Name	**Description**	**Size**
No Attachments		

Contact Information of the Person Submitting the Form	
First Name	Lauren
Last Name	Layne
Relation to Water Right	Other: Legal Counsel
The information in the report is true to the best of his/her knowledge and belief	Yes

Stephanie Anagnoson

From: Bill Diedrich <agspray@sbcglobal.net>
Sent: Sunday, May 19, 2019 8:56 AM
To: MaderaGSPComments

Subject: Figures

Follow Up Flag: Follow up
Flag Status: Flagged

Stephanie,

I'm trying to read and refer to tables and figures as I read. Can I suggest that they be placed closer to the narrative that refers to them. Where is figure 2-55? There are numerous figures that are referred to in Chapter 2 that I cannot find.

Best,

Bill D

California Poultry Federation
4640 Spyres Way, Suite 4 | Modesto, CA 95356 | Phone: (209) 576-6355 | Fax: (209) 576-6119 | www.cpif.org

VIA E-MAIL
(MaderaGSPComments@maderacounty.com)

November 8, 2019

Members of the Madera Subbasin
Coordination Committee
c/o Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, California 93637

Re: Madera Subbasin GSP

Dear Members of the Madera Subbasin Coordination Committee:

The California Poultry Federation ("CPF") appreciates the opportunity to comment on the draft Madera Subbasin Groundwater Sustainability Plan (the "Draft GSP"). CPF is the trade association for California's diverse and dynamic poultry industry. Our members include growers, hatchers, breeders, and processors that work with chickens, turkeys, ducks, game birds, and squab. Water is essential for all of them—both for nutrition and for maintaining sanitary conditions. CPF therefore supports effective measures to assure reliable water supplies.

In this regard, CPF was pleased to see that the Draft GSP included recharge and conveyance projects. We recommend that the Madera Subbasin Coordination Committee make supply augmentation its top priority. CPF commends the Madera Irrigation District in particular for considering ways to encourage growers to participate in augmentation. Incentives such as additional extraction rights would be an excellent method of increasing landowner support for and participation in supply projects.

But we are concerned that the Madera County GSA appears to be emphasizing a "substantial demand management" program that contemplates reducing irrigated acreage by 50% without explaining specifically how that would be done. Although the Draft GSP sets out principles for developing any demand management program such as minimizing economic impact, maintaining established water rights, and incentivizing investment in water supply infrastructure, it was unclear how those were applied to choose the demand management goals and how they would be applied in the future. The public will need to have meaningful opportunities to participate in the development of any demand management measures, which should include adequate time to evaluate supporting information and submit written comments. That is especially important in light of the finding (at Draft GSP page 4-45) that demand management will have direct economic costs of $53.9 million per year and additional indirect costs that currently are unknown. And we would expect all the Subbasin GSAs to do their best to ameliorate such impacts by adopting implementation measures that are cost-effective.

Please contact me if you need any further information about these comments.

Very truly yours,

Bill Mattos

Bill Mattos
President

Erik Smith's Mark-up 4/3/2019 Page 1 of 2

1.3.1.3 Madera County GSA

Madera County (MC) GSA was formed on January 27, 2017 and manages approximately 177,800 acres of the Madera Subbasin, representing the largest jurisdictional area within the subbasin (Figure 1-6). As of 2015, the majority of this area is comprised of agricultural land (48%) or native vegetation (39%). The remaining area is primarily developed land (includes urban, semi-agricultural, and industrial land) (12%), though some water surface exists (1%).

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* Also, some landowners within the Madera County GSA hold riparian water rights to the Fresno River and receive deliveries of riparian water to satisfy their demands.

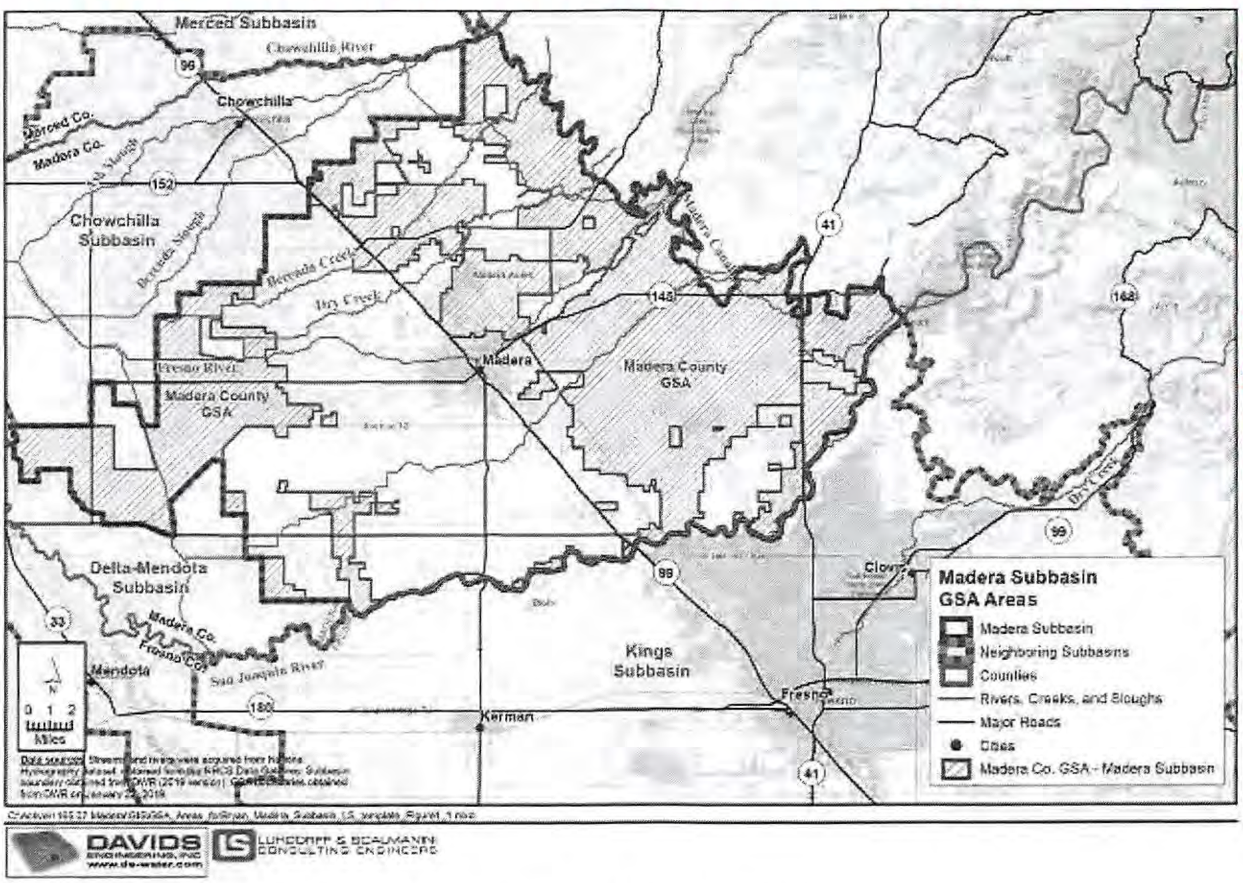


Figure 1-6. Madera County GSA Map.

Erik Smith's Mark-up 4/3/2019 Page 2 of 2

Figure 1-7. Almond Orchard in the Madera Subbasin.

1.3.1.4 Madera Irrigation District GSA

Madera Irrigation District (MID) GSA was formed on March 31, 2016 and manages approximately 133,850 acres of the Madera Subbasin (Figure 1-8). As of 2015, the majority of this area is comprised of agricultural land (80%). Much of the remaining area consists of native vegetation (12%) or developed land (7%), including urban, semi-agricultural, and industrial land. A small portion of the GSA is also covered by water surfaces (1%).

In 2015, irrigated agricultural land represented over 106,600 acres in MID GSA. This area is used primarily for cultivating almonds, grapes, and pistachios. MID GSA receives substantial surface water supplies to support agriculture. These include CVP supplies received under contract with Reclamation from the Madera Canal and local supplies received from Hidden Dam releases along the Fresno River (Figure 1-9), along with the MID's Pre 1914 water rights. Remaining agricultural water demand in MID GSA is fulfilled by privately owned groundwater wells, as well as riparian water-rights water delivered to landowners along riparian to the Fresno River.

The Board of Directors for MID GSA is the MID Board of Directors. The MID GSA Board of Directors meetings are held concurrently with the regular MID Board of Directors meetings on the third Tuesday of every month at 2:00 p.m. These meetings are open to the public at the Madera Irrigation District offices (12152 Road 28 1/4, Madera, CA, 93637).

From: Erik Smith [smith415@gmail.com]
Sent: Wednesday, April 03, 2019 7:37 AM
To: Stephanie Anagnoson
Subject: Re: Madera Subbasin Joint GSP: Chapter 1 IS NOW AVAILABLE

Hi Stephanie,

I am a landowner. My property is within both the Madera County GSA and the Madera Irrigation District GSA. Portions of my property in both of said GSAs receives riparian water-rights deliveries from the Fresno River. I noticed that riparian rights to the Fresno River for these GSAs were not mentioned in the draft of Chapter 1 of the Madera Subbasin Groundwater Sustainability Plan.

The riparain water-rights holders along the Fresno River use thousands of acre-feet of riparian water-rights water annually and this water is a critical part of the groundwater sustainability of the Madera Subbasin. There may even be additional riparian landowners who are not aware that they have surface water rights to riparian water. The more riparian water-rights water that is used, the better! Please see the attached information.

The names of the attached files are:
<2019_04_03_erik_smiths_markup_of_gsp_plan_ch_1.pdf>
<Riparian Initial Letter_10-25-18_for_email.pdf>

Can these important riparian water-rights please be included in the next draft of Chapter 1 of the Madera Subbasin Groundwater Sustainability Plan?

Please let me know if you have any questions, points of clarification, or if there is someone else I need to contact with regard to the above.

Thank you!

Erik Smith
Smith Adobe, LLC
(559) 840-7985 cell

Phone (559) 673-3514
www.madera-id.org

General Manager
Thomas Greci

Assistant
General Manager
Dina Cadenazzi Nolan

Legal Counsel
John P. Kinsey

EST 1920
MADERA
IRRIGATION DISTRICT

12152 Road 28 1/4
Madera, CA 93637

October 25, 2018

GSO Priority Mail

Clarkson Smith
Adobe Ranch
1547 34th Ave
San Francisco, CA 94122

Re: Fresno River Riparian and Appropriative Right Holders Land Crop Report and Map

Dear Riparian and Appropriative Right Holders:

Below is the summary of your 2018 entitlement and water diverted:

2018 Entitlement	Riparian Water Diverted
997.03 AF	117.36 AF

For 2019, in accordance with the Fresno River Operations Protocols, Madera Irrigation District (MID or District) is required to request the following documents from Fresno River Riparian and Appropriative Right Holders annually for the purpose of allocating Fresno River flows to each Riparian and Appropriative Right Holder for the upcoming year:

ANNUAL CROPPING SUBMITTAL
Madera Irrigation District, in compliance with the Fresno River Operations Protocols, calls on Fresno River Riparian and Appropriative Right Holders to annually submit their current crop pattern for the Riparian water year (October 2018-September 2019), acreage map, and diversion capacity to the District.

A map and form(s) have been included with this letter, for the following information:

- Acreage
- Crop pattern
- Irrigation type
- Cover crop (if applicable)
- Diversion capacity

The District reserves the right to visually inspect the subject property, either on the ground or via satellite imagery, and to compare each parcel's cropping pattern that is submitted.

The attached form and any other requested information must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions. If the data requested is not provided by the deadline, the District will assume that the Riparian and Appropriative Right Holders will not be diverting Fresno River flows for this coming year.

ADDITIONAL REQUIRED DOCUMENTS
District records indicate the required documents checked below have not been provided to the District. These documents must also be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions.

☐ 1. Independent pump test or diversion capacity flow test documenting your diversion capacity. ***NOTE: If your diversion capacity has changed since your last submittal, it is your responsibility to notify MID***.

☒ 2. A copy of your latest "Statement of Diversion and Use" as required by the State Water Resources Control Board. For more information, please refer to State website: http://www.waterboards.ca.gov/waterrights/water_issues/programs/diversion_use/

☒ 3. 2019 Riparian and Appropriative Right Holders cropping information sheet (enclosed). ***By signing the attached form, the landowner is certifying that only the riparian and/or appropriate acreage is being provided to the District for entitlement calculations.***

a. 2019 crop map for Riparian and Appropriative Right acreage only (enclosed map for reference).

Thank you in advance for your cooperation.

Sincerely,

Ramon E Mendez

Ramon E Mendez, PE
Project Engineer

Enclosure

2019 RIPARIAN AND SENIOR APPROPRIATIVE RIGHT HOLDERS CROPPING INFORMATION
must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions

Name: Adobe

This form must be filled out completely and accurately and all numbers must sum to be included in the 2019 Fresno River Allocation Model runs. Include below acreage of river bottom, fallow land, residences, etc., if riparian land.

Riparian Acres 2,341.04

Crop / Land Use	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
Total		(Total must add up to Riparian Acres above)	

Riparian / Appropriative Only Points of Diversion
MID reserves the right to inspect points of diversion, capacity, and request proof of permitting.

Point of Diversion Location:____________________; Diversion Capacity:____________________

Point of Diversion Location:____________________; Diversion Capacity:____________________

Point of Diversion Location:____________________; Diversion Capacity:____________________

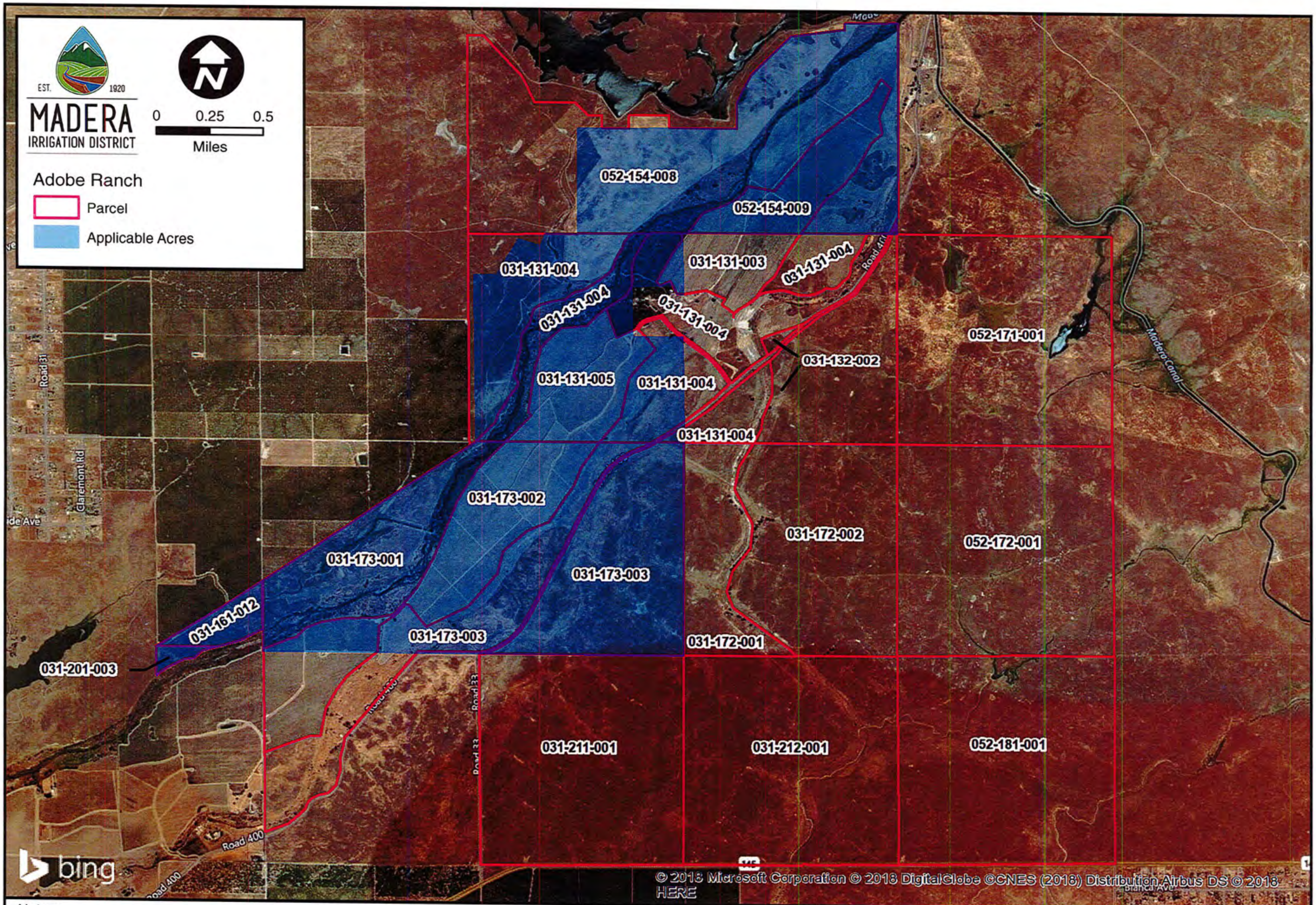
Total Diversion Capacity: ____________________

Name (Print): Date:

Signature:

By signing this form, the landowner is certifying that only the riparian and/or appropriative acreage is being provided to MID for allocation calculations.

The landowner is also certifying that they have the authority to sign this form and that the numbers are accurate.



Notes:
1. Boundaries are approximate.
2. Applicable acres is the total riparian and/or appropriative parcel acreage, less the overlap between riparian and appropriative acres.

MID Special Board Meeting – Fresno River Workshop

November 5, 2018 from 10:00 a.m. - 12:00 p.m.

Madera County Office of Education, Conference Center Rooms 3 & 4

1105 South Madera Ave., Madera, CA 93637

Pursuant to the request of several stakeholders in attendance at the Madera Irrigation District (the "District") Board of Directors meeting on October 16, 2018, the District will be holding a workshop to receive input from stakeholders on potential comprehensive solutions to resolve the issues raised in the Petition for the Adjudication of Rights to the Fresno River, filed on October 18, 2018 (the "Petition").

This workshop is being held to allow landowners and the public to present ***comprehensive solutions to address all concerns*** related to current Fresno River operations including, but not limited to, the following:

- Riparian and appropriate acreage disputes
- Diversion capacity disputes
- Unexercised riparian water rights
- Priority of water rights
- Operational constraints

District representatives will attend the workshop to hear proposed solutions from stakeholders, including riparian landowners. This will be a "Discussion Only" agenda item.

This is a public meeting and the public is welcome to attend. See attached agenda for further information.

Riparian Landowner Workshop

November 5, 2018 from 8:00 a.m. - 10:00 a.m.

Madera County Office of Education, Conference Center Rooms 3 & 4

1105 South Madera Ave., Madera, CA 93637

Madera Irrigation District is providing the opportunity for Fresno River riparian and appropriative rights holders to discuss amongst each other proposed comprehensive solutions to address all concerns raised by the Petition between 8:00 a.m. - 10:00 a.m. This workshop is being offered to allow Fresno River riparian and appropriative rights holders to discuss and develop potential comprehensive solutions to be presented at the 10:00 a.m. MID Special Board Meeting.

Representatives of the District will not be in attendance during this portion of the workshop. However, to help further the discussions, a neutral facilitator will be available to those in attendance.

MADERA IRRIGATION DISTRICT
BOARD OF DIRECTORS SPECIAL MEETING
FRESNO RIVER WORKSHOP

AGENDA

MISSION STATEMENT

To obtain and manage affordable surface water and groundwater supplies in a manner which will ensure the long-term viability of irrigated agriculture in the District.

Special Meeting Date:
Monday, November 5, 2018
10:00 a.m.-12:00 p.m.

Madera County Office of Education
Conference Center Rooms 3 & 4
1105 S. Madera Avenue
Madera, CA 93637

In compliance with the Americans with Disabilities Act, if you need special assistance to participate in this meeting, please contact the Administration Office at 559-673-3514, ext. 215. Notification in advance of the meeting will enable MID to make reasonable arrangements to ensure accessibility to this meeting.

In compliance with the California Government Code, members of the public may inspect the agenda and any associated writings, including documents delivered after the 72-hour advance posting of the agenda during regular business hours at the Madera Irrigation District Office, located at 12152 Road 28 1/4, Madera, California 93637.

WELCOME

1. INFORMATIONAL ITEMS

a. Discussion only – presentation of proposals by Fresno River stakeholders to discuss a potential for resolution of the issues raised in the Petition for the Adjudication of Rights to the Fresno River, filed on October 18, 2018.

2. ADJOURNMENT

Phone (559) 673-3514
www.madera-id.org

General Manager
Thomas Greci

Assistant General Manager
Dina Cadenazzi Nolan

Legal Counsel
John P. Kinsey

EST. 1920
MADERA
IRRIGATION DISTRICT

12152 Road 28 1/4
Madera, CA 93637

October 25, 2018

GSO Priority Mail

Kevin Herman
2985 Airport Dr
Madera, CA 93637

Re: Fresno River Riparian and Appropriative Right Holders Land Crop Report and Map

Dear Riparian and Appropriative Right Holders:

Below is the summary of your 2018 entitlement and water diverted:

2018 Entitlement	Riparian Water Diverted
53.63 AF	45.70 AF

For 2019, in accordance with the Fresno River Operations Protocols, Madera Irrigation District (MID or District) is required to request the following documents from Fresno River Riparian and Appropriative Right Holders annually for the purpose of allocating Fresno River flows to each Riparian and Appropriative Right Holder for the upcoming year:

ANNUAL CROPPING SUBMITTAL
Madera Irrigation District, in compliance with the Fresno River Operations Protocols, calls on Fresno River Riparian and Appropriative Right Holders to annually submit their current crop pattern for the Riparian water year (October 2018-September 2019), acreage map, and diversion capacity to the District.

A map and form(s) have been included with this letter, for the following information:

- Acreage
- Crop pattern
- Irrigation type
- Cover crop (if applicable)
- Diversion capacity

The District reserves the right to visually inspect the subject property, either on the ground or via satellite imagery, and to compare each parcel's cropping pattern that is submitted.

The attached form and any other requested information must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions. If the data requested is not provided by the deadline, the District will assume that the Riparian and Appropriative Right Holders will not be diverting Fresno River flows for this coming year.

ADDITIONAL REQUIRED DOCUMENTS

District records indicate the required documents checked below have not been provided to the District. These documents must also be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions.

☐ 1. Independent pump test or diversion capacity flow test documenting your diversion capacity. ***NOTE: If your diversion capacity has changed since your last submittal, it is your responsibility to notify MID.***

☒ 2. A copy of your latest "Statement of Diversion and Use" as required by the State Water Resources Control Board. For more information, please refer to State website: http://www.waterboards.ca.gov/waterrights/water_issues/programs/diversion_use/

☒ 3. 2019 Riparian and Appropriative Right Holders cropping information sheet (enclosed). ***By signing the attached form, the landowner is certifying that only the riparian and/or appropriate acreage is being provided to the District for entitlement calculations.***

a. 2019 crop map for Riparian and Appropriative Right acreage only (enclosed map for reference).

Thank you in advance for your cooperation.

Sincerely,

Ramon E Mendez

Ramon E Mendez, PE
Project Engineer

Enclosure

2019 RIPARIAN AND SENIOR APPROPRIATIVE RIGHT HOLDERS CROPPING INFORMATION
must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions

Name: Kevin Herman

This form must be filled out completely and accurately and all numbers must sum to be included in the 2019 Fresno River Allocation Model runs. Include below acreage of river bottom, fallow land, residences, etc., if riparian land.

Riparian Acres 171

Crop / Land Use	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
Total		(Total must add up to Riparian Acres above)	

Riparian / Appropriative Only Points of Diversion
MID reserves the right to inspect points of diversion, capacity, and request proof of permitting.

Point of Diversion Location:____________________; Diversion Capacity:____________________

Point of Diversion Location:____________________; Diversion Capacity:____________________

Point of Diversion Location:____________________; Diversion Capacity:____________________

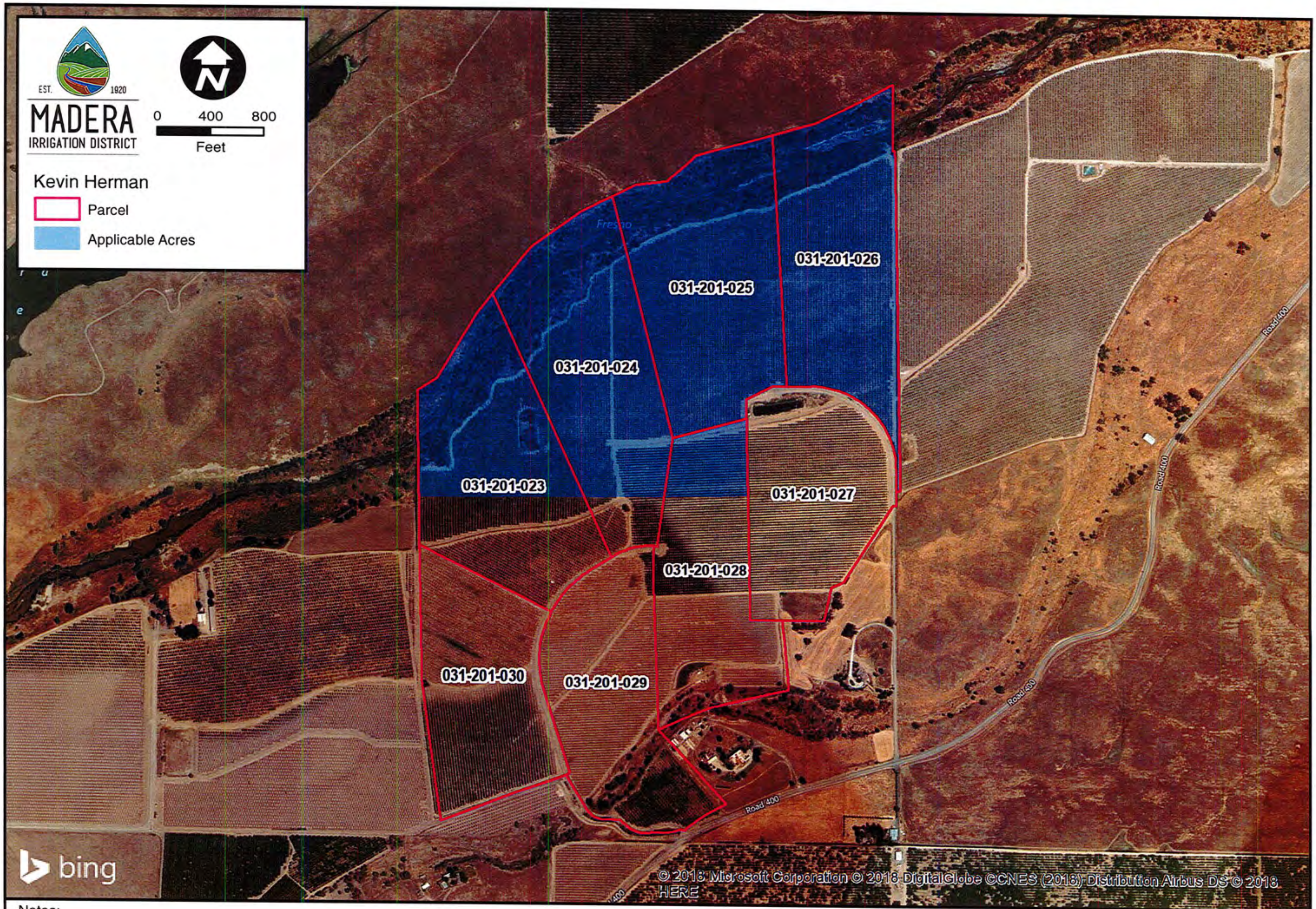
Total Diversion Capacity: ____________________

Name (Print): Date:

Signature:

By signing this form, the landowner is certifying that only the riparian and/or appropriative acreage is being provided to MID for allocation calculations.

The landowner is also certifying that they have the authority to sign this form and that the numbers are accurate.



Notes:
1. Boundaries are approximate.
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MID Special Board Meeting – Fresno River Workshop

November 5, 2018 from 10:00 a.m. - 12:00 p.m.

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- Riparian and appropriate acreage disputes
- Diversion capacity disputes
- Unexercised riparian water rights
- Priority of water rights
- Operational constraints

District representatives will attend the workshop to hear proposed solutions from stakeholders, including riparian landowners. This will be a "Discussion Only" agenda item.

This is a public meeting and the public is welcome to attend. See attached agenda for further information.

Riparian Landowner Workshop

November 5, 2018 from 8:00 a.m. - 10:00 a.m.

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MADERA IRRIGATION DISTRICT
BOARD OF DIRECTORS SPECIAL MEETING
FRESNO RIVER WORKSHOP

AGENDA

MISSION STATEMENT

To obtain and manage affordable surface water and groundwater supplies in a manner which will ensure the long-term viability of irrigated agriculture in the District.

Special Meeting Date:
Monday, November 5, 2018
10:00 a.m.-12:00 p.m.

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Conference Center Rooms 3 & 4
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WELCOME

1. INFORMATIONAL ITEMS

a. Discussion only – presentation of proposals by Fresno River stakeholders to discuss a potential for resolution of the issues raised in the Petition for the Adjudication of Rights to the Fresno River, filed on October 18, 2018.

2. ADJOURNMENT

Phone (559) 673-3514
www.madera-id.org

General Manager
Thomas Greci

Assistant
General Manager
Dina Cadenazzi Nolan

Legal Counsel
John P. Kinsey

EST. 1920
MADERA
IRRIGATION DISTRICT

12152 Road 28 1/4
Madera, CA 93637

October 25, 2018

GSO Priority Mail

Kirk Parrish
Famous Software
8080 N Palm Suite 210
Fresno, CA 93711

Re: Fresno River Riparian and Appropriative Right Holders Land Crop Report and Map

Dear Riparian and Appropriative Right Holders:

Below is the summary of your 2018 entitlement and water diverted:

2018 Entitlement	Riparian Water Diverted
163.00 AF	0 AF

For 2019, in accordance with the Fresno River Operations Protocols, Madera Irrigation District (MID or District) is required to request the following documents from Fresno River Riparian and Appropriative Right Holders annually for the purpose of allocating Fresno River flows to each Riparian and Appropriative Right Holder for the upcoming year:

ANNUAL CROPPING SUBMITTAL

Madera Irrigation District, in compliance with the Fresno River Operations Protocols, calls on Fresno River Riparian and Appropriative Right Holders to annually submit their current crop pattern for the Riparian water year (October 2018-September 2019), acreage map, and diversion capacity to the District.

A map and form(s) have been included with this letter, for the following information:

- Acreage
- Crop pattern
- Irrigation type
- Cover crop (if applicable)
- Diversion capacity

The District reserves the right to visually inspect the subject property, either on the ground or via satellite imagery, and to compare each parcel's cropping pattern that is submitted.

The attached form and any other requested information must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions. If the data requested is not provided by the deadline, the District will assume that the Riparian and Appropriative Right Holders will not be diverting Fresno River flows for this coming year.

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☐ 1. Independent pump test or diversion capacity flow test documenting your diversion capacity. ***NOTE: If your diversion capacity has changed since your last submittal, it is your responsibility to notify MID.***

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☒ 3. 2019 Riparian and Appropriative Right Holders cropping information sheet (enclosed). ***By signing the attached form, the landowner is certifying that only the riparian and/or appropriate acreage is being provided to the District for entitlement calculations.***

a. 2019 crop map for Riparian and Appropriative Right acreage only (enclosed map for reference).

Thank you in advance for your cooperation.

Sincerely,

Ramon E Mendez

Ramon E Mendez, PE
Project Engineer

Enclosure

2019 RIPARIAN AND SENIOR APPROPRIATIVE RIGHT HOLDERS CROPPING INFORMATION
must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions

Name: Kirk Parrish

This form must be filled out completely and accurately and all numbers must sum to be included in the 2019 Fresno River Allocation Model runs. Include below acreage of river bottom, fallow land, residences, etc., if riparian land.

Riparian Acres 309.50

Crop / Land Use	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
Total		(Total must add up to Riparian Acres above)	

Riparian / Appropriative Only Points of Diversion
MID reserves the right to inspect points of diversion, capacity, and request proof of permitting.

Point of Diversion Location:______________________________; Diversion Capacity:________________________________

Point of Diversion Location:______________________________; Diversion Capacity:________________________________

Point of Diversion Location:______________________________; Diversion Capacity:________________________________

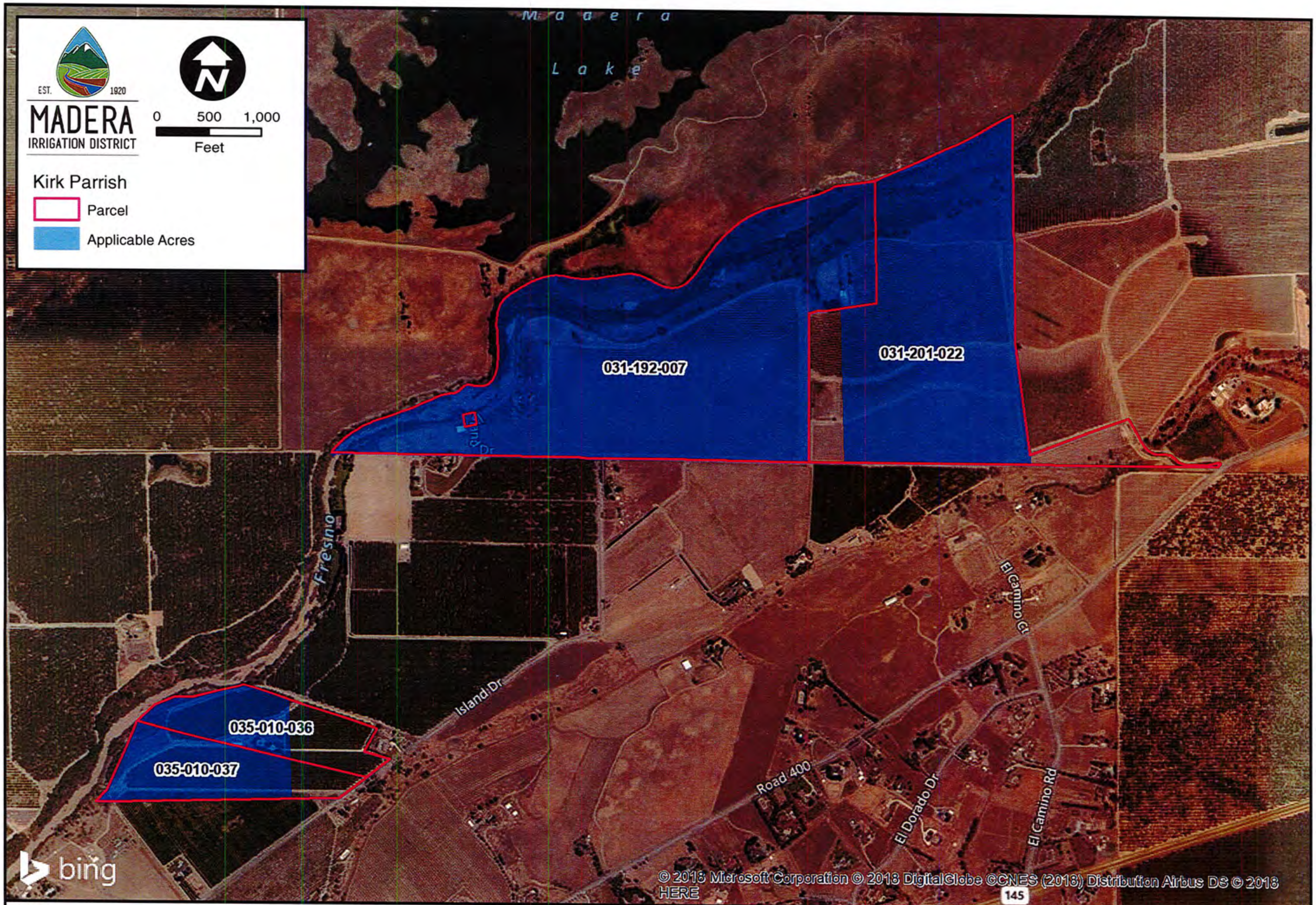
Total Diversion Capacity: ________________________

Name (Print): ____________________ Date: ____________

Signature: ________________________________

By signing this form, the landowner is certifying that only the riparian and/or appropriative acreage is being provided to MID for allocation calculations.

The landowner is also certifying that they have the authority to sign this form and that the numbers are accurate.



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MADERA IRRIGATION DISTRICT
BOARD OF DIRECTORS SPECIAL MEETING
FRESNO RIVER WORKSHOP

AGENDA

MISSION STATEMENT

To obtain and manage affordable surface water and groundwater supplies in a manner which will ensure the long-term viability of irrigated agriculture in the District.

Special Meeting Date:
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WELCOME

1. **INFORMATIONAL ITEMS**

   a. Discussion only – presentation of proposals by Fresno River stakeholders to discuss a potential for resolution of the issues raised in the Petition for the Adjudication of Rights to the Fresno River, filed on October 18, 2018.

2. **ADJOURNMENT**

Phone (559) 673-3514
www.madera-id.org

General Manager
Thomas Greci

Assistant
General Manager
Dina Cadenazzi Nolan

Legal Counsel
John P. Kinsey

EST. 1920
MADERA
IRRIGATION DISTRICT

12152 Road 28 1/4
Madera, CA 93637

October 25, 2018

GSO Priority Mail

Kevin Herman
DaSilva
2985 Airport Dr
Madera, CA 93637

Re: Fresno River Riparian and Appropriative Right Holders Land Crop Report and Map

Dear Riparian and Appropriative Right Holders:

Below is the summary of your 2018 entitlement and water diverted:

2018 Entitlement	Riparian Water Diverted
12.36 AF	0 AF

For 2019, in accordance with the Fresno River Operations Protocols, Madera Irrigation District (MID or District) is required to request the following documents from Fresno River Riparian and Appropriative Right Holders annually for the purpose of allocating Fresno River flows to each Riparian and Appropriative Right Holder for the upcoming year:

ANNUAL CROPPING SUBMITTAL
Madera Irrigation District, in compliance with the Fresno River Operations Protocols, calls on Fresno River Riparian and Appropriative Right Holders to annually submit their current crop pattern for the Riparian water year (October 2018-September 2019), acreage map, and diversion capacity to the District.

A map and form(s) have been included with this letter, for the following information:

- Acreage
- Crop pattern
- Irrigation type
- Cover crop (if applicable)
- Diversion capacity

The District reserves the right to visually inspect the subject property, either on the ground or via satellite imagery, and to compare each parcel's cropping pattern that is submitted.

The attached form and any other requested information must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions. If the data requested is not provided by the deadline, the District will assume that the Riparian and Appropriative Right Holders will not be diverting Fresno River flows for this coming year.

ADDITIONAL REQUIRED DOCUMENTS
District records indicate the required documents checked below have not been provided to the District. These documents must also be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions.

☐ 1. Independent pump test or diversion capacity flow test documenting your diversion capacity. ***NOTE: If your diversion capacity has changed since your last submittal, it is your responsibility to notify MID.***

☒ 2. A copy of your latest "Statement of Diversion and Use" as required by the State Water Resources Control Board. For more information, please refer to State website: http://www.waterboards.ca.gov/waterrights/water_issues/programs/diversion_use/

☒ 3. 2019 Riparian and Appropriative Right Holders cropping information sheet (enclosed). ***By signing the attached form, the landowner is certifying that only the riparian and/or appropriate acreage is being provided to the District for entitlement calculations.***

   a. 2019 crop map for Riparian and Appropriative Right acreage only (enclosed map for reference).

Thank you in advance for your cooperation.

Sincerely,

Ramon E Mendez

Ramon E Mendez, PE
Project Engineer

Enclosure

2019 RIPARIAN AND SENIOR APPROPRIATIVE RIGHT HOLDERS CROPPING INFORMATION
must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions

Name: DaSilva

This form must be filled out completely and accurately and all numbers must sum to be included in the 2019 Fresno River Allocation Model runs. Include below acreage of river bottom, fallow land, residences, etc., if riparian land.

Riparian Acres 36.8

Crop / Land Use	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
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		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
Total		(Total must add up to Riparian Acres above)	

Riparian / Appropriative Only Points of Diversion
MID reserves the right to inspect points of diversion, capacity, and request proof of permitting.

Point of Diversion Location:____________________; Diversion Capacity:____________________

Point of Diversion Location:____________________; Diversion Capacity:____________________

Point of Diversion Location:____________________; Diversion Capacity:____________________

Total Diversion Capacity: ____________________

Name (Print): Date:

Signature:

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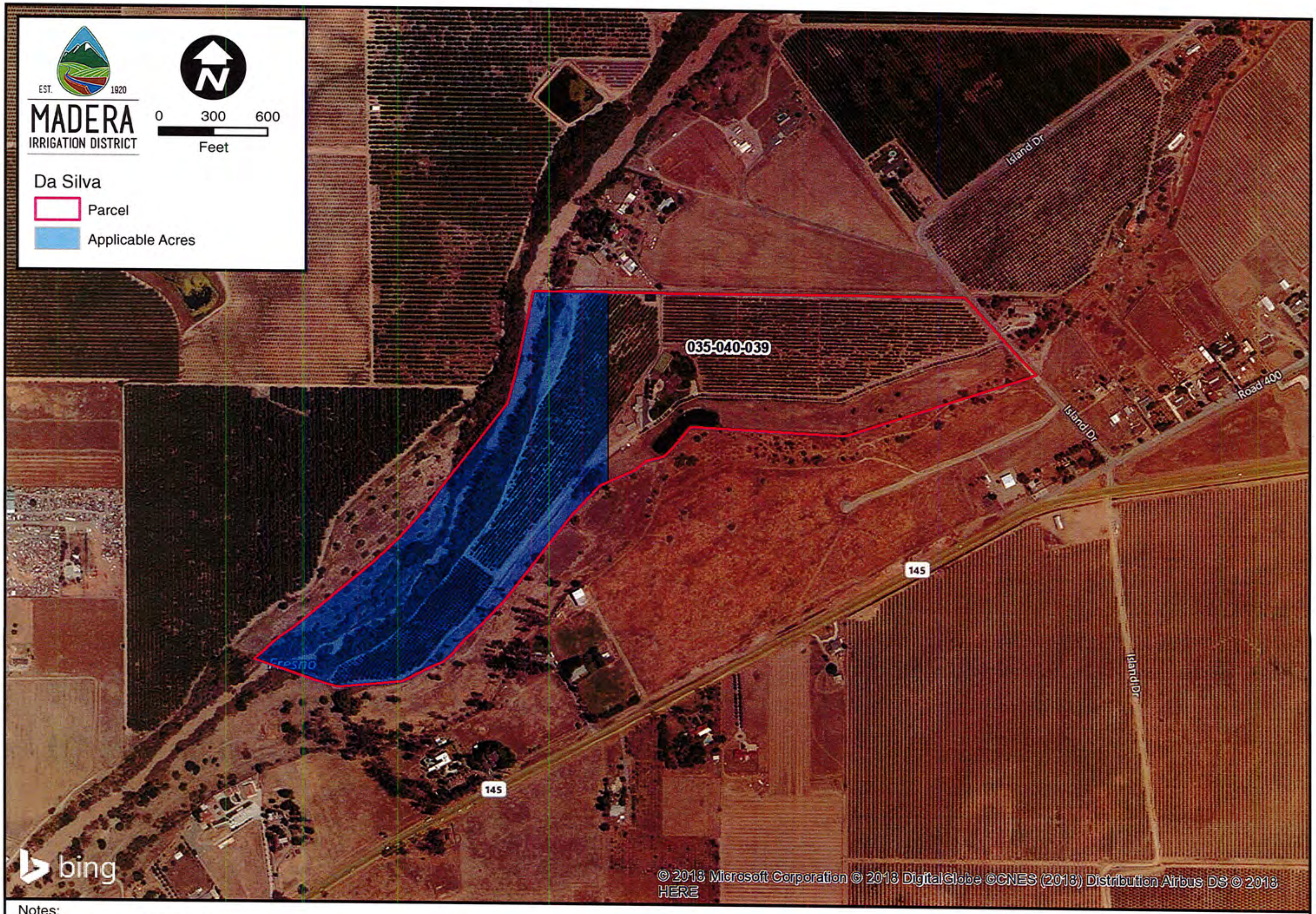
The landowner is also certifying that they have the authority to sign this form and that the numbers are accurate.



Notes:
1. Boundaries are approximate.
2. Applicable acres is the total riparian and/or appropriative parcel acreage, less the overlap between riparian and appropriative acres.

MID Special Board Meeting – Fresno River Workshop

November 5, 2018 from <u>10:00 a.m. - 12:00 p.m.</u>

Madera County Office of Education, Conference Center Rooms 3 & 4

1105 South Madera Ave., Madera, CA 93637

Pursuant to the request of several stakeholders in attendance at the Madera Irrigation District (the "District") Board of Directors meeting on October 16, 2018, the District will be holding a workshop to receive input from stakeholders on potential comprehensive solutions to resolve the issues raised in the Petition for the Adjudication of Rights to the Fresno River, filed on October 18, 2018 (the "Petition").

This workshop is being held to allow landowners and the public to present ***comprehensive solutions to address all concerns*** related to current Fresno River operations including, but not limited to, the following:

- Riparian and appropriate acreage disputes
- Diversion capacity disputes
- Unexercised riparian water rights
- Priority of water rights
- Operational constraints

District representatives will attend the workshop to hear proposed solutions from stakeholders, including riparian landowners. This will be a "Discussion Only" agenda item.

This is a public meeting and the public is welcome to attend. See attached agenda for further information.

Riparian Landowner Workshop

November 5, 2018 from <u>8:00 a.m. - 10:00 a.m.</u>

Madera County Office of Education, Conference Center Rooms 3 & 4

1105 South Madera Ave., Madera, CA 93637

Madera Irrigation District is providing the opportunity for Fresno River riparian and appropriative rights holders to discuss amongst each other proposed comprehensive solutions to address all concerns raised by the Petition between 8:00 a.m. - 10:00 a.m. This workshop is being offered to allow Fresno River riparian and appropriative rights holders to discuss and develop potential comprehensive solutions to be presented at the 10:00 a.m. MID Special Board Meeting.

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EST 1920
MADERA
IRRIGATION DISTRICT

MADERA IRRIGATION DISTRICT
BOARD OF DIRECTORS SPECIAL MEETING
FRESNO RIVER WORKSHOP

AGENDA

MISSION STATEMENT

To obtain and manage affordable surface water and groundwater supplies in a manner which will ensure the long-term viability of irrigated agriculture in the District.

Special Meeting Date:
Monday, November 5, 2018
10:00 a.m.-12:00 p.m.

Madera County Office of Education
Conference Center Rooms 3 & 4
1105 S. Madera Avenue
Madera, CA 93637

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General Manager
Thomas Greci

Assistant
General Manager
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Legal Counsel
John P. Kinsey

EST. 1920
MADERA
IRRIGATION DISTRICT

12152 Road 28 1/4
Madera, CA 93637

October 25, 2018

GSO Priority Mail

Richard DeBenedetto
DeBennedetto/Mesple
26393 Road 22 1/2
Chowchilla, CA 93610

Re: Fresno River Riparian and Appropriative Right Holders Land Crop Report and Map

Dear Riparian and Appropriative Right Holders:

Below is the summary of your 2018 entitlement and water diverted[1]:

2018 Entitlement	Riparian Water Diverted
332.83 AF	165.36 AF

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A map and form(s) have been included with this letter, for the following information:

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- Cover crop (if applicable)
- Diversion capacity

1. These are totals for DeBenedetto and Mesple, as the point of diversion is shared.

The District reserves the right to visually inspect the subject property, either on the ground or via satellite imagery, and to compare each parcel's cropping pattern that is submitted.

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a. 2019 crop map for Riparian and Appropriative Right acreage only (enclosed map for reference).

Thank you in advance for your cooperation.

Sincerely,

Ramon E Mendez

Ramon E Mendez, PE
Project Engineer

Enclosure

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must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions

Name: DeBenedetto

This form must be filled out completely and accurately and all numbers must sum to be included in the 2019 Fresno River Allocation Model runs. Include below acreage of river bottom, fallow land, residences, etc., if riparian land.

Riparian Acres 219.56

Crop / Land Use	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
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		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
Total		(Total must add up to Riparian Acres above)	

Riparian / Appropriative Only Points of Diversion
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Point of Diversion Location:____________________________; Diversion Capacity:______________________________

Point of Diversion Location:____________________________; Diversion Capacity:______________________________

Point of Diversion Location:____________________________; Diversion Capacity:______________________________

Total Diversion Capacity: ______________________

Name (Print): Date:

Signature:

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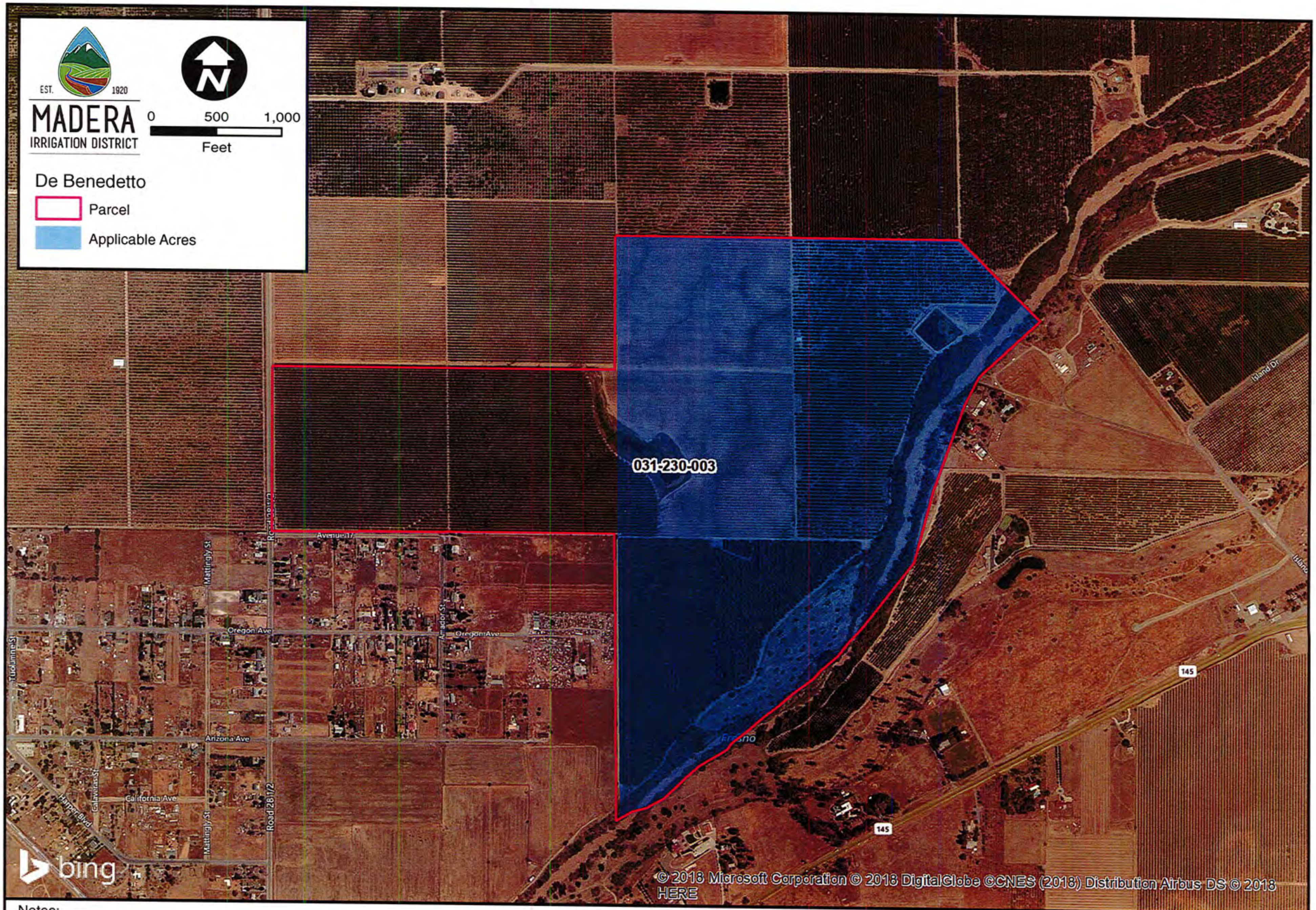

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EST. 1920
MADERA
IRRIGATION DISTRICT

12152 Road 28 1/4
Madera, CA 93637

October 25, 2018

GSO Priority Mail

Paul Mesple
DeBennedetto/Mesple
7443 N Millbrook
Fresno, CA 93720

Re: Fresno River Riparian and Appropriative Right Holders Land Crop Report and Map

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2018 Entitlement	Riparian Water Diverted
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Project Engineer

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Name: Mesple

This form must be filled out completely and accurately and all numbers must sum to be included in the 2019 Fresno River Allocation Model runs. Include below acreage of river bottom, fallow land, residences, etc., if riparian land.

Riparian Acres 198.52

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		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
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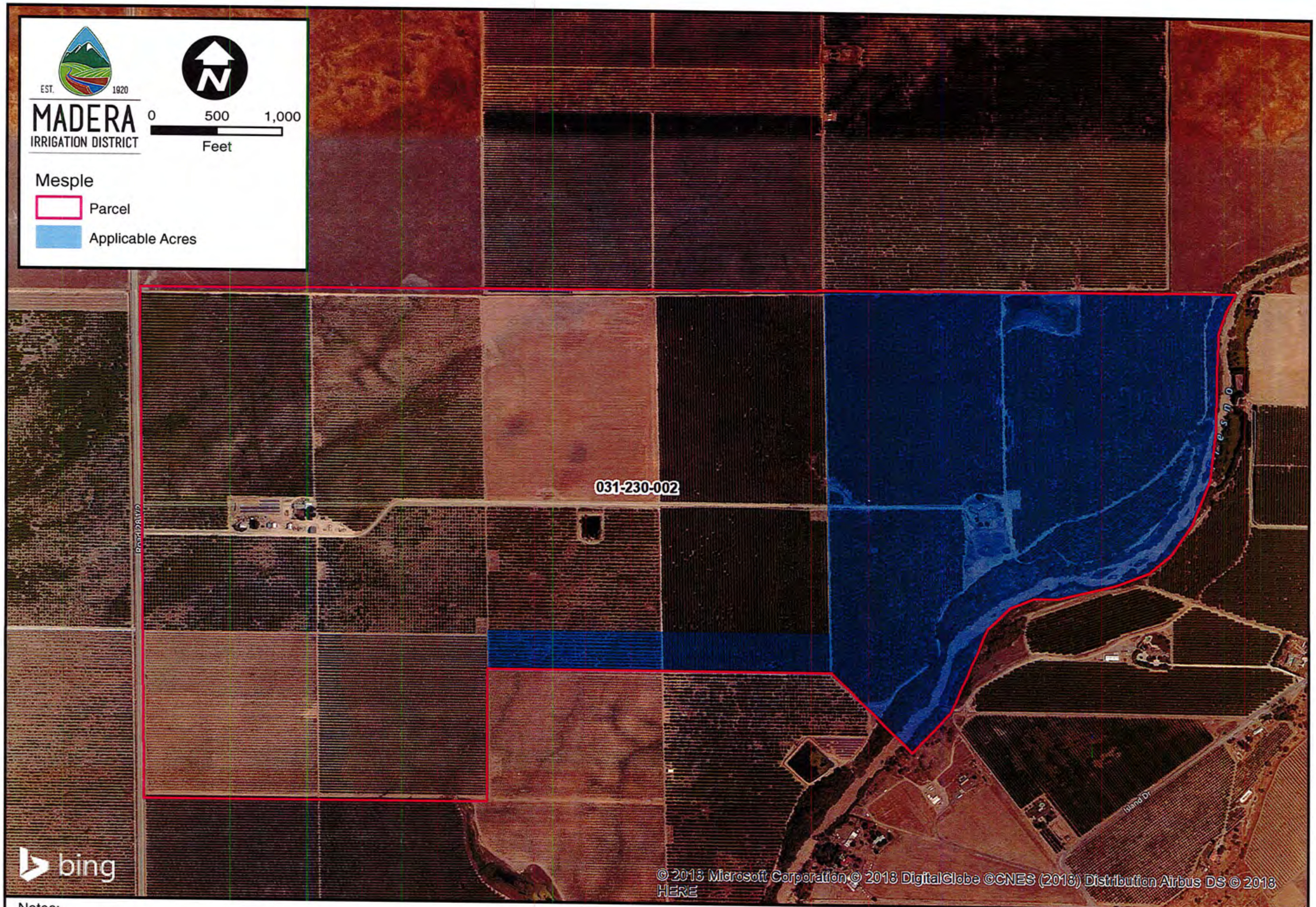

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12152 Road 28 1/4
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October 25, 2018

GSO Priority Mail

Jeff Schmiederer
Rancho Bella Vista
2578 S. Lyon Avenue
Mendota, CA 93640

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11.70 AF	4.91 AF

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☒ 3. 2019 Riparian and Appropriative Right Holders cropping information sheet (enclosed). ***By signing the attached form, the landowner is certifying that only the riparian and/or appropriate acreage is being provided to the District for entitlement calculations.***

   a. 2019 crop map for Riparian and Appropriative Right acreage only (enclosed map for reference).

Thank you in advance for your cooperation.

Sincerely,

Ramon E Mendez

Ramon E Mendez, PE
Project Engineer

Enclosure

2019 RIPARIAN AND SENIOR APPROPRIATIVE RIGHT HOLDERS CROPPING INFORMATION
must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions

Name: Rancho Bella Vista

This form must be filled out completely and accurately and all numbers must sum to be included in the 2019 Fresno River Allocation Model runs. Include below acreage of river bottom, fallow land, residences, etc., if riparian land.

Riparian Acres 21.24

Crop / Land Use	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
Total		(Total must add up to Riparian Acres above)	

Riparian / Appropriative Only Points of Diversion

MID reserves the right to inspect points of diversion, capacity, and request proof of permitting.

Point of Diversion Location:____________________________; Diversion Capacity:______________________________

Point of Diversion Location:____________________________; Diversion Capacity:______________________________

Point of Diversion Location:____________________________; Diversion Capacity:______________________________

Total Diversion Capacity: ______________________

Name (Print): Date:

Signature:

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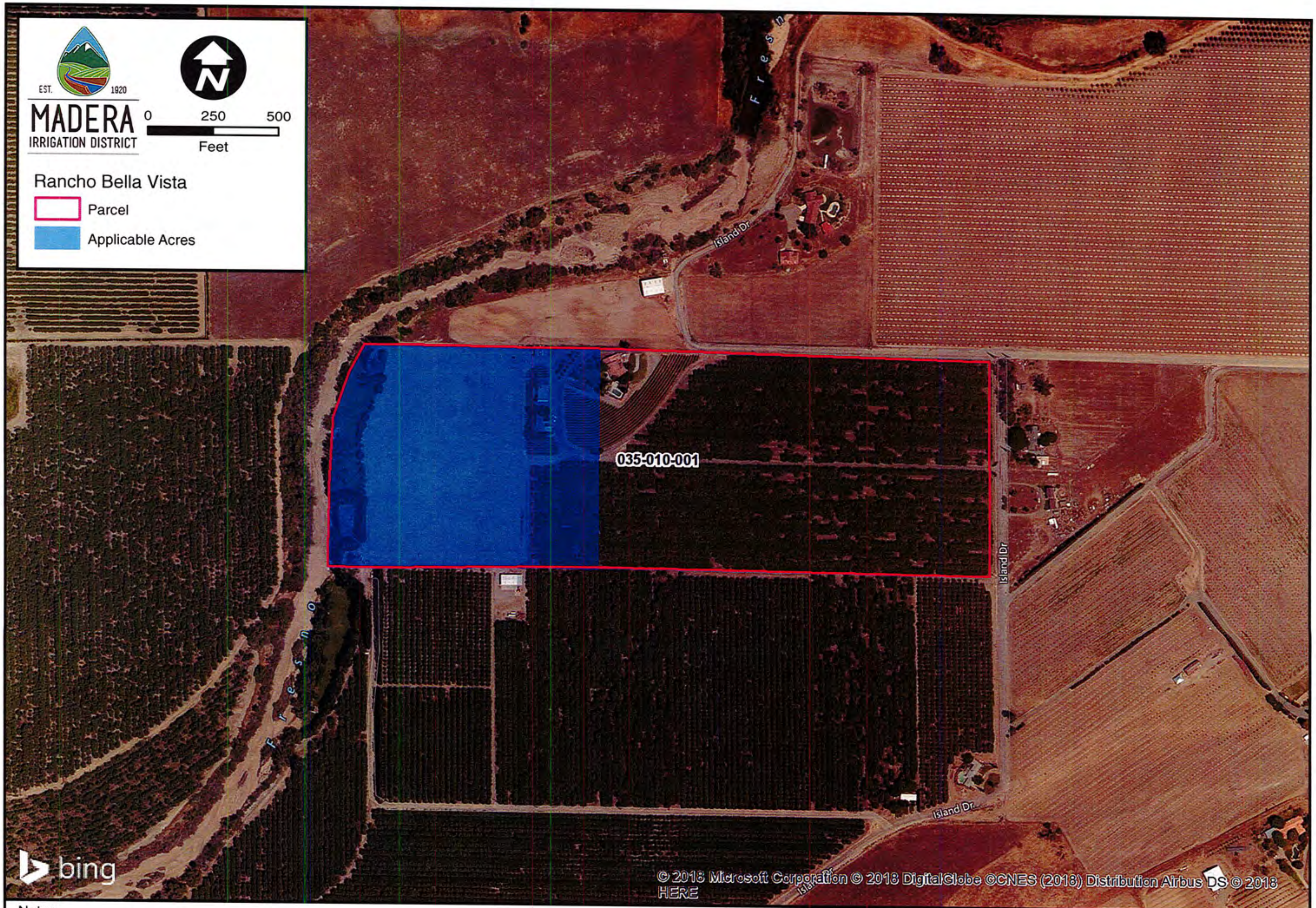
The landowner is also certifying that they have the authority to sign this form and that the numbers are accurate.



Notes:
1. Boundaries are approximate.
2. Applicable acres is the total riparian and/or appropriative parcel acreage, less the overlap between riparian and appropriative acres.

MID Special Board Meeting – Fresno River Workshop

November 5, 2018 from 10:00 a.m. - 12:00 p.m.

Madera County Office of Education, Conference Center Rooms 3 & 4

1105 South Madera Ave., Madera, CA 93637

Pursuant to the request of several stakeholders in attendance at the Madera Irrigation District (the "District") Board of Directors meeting on October 16, 2018, the District will be holding a workshop to receive input from stakeholders on potential comprehensive solutions to resolve the issues raised in the Petition for the Adjudication of Rights to the Fresno River, filed on October 18, 2018 (the "Petition").

This workshop is being held to allow landowners and the public to present ***comprehensive solutions to address all concerns*** related to current Fresno River operations including, but not limited to, the following:

- Riparian and appropriate acreage disputes
- Diversion capacity disputes
- Unexercised riparian water rights
- Priority of water rights
- Operational constraints

District representatives will attend the workshop to hear proposed solutions from stakeholders, including riparian landowners. This will be a "Discussion Only" agenda item.

This is a public meeting and the public is welcome to attend. See attached agenda for further information.

Riparian Landowner Workshop

November 5, 2018 from 8:00 a.m. - 10:00 a.m.

Madera County Office of Education, Conference Center Rooms 3 & 4

1105 South Madera Ave., Madera, CA 93637

Madera Irrigation District is providing the opportunity for Fresno River riparian and appropriative rights holders to discuss amongst each other proposed comprehensive solutions to address all concerns raised by the Petition between 8:00 a.m. - 10:00 a.m. This workshop is being offered to allow Fresno River riparian and appropriative rights holders to discuss and develop potential comprehensive solutions to be presented at the 10:00 a.m. MID Special Board Meeting.

Representatives of the District will not be in attendance during this portion of the workshop. However, to help further the discussions, a neutral facilitator will be available to those in attendance.

MADERA IRRIGATION DISTRICT
BOARD OF DIRECTORS SPECIAL MEETING
FRESNO RIVER WORKSHOP

AGENDA

MISSION STATEMENT

To obtain and manage affordable surface water and groundwater supplies in a manner which will ensure the long-term viability of irrigated agriculture in the District.

Special Meeting Date:
Monday, November 5, 2018
10:00 a.m.-12:00 p.m.

Madera County Office of Education
Conference Center Rooms 3 & 4
1105 S. Madera Avenue
Madera, CA 93637

In compliance with the Americans with Disabilities Act, if you need special assistance to participate in this meeting, please contact the Administration Office at 559-673-3514, ext. 215. Notification in advance of the meeting will enable MID to make reasonable arrangements to ensure accessibility to this meeting.

In compliance with the California Government Code, members of the public may inspect the agenda and any associated writings, including documents delivered after the 72-hour advance posting of the agenda during regular business hours at the Madera Irrigation District Office, located at 12152 Road 28 1/4, Madera, California 93637.

WELCOME

1. **INFORMATIONAL ITEMS**

   a. Discussion only – presentation of proposals by Fresno River stakeholders to discuss a potential for resolution of the issues raised in the Petition for the Adjudication of Rights to the Fresno River, filed on October 18, 2018.

2. **ADJOURNMENT**

Phone (559) 673-3514
www.madera-id.org

General Manager
Thomas Greci

Assistant
General Manager
Dina Cadenazzi Nolan

Legal Counsel
John P. Kinsey

EST. 1920
MADERA
IRRIGATION DISTRICT

12152 Road 28 1/4
Madera, CA 93637

October 25, 2018

GSO Priority Mail

Frank Roque
Isla Vista Farms
3611 W Beechwood #101
Fresno, CA 93711

Re: Fresno River Riparian and Appropriative Right Holders Land Crop Report and Map

Dear Riparian and Appropriative Right Holders:

Below is the summary of your 2018 entitlement and water diverted:

2018 Entitlement	Riparian Water Diverted
73.60 AF	17.87 AF

For 2019, in accordance with the Fresno River Operations Protocols, Madera Irrigation District (MID or District) is required to request the following documents from Fresno River Riparian and Appropriative Right Holders annually for the purpose of allocating Fresno River flows to each Riparian and Appropriative Right Holder for the upcoming year:

ANNUAL CROPPING SUBMITTAL
Madera Irrigation District, in compliance with the Fresno River Operations Protocols, calls on Fresno River Riparian and Appropriative Right Holders to annually submit their current crop pattern for the Riparian water year (October 2018-September 2019), acreage map, and diversion capacity to the District.

A map and form(s) have been included with this letter, for the following information:

- Acreage
- Crop pattern
- Irrigation type
- Cover crop (if applicable)
- Diversion capacity

The District reserves the right to visually inspect the subject property, either on the ground or via satellite imagery, and to compare each parcel's cropping pattern that is submitted.

The attached form and any other requested information must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions. If the data requested is not provided by the deadline, the District will assume that the Riparian and Appropriative Right Holders will not be diverting Fresno River flows for this coming year.

ADDITIONAL REQUIRED DOCUMENTS

District records indicate the required documents checked below have not been provided to the District. These documents must also be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions.

☐ 1. Independent pump test or diversion capacity flow test documenting your diversion capacity. ***NOTE: If your diversion capacity has changed since your last submittal, it is your responsibility to notify MID***.

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☒ 3. 2019 Riparian and Appropriative Right Holders cropping information sheet (enclosed). ***By signing the attached form, the landowner is certifying that only the riparian and/or appropriate acreage is being provided to the District for entitlement calculations.***

a. 2019 crop map for Riparian and Appropriative Right acreage only (enclosed map for reference).

Thank you in advance for your cooperation.

Sincerely,

Ramon E Mendez

Ramon E Mendez, PE
Project Engineer

Enclosure

2019 RIPARIAN AND SENIOR APPROPRIATIVE RIGHT HOLDERS CROPPING INFORMATION
must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions

Name: Isla Vista Farms

This form must be filled out completely and accurately and all numbers must sum to be included in the 2019 Fresno River Allocation Model runs. Include below acreage of river bottom, fallow land, residences, etc., if riparian land.

Riparian Acres 93.39

Crop / Land Use	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
Total		(Total must add up to Riparian Acres above)	

Riparian / Appropriative Only Points of Diversion
MID reserves the right to inspect points of diversion, capacity, and request proof of permitting.

Point of Diversion Location:__________; Diversion Capacity:__________

Point of Diversion Location:__________; Diversion Capacity:__________

Point of Diversion Location:__________; Diversion Capacity:__________

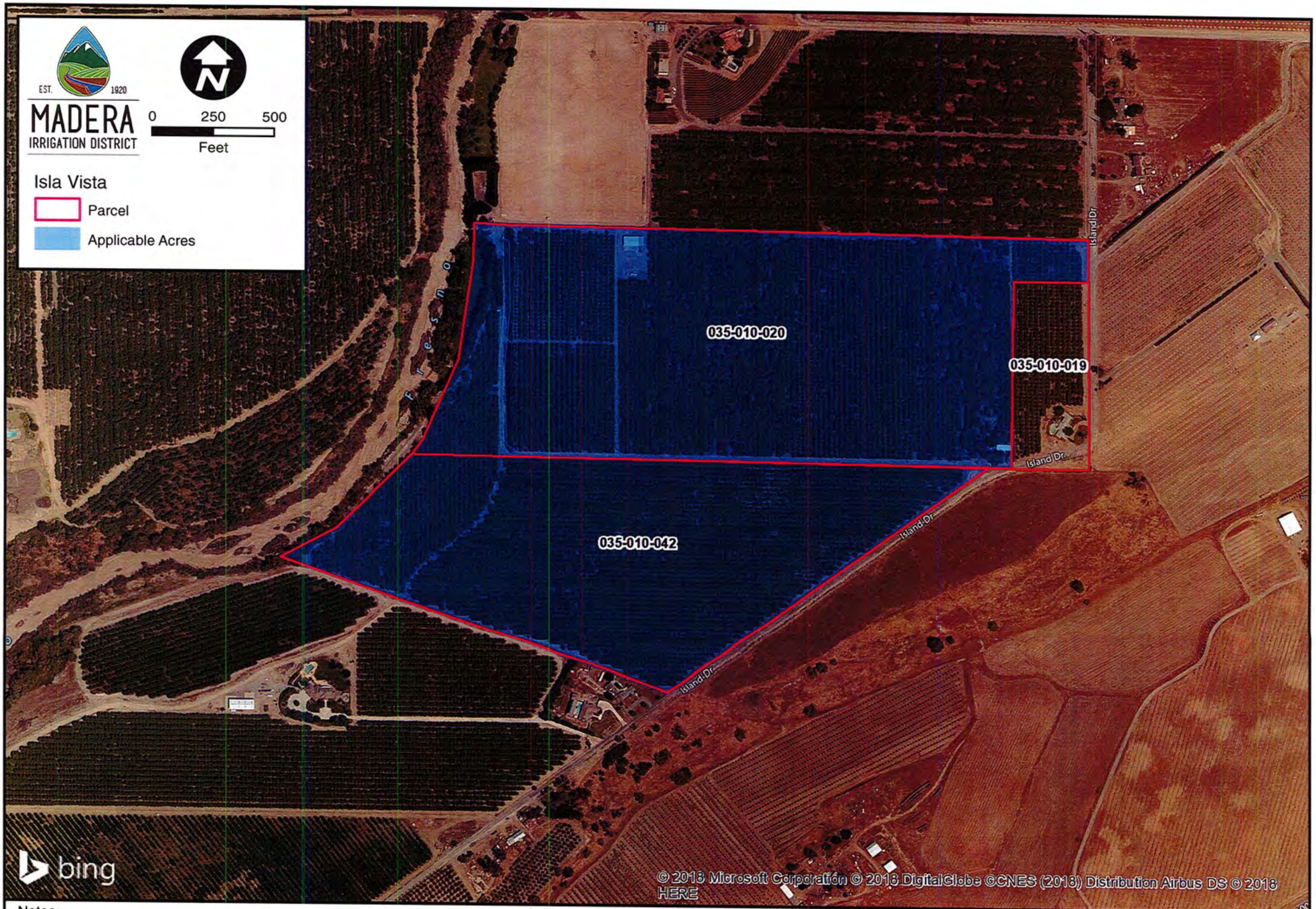
Total Diversion Capacity: __________

Name (Print): Date:

Signature:

By signing this form, the landowner is certifying that only the riparian and/or appropriative acreage is being provided to MID for allocation calculations.

The landowner is also certifying that they have the authority to sign this form and that the numbers are accurate.



Notes:
1. Boundaries are approximate.
2. Applicable acres is the total riparian and/or appropriative parcel acreage, less the overlap between riparian and appropriative acres.

MID Special Board Meeting – Fresno River Workshop

November 5, 2018 from <u>10:00 a.m. - 12:00 p.m.</u>

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1105 South Madera Ave., Madera, CA 93637

Pursuant to the request of several stakeholders in attendance at the Madera Irrigation District (the "District") Board of Directors meeting on October 16, 2018, the District will be holding a workshop to receive input from stakeholders on potential comprehensive solutions to resolve the issues raised in the Petition for the Adjudication of Rights to the Fresno River, filed on October 18, 2018 (the "Petition").

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- Riparian and appropriate acreage disputes
- Diversion capacity disputes
- Unexercised riparian water rights
- Priority of water rights
- Operational constraints

District representatives will attend the workshop to hear proposed solutions from stakeholders, including riparian landowners. This will be a "Discussion Only" agenda item.

This is a public meeting and the public is welcome to attend. See attached agenda for further information.

Riparian Landowner Workshop

November 5, 2018 from <u>8:00 a.m. - 10:00 a.m.</u>

Madera County Office of Education, Conference Center Rooms 3 & 4

1105 South Madera Ave., Madera, CA 93637

Madera Irrigation District is providing the opportunity for Fresno River riparian and appropriative rights holders to discuss amongst each other proposed comprehensive solutions to address all concerns raised by the Petition between 8:00 a.m. - 10:00 a.m. This workshop is being offered to allow Fresno River riparian and appropriative rights holders to discuss and develop potential comprehensive solutions to be presented at the 10:00 a.m. MID Special Board Meeting.

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MADERA IRRIGATION DISTRICT
BOARD OF DIRECTORS SPECIAL MEETING
FRESNO RIVER WORKSHOP

AGENDA

MISSION STATEMENT

To obtain and manage affordable surface water and groundwater supplies in a manner which will ensure the long-term viability of irrigated agriculture in the District.

Special Meeting Date:
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10:00 a.m.-12:00 p.m.

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Conference Center Rooms 3 & 4
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Madera, CA 93637

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WELCOME

1. **INFORMATIONAL ITEMS**

    a. Discussion only – presentation of proposals by Fresno River stakeholders to discuss a potential for resolution of the issues raised in the Petition for the Adjudication of Rights to the Fresno River, filed on October 18, 2018.

2. **ADJOURNMENT**

Phone (559) 673-3514
www.madera-id.org
General Manager
Thomas Greci
Assistant
General Manager
Dina Cadenazzi Nolan
Legal Counsel
John P. Kinsey

EST. 1920
MADERA
IRRIGATION DISTRICT

12152 Road 28 1/4
Madera, CA 93637

October 25, 2018

GSO Priority Mail

Cal Fischer
Madera Throughbreds
28799 Hwy 145
Madera, CA 93638

Re: Fresno River Riparian and Appropriative Right Holders Land Crop Report and Map

Dear Riparian and Appropriative Right Holders:

Below is the summary of your 2018 entitlement and water diverted:

2018 Entitlement	Riparian Water Diverted
132.16 AF	41.45 AF

For 2019, in accordance with the Fresno River Operations Protocols, Madera Irrigation District (MID or District) is required to request the following documents from Fresno River Riparian and Appropriative Right Holders annually for the purpose of allocating Fresno River flows to each Riparian and Appropriative Right Holder for the upcoming year:

ANNUAL CROPPING SUBMITTAL

Madera Irrigation District, in compliance with the Fresno River Operations Protocols, calls on Fresno River Riparian and Appropriative Right Holders to annually submit their current crop pattern for the Riparian water year (October 2018-September 2019), acreage map, and diversion capacity to the District.

A map and form(s) have been included with this letter, for the following information:

- Acreage
- Crop pattern
- Irrigation type
- Cover crop (if applicable)
- Diversion capacity

The District reserves the right to visually inspect the subject property, either on the ground or via satellite imagery, and to compare each parcel's cropping pattern that is submitted.

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ADDITIONAL REQUIRED DOCUMENTS

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  a. 2019 crop map for Riparian and Appropriative Right acreage only (enclosed map for reference).

Thank you in advance for your cooperation.

Sincerely,

Ramon E Mendez

Ramon E Mendez, PE
Project Engineer

Enclosure

2019 RIPARIAN AND SENIOR APPROPRIATIVE RIGHT HOLDERS CROPPING INFORMATION
must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions

Name: Cal Fisher

This form must be filled out completely and accurately and all numbers must sum to be included in the 2019 Fresno River Allocation Model runs. Include below acreage of river bottom, fallow land, residences, etc., if riparian land.

Riparian Acres 149

Crop / Land Use	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
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		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
Total		(Total must add up to Riparian Acres above)	

Riparian / Appropriative Only Points of Diversion
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Point of Diversion Location:______________________; Diversion Capacity:______________________

Point of Diversion Location:______________________; Diversion Capacity:______________________

Point of Diversion Location:______________________; Diversion Capacity:______________________

Total Diversion Capacity: ______________

Name (Print): Date:

Signature:

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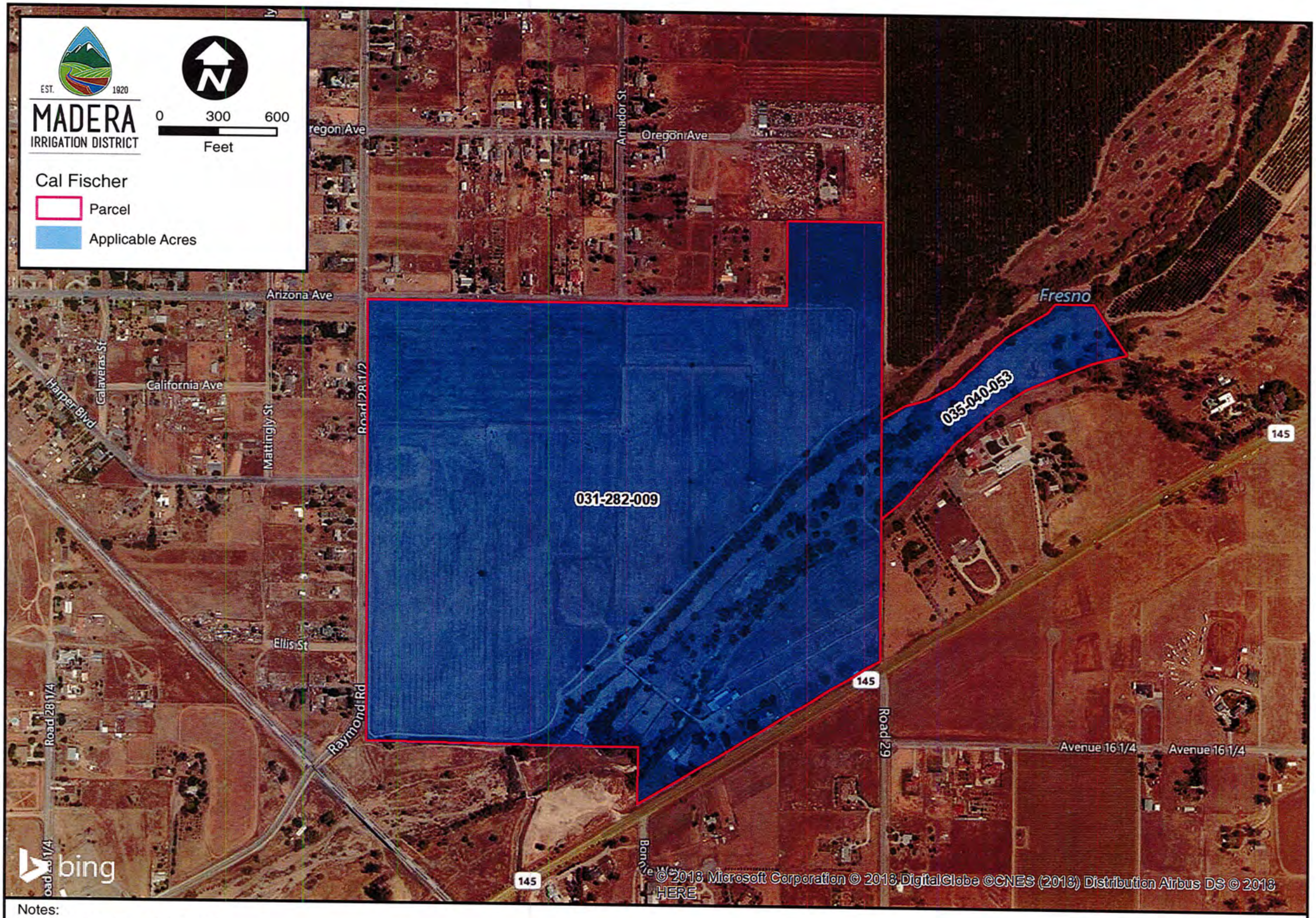

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MADERA IRRIGATION DISTRICT

MADERA IRRIGATION DISTRICT
BOARD OF DIRECTORS SPECIAL MEETING
FRESNO RIVER WORKSHOP

AGENDA

MISSION STATEMENT

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Special Meeting Date:
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1. **INFORMATIONAL ITEMS**

   a. Discussion only – presentation of proposals by Fresno River stakeholders to discuss a potential for resolution of the issues raised in the Petition for the Adjudication of Rights to the Fresno River, filed on October 18, 2018.

2. **ADJOURNMENT**

Phone (559) 673-3514
www.madera-id.org

General Manager
Thomas Greci

Assistant
General Manager
Dina Cadenazzi Nolan

Legal Counsel
John P. Kinsey

EST. 1920
MADERA
IRRIGATION DISTRICT

12152 Road 28 1/4
Madera, CA 93637

October 25, 2018

GSO Priority Mail

Costa View Farms
16800 Road 15
Madera, CA 93637

Re: Fresno River Riparian and Appropriative Right Holders Land Crop Report and Map

Dear Riparian and Appropriative Right Holders:

Below is the summary of your 2018 entitlement and water diverted:

2018 Entitlement	Riparian Water Diverted
2,630.87 AF	1,366.15 AF

For 2019, in accordance with the Fresno River Operations Protocols, Madera Irrigation District (MID or District) is required to request the following documents from Fresno River Riparian and Appropriative Right Holders annually for the purpose of allocating Fresno River flows to each Riparian and Appropriative Right Holder for the upcoming year:

ANNUAL CROPPING SUBMITTAL
Madera Irrigation District, in compliance with the Fresno River Operations Protocols, calls on Fresno River Riparian and Appropriative Right Holders to annually submit their current crop pattern for the Riparian water year (October 2018-September 2019), acreage map, and diversion capacity to the District.

A map and form(s) have been included with this letter, for the following information:

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- Crop pattern
- Irrigation type
- Cover crop (if applicable)
- Diversion capacity

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a. 2019 crop map for Riparian and Appropriative Right acreage only (enclosed map for reference).

Thank you in advance for your cooperation.

Sincerely,

Ramon E Mendez

Ramon E Mendez, PE
Project Engineer

Enclosure

2019 RIPARIAN AND SENIOR APPROPRIATIVE RIGHT HOLDERS CROPPING INFORMATION
must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions

Name: Costa View

This form must be filled out completely and accurately and all numbers must sum to be included in the 2019 Fresno River Allocation Model runs. Include below acreage of river bottom, fallow land, residences, etc., if riparian land.

Riparian Acres 1,800

Crop	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
Total		(Total must add up to Riparian Acres above)	

Appropriative Acres 1,565

Crop	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
Total		(Total must add up to Appropriative Acres above)	

Riparian / Appropriative Only Points of Diversion
MID reserves the right to inspect points of diversion, capacity, and request proof of permitting.

Point of Diversion Location:____________________; Diversion Capacity:____________________

Point of Diversion Location:____________________; Diversion Capacity:____________________

Point of Diversion Location:____________________; Diversion Capacity:____________________

Total Diversion Capacity: ____________________

Name (Print): Date:

Signature:

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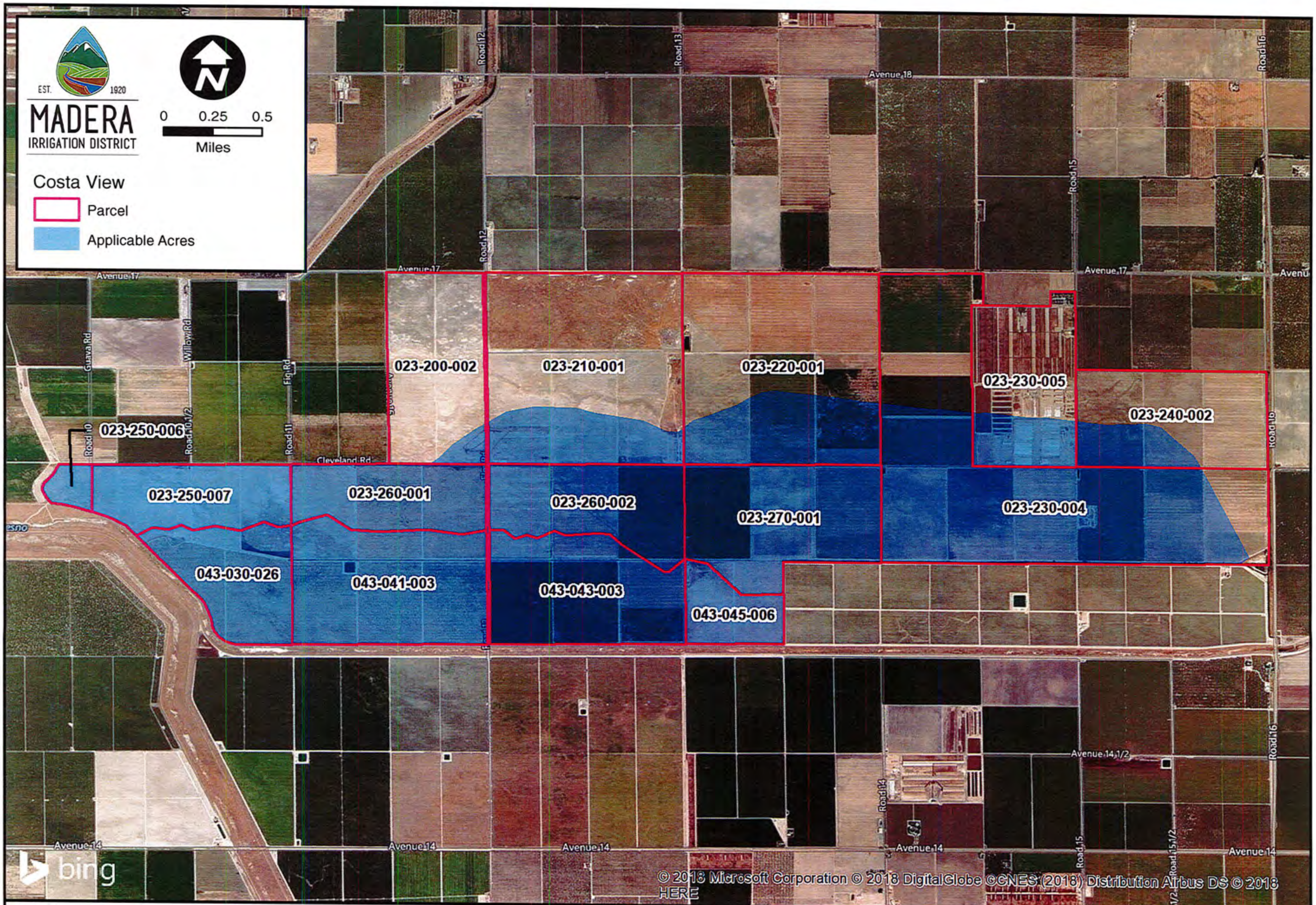

Notes:

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MID Special Board Meeting – Fresno River Workshop

November 5, 2018 from 10:00 a.m. - 12:00 p.m.

Madera County Office of Education, Conference Center Rooms 3 & 4

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MADERA IRRIGATION DISTRICT
BOARD OF DIRECTORS SPECIAL MEETING
FRESNO RIVER WORKSHOP

AGENDA

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   a. Discussion only – presentation of proposals by Fresno River stakeholders to discuss a potential for resolution of the issues raised in the Petition for the Adjudication of Rights to the Fresno River, filed on October 18, 2018.

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Phone (559) 673-3514
www.madera-id.org

General Manager
Thomas Greci

Assistant
General Manager
Dina Cadenazzi Nolan

Legal Counsel
John P. Kinsey

EST. 1920
MADERA
IRRIGATION DISTRICT

12152 Road 28 1/4
Madera, CA 93637

October 25, 2018

GSO Priority Mail

Cosyns Farms
15310 Road 19
Madera, CA 93637

Re: Fresno River Riparian and Appropriative Right Holders Land Crop Report and Map

Dear Riparian and Appropriative Right Holders:

Below is the summary of your 2018 entitlement and water diverted:

2018 Entitlement	Riparian Water Diverted
191.77 AF	178.83 AF

For 2019, in accordance with the Fresno River Operations Protocols, Madera Irrigation District (MID or District) is required to request the following documents from Fresno River Riparian and Appropriative Right Holders annually for the purpose of allocating Fresno River flows to each Riparian and Appropriative Right Holder for the upcoming year:

ANNUAL CROPPING SUBMITTAL
Madera Irrigation District, in compliance with the Fresno River Operations Protocols, calls on Fresno River Riparian and Appropriative Right Holders to annually submit their current crop pattern for the Riparian water year (October 2018-September 2019), acreage map, and diversion capacity to the District.

A map and form(s) have been included with this letter, for the following information:

- Acreage
- Crop pattern
- Irrigation type
- Cover crop (if applicable)
- Diversion capacity

The District reserves the right to visually inspect the subject property, either on the ground or via satellite imagery, and to compare each parcel's cropping pattern that is submitted.

The attached form and any other requested information must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions. If the data requested is not provided by the deadline, the District will assume that the Riparian and Appropriative Right Holders will not be diverting Fresno River flows for this coming year.

ADDITIONAL REQUIRED DOCUMENTS

District records indicate the required documents checked below have not been provided to the District. These documents must also be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions.

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a. 2019 crop map for Riparian and Appropriative Right acreage only (enclosed map for reference).

Thank you in advance for your cooperation.

Sincerely,

Ramon E Mendez

Ramon E Mendez, PE
Project Engineer

Enclosure

2019 RIPARIAN AND SENIOR APPROPRIATIVE RIGHT HOLDERS CROPPING INFORMATION
must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions

Name: Cosyns

This form must be filled out completely and accurately and all numbers must sum to be included in the 2019 Fresno River Allocation Model runs. Include below acreage of river bottom, fallow land, residences, etc., if riparian land.

Riparian Acres 686.06

Crop / Land Use	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
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Total		(Total must add up to Riparian Acres above)	

Riparian / Appropriative Only Points of Diversion
MID reserves the right to inspect points of diversion, capacity, and request proof of permitting.

Point of Diversion Location:________________; Diversion Capacity:________________

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Total Diversion Capacity: ________________

Name (Print): Date:

Signature:

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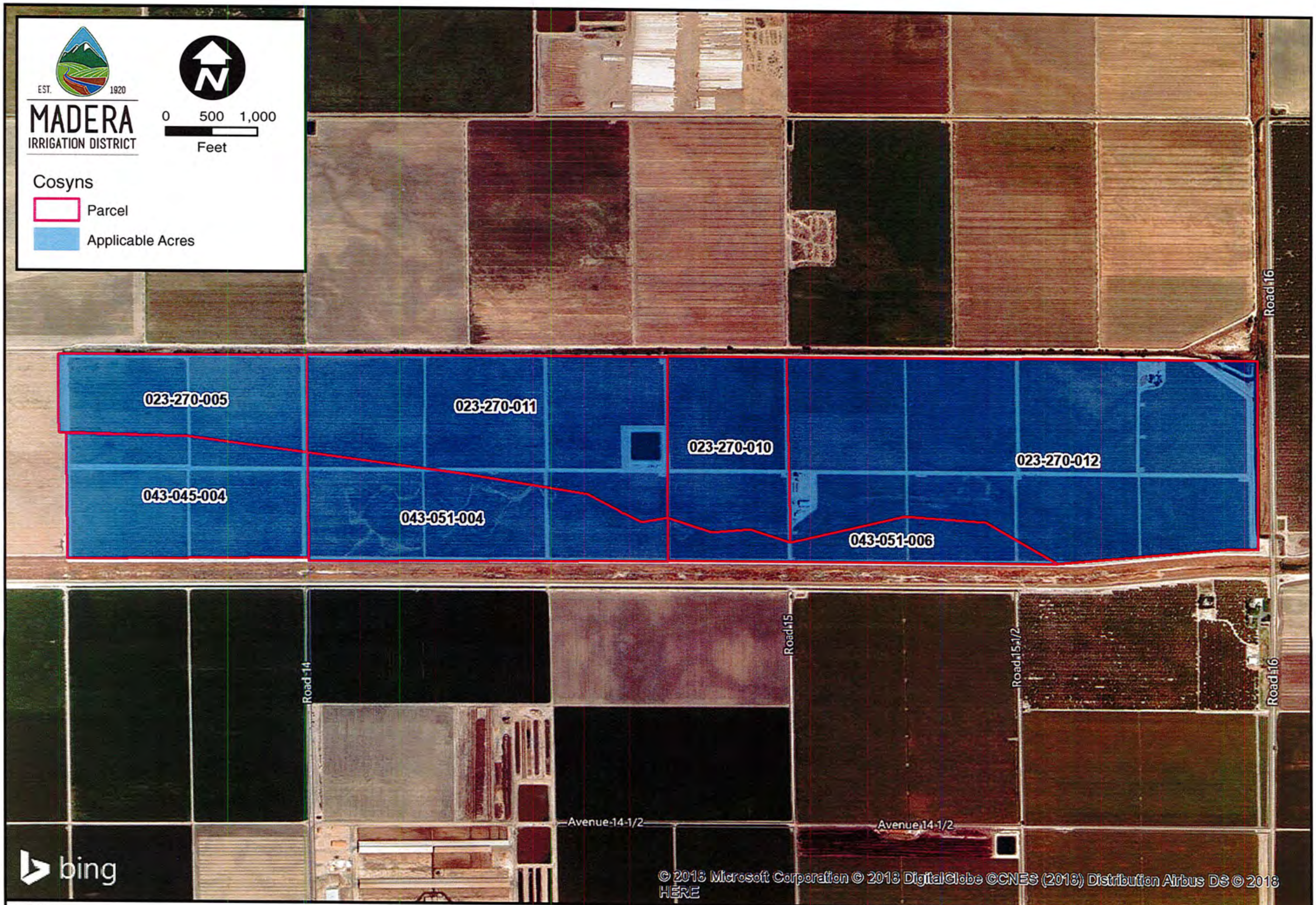

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GSO Priority Mail

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20633 Road 4
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Richard & Dale Harman
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16001 Flangan Rd
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Mark Hutson
Triangle T
Farmland Management Services
301 E. Main St
Turlock, CA 95380

Re: Fresno River Riparian and Appropriative Right Holders Land Crop Report and Map

Dear Riparian and Appropriative Right Holders:

Below is the summary of the 2018 Road 9 entitlement and water diverted[1]:

Total 2018 Entitlement at Road 9	Total Water Diverted at Road 9
964.93 AF	1850 AF

For 2019, in accordance with the Fresno River Operations Protocols, Madera Irrigation District (MID or District) is required to request the following documents from Fresno River Riparian and Appropriative Right Holders annually for the purpose of allocating Fresno River flows to each Riparian and Appropriative Right Holder for the upcoming year:

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A map and form(s) have been included with this letter, for the following information:

- Acreage
- Crop pattern
- Irrigation type
- Cover crop (if applicable)
- Diversion capacity

1. Totals include all Road 9 entitlements and diversions for all riparian and appropriative right holders downstream of the Road 9 diversion.

The District reserves the right to visually inspect the subject property, either on the ground or via satellite imagery, and to compare each parcel's cropping pattern that is submitted.

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Enclosure

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Name: Harman Ranch (Harman, Vlot, Triangle T)

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Riparian Acres 1,497

Crop / Land Use	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
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Name (Print): ____________________ Date: ____________________

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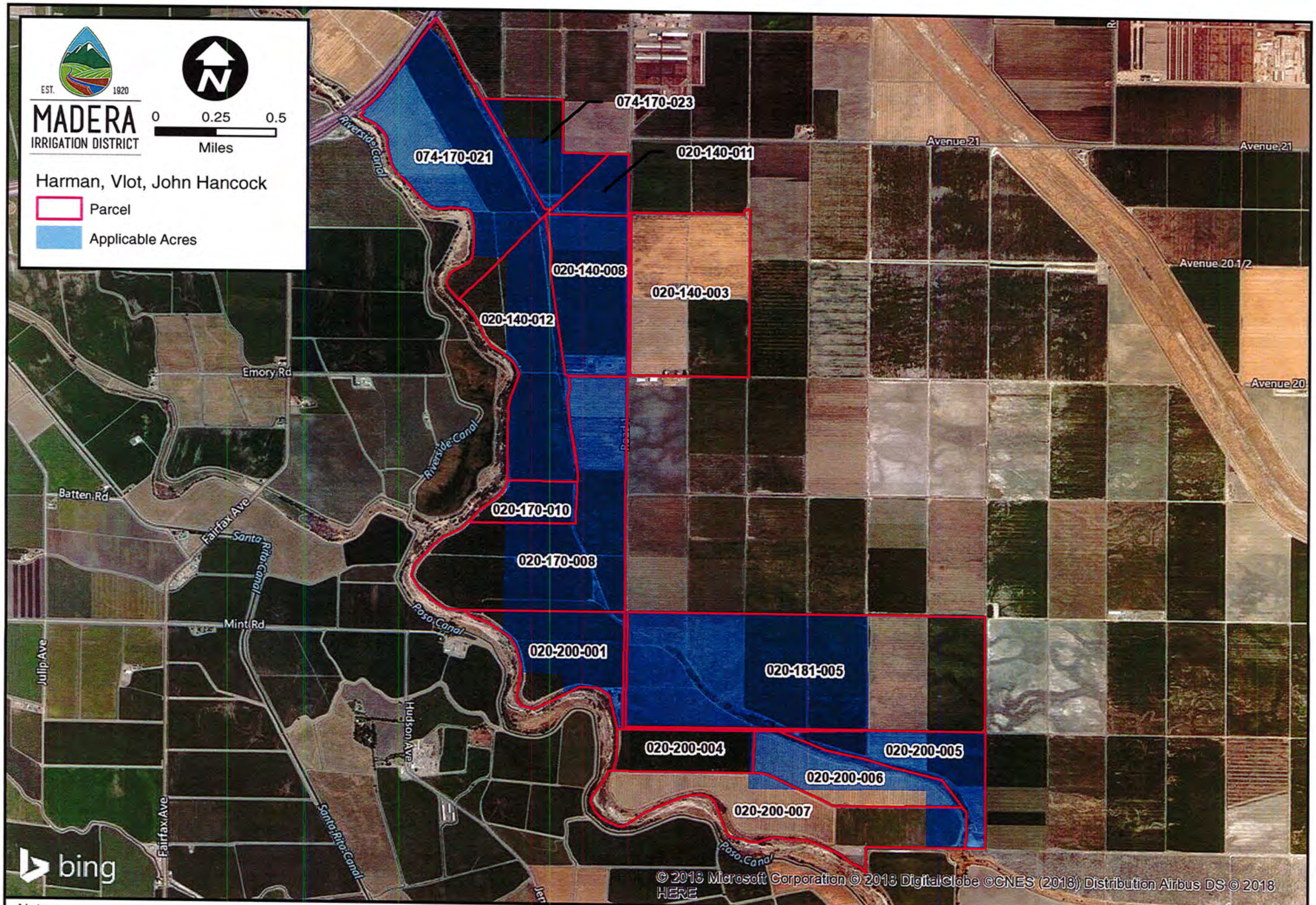

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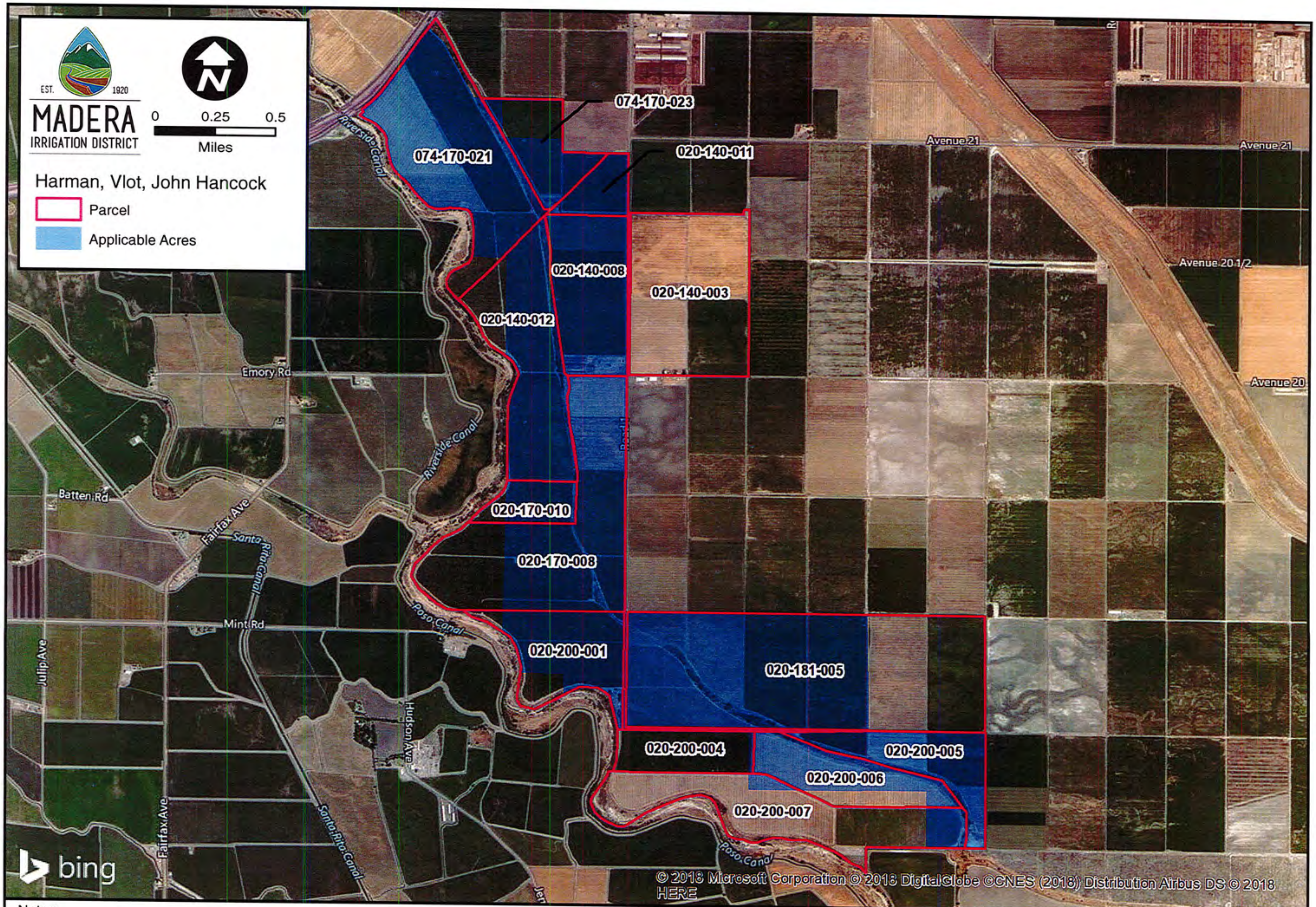

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Madera Irrigation District is providing the opportunity for Fresno River riparian and appropriative rights holders to discuss amongst each other proposed comprehensive solutions to address all concerns raised by the Petition between 8:00 a.m. - 10:00 a.m. This workshop is being offered to allow Fresno River riparian and appropriative rights holders to discuss and develop potential comprehensive solutions to be presented at the 10:00 a.m. MID Special Board Meeting.

Representatives of the District will not be in attendance during this portion of the workshop. However, to help further the discussions, a neutral facilitator will be available to those in attendance.

MADERA IRRIGATION DISTRICT
BOARD OF DIRECTORS SPECIAL MEETING
FRESNO RIVER WORKSHOP

AGENDA

MISSION STATEMENT

To obtain and manage affordable surface water and groundwater supplies in a manner which will ensure the long-term viability of irrigated agriculture in the District.

Special Meeting Date:
Monday, November 5, 2018
10:00 a.m.-12:00 p.m.

Madera County Office of Education
Conference Center Rooms 3 & 4
1105 S. Madera Avenue
Madera, CA 93637

In compliance with the Americans with Disabilities Act, if you need special assistance to participate in this meeting, please contact the Administration Office at 559-673-3514, ext. 215. Notification in advance of the meeting will enable MID to make reasonable arrangements to ensure accessibility to this meeting.

In compliance with the California Government Code, members of the public may inspect the agenda and any associated writings, including documents delivered after the 72-hour advance posting of the agenda during regular business hours at the Madera Irrigation District Office, located at 12152 Road 28 1/4, Madera, California 93637.

WELCOME

1. **INFORMATIONAL ITEMS**

   a. Discussion only – presentation of proposals by Fresno River stakeholders to discuss a potential for resolution of the issues raised in the Petition for the Adjudication of Rights to the Fresno River, filed on October 18, 2018.

2. **ADJOURNMENT**

Phone (559) 673-3514
www.madera-id.org
General Manager
Thomas Greci
Assistant General Manager
Dina Cadenazzi Nolan
Legal Counsel
John P. Kinsey

EST 1920
MADERA
IRRIGATION DISTRICT

12152 Road 28 1/4
Madera, CA 93637

October 25, 2018

GSO Priority Mail

Mark Hutson
Triangle T
Farmland Management Services
301 E Main St
Turlock, CA 95380

Re: Fresno River Riparian and Appropriative Right Holders Land Crop Report and Map

Dear Riparian and Appropriative Right Holders:

Below is the summary of the 2018 Road 9 entitlement and water diverted[1]:

Total 2018 Entitlement at Road 9	Total Water Diverted at Road 9
964.93 AF	1850 AF

For 2019, in accordance with the Fresno River Operations Protocols, Madera Irrigation District (MID or District) is required to request the following documents from Fresno River Riparian and Appropriative Right Holders annually for the purpose of allocating Fresno River flows to each Riparian and Appropriative Right Holder for the upcoming year:

ANNUAL CROPPING SUBMITTAL

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A map and form(s) have been included with this letter, for the following information:

- Acreage
- Crop pattern
- Irrigation type
- Cover crop (if applicable)
- Diversion capacity

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The District reserves the right to visually inspect the subject property, either on the ground or via satellite imagery, and to compare each parcel's cropping pattern that is submitted.

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   a. 2019 crop map for Riparian and Appropriative Right acreage only (enclosed map for reference).

Thank you in advance for your cooperation.

Sincerely,

Ramon E Mendez

Ramon E Mendez, PE
Project Engineer

Enclosure

2019 RIPARIAN AND SENIOR APPROPRIATIVE RIGHT HOLDERS CROPPING INFORMATION
must be received by the District no later than 4:00 PM on Monday, December 31, 2018 with no exceptions

Name: Triangle T

This form must be filled out completely and accurately and all numbers must sum to be included in the 2019 Fresno River Allocation Model runs. Include below acreage of river bottom, fallow land, residences, etc., if riparian land.

Riparian Acres 2,676

Crop / Land Use	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
Total		(Total must add up to Riparian Acres above)	

Appropriative Acres 1,550 (excludes overlapping acreage)

Crop / Land Use	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
Total		(Total must add up to Approprative Acres above)	

Riparian / Appropriative Only Points of Diversion

MID reserves the right to inspect points of diversion, capacity, and request proof of permitting.

Point of Diversion Location:______________________; Diversion Capacity:______________________

Point of Diversion Location:______________________; Diversion Capacity:______________________

Point of Diversion Location:______________________; Diversion Capacity:______________________

Total Diversion Capacity: ______________________

Name (Print): Date:

Signature:

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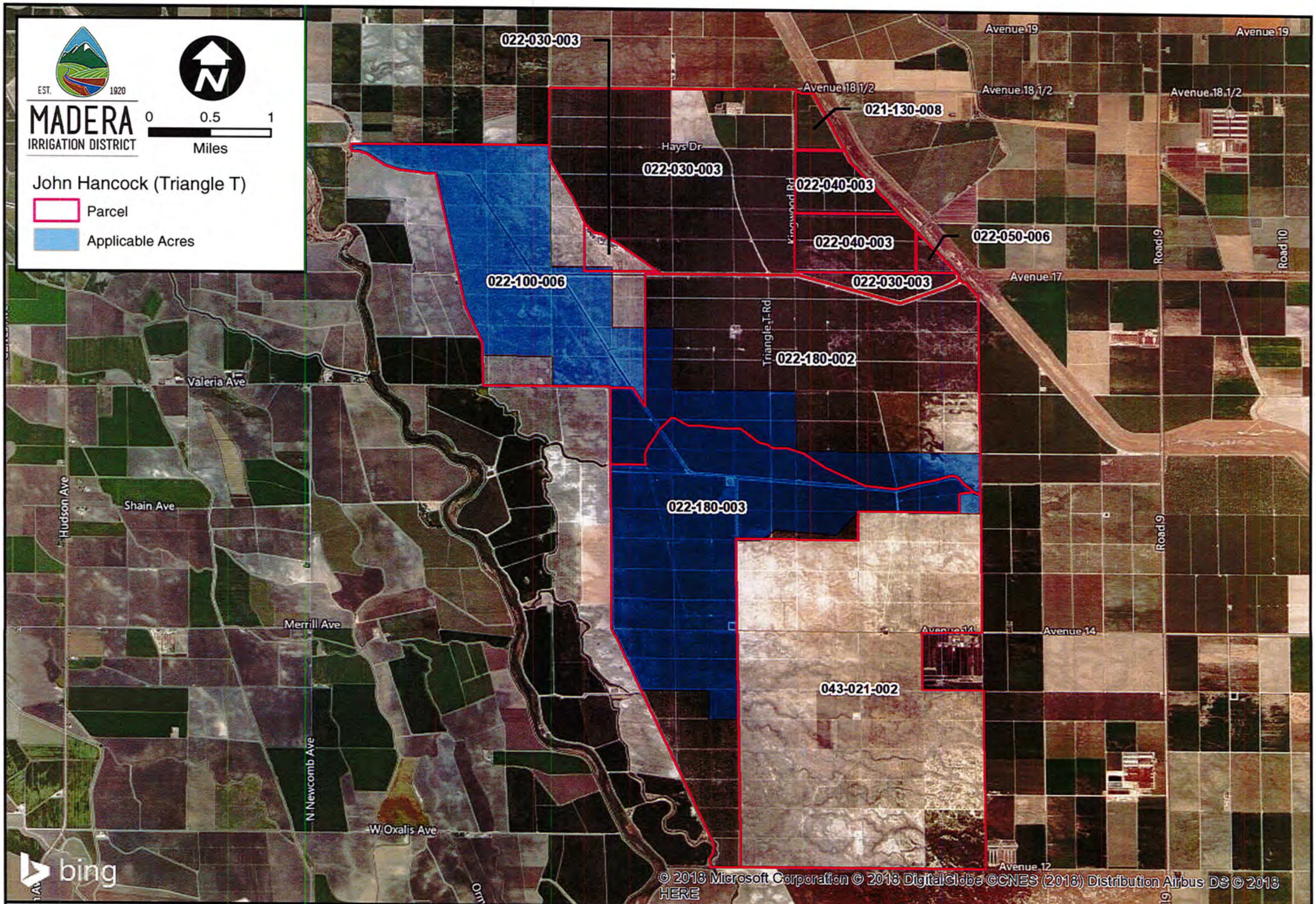

Notes:
1. Boundaries are approximate.
2. Applicable acres is the total riparian and/or appropriative parcel acreage, less the overlap between riparian and appropriative acres.

Phone (559) 673-3514
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General Manager
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Assistant
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John P. Kinsey

EST 1920
MADERA
IRRIGATION DISTRICT

12152 Road 28 1/4
Madera, CA 93637

October 25, 2018

GSO Priority Mail

Harman Ranch

Case Vlot
20633 Road 4
Chowchilla, CA 93610

Richard & Dale Harman
Harman Brothers
16001 Flangan Rd
Dos Palos, CA 93620

Mark Hutson
Triangle T
Farmland Management Services
301 E. Main St
Turlock, CA 95380

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c. 2019 crop map for Riparian and Appropriative Right acreage only (enclosed map for reference).

Thank you in advance for your cooperation.

Sincerely,

Ramon E Mendez

Ramon E Mendez, PE
Project Engineer

Enclosure

2019 RIPARIAN AND SENIOR APPROPRIATIVE RIGHT HOLDERS CROPPING INFORMATION
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Name: Harman Ranch (Harman, Vlot, Triangle T)

This form must be filled out completely and accurately and all numbers must sum to be included in the 2019 Fresno River Allocation Model runs. Include below acreage of river bottom, fallow land, residences, etc., if riparian land.

Riparian Acres 1,497

Crop / Land Use	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
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		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
Total		(Total must add up to Riparian Acres above)	

Riparian / Appropriative Only Points of Diversion
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Name (Print): Date:

Signature:

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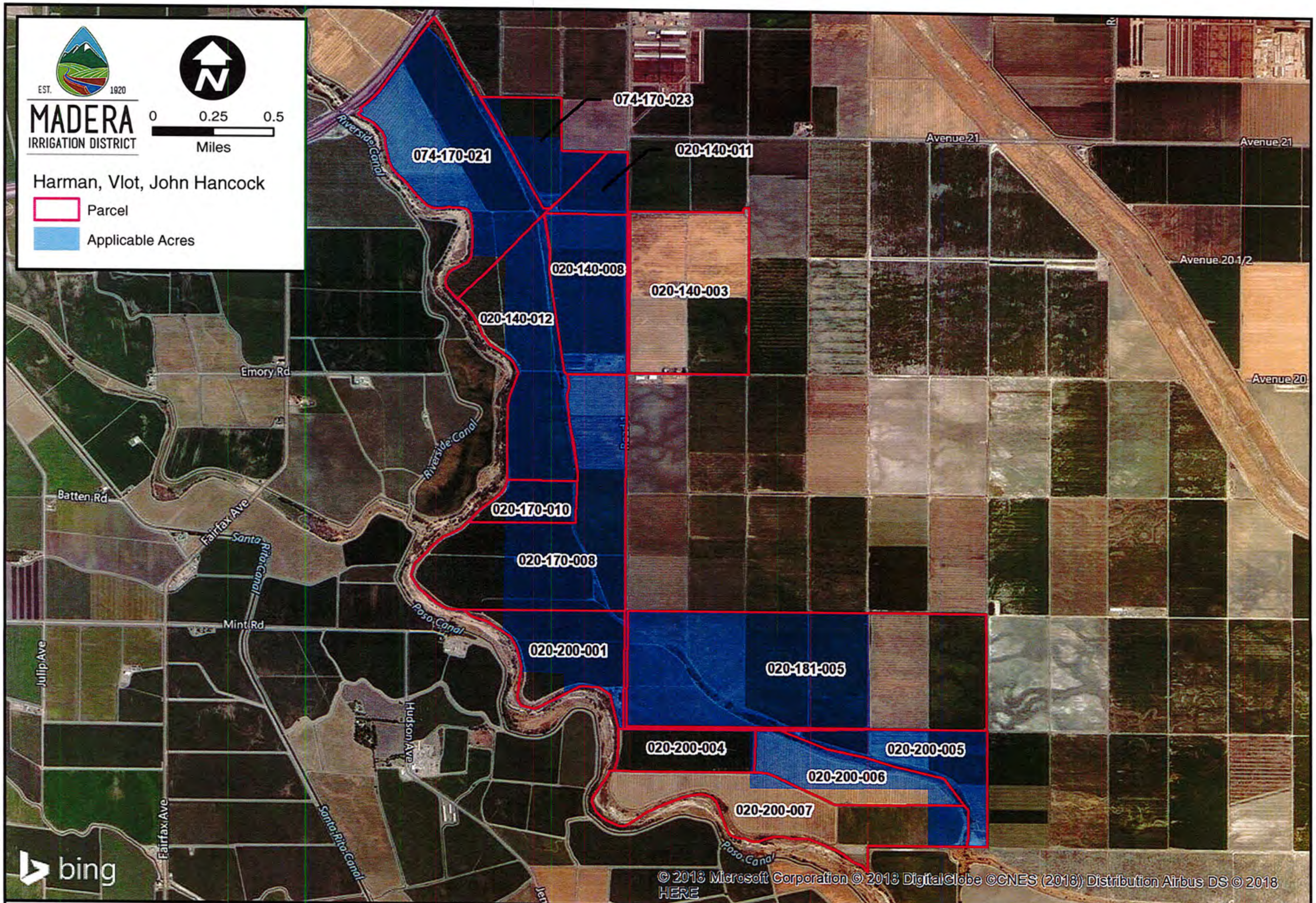

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MID Special Board Meeting – Fresno River Workshop

November 5, 2018 from 10:00 a.m. - 12:00 p.m.

Madera County Office of Education, Conference Center Rooms 3 & 4

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MADERA IRRIGATION DISTRICT

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EST. 1920
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October 25, 2018

GSO Priority Mail

Menefee River Ranch
1624 East Pacheco Blvd
Los Banos, CA 93635

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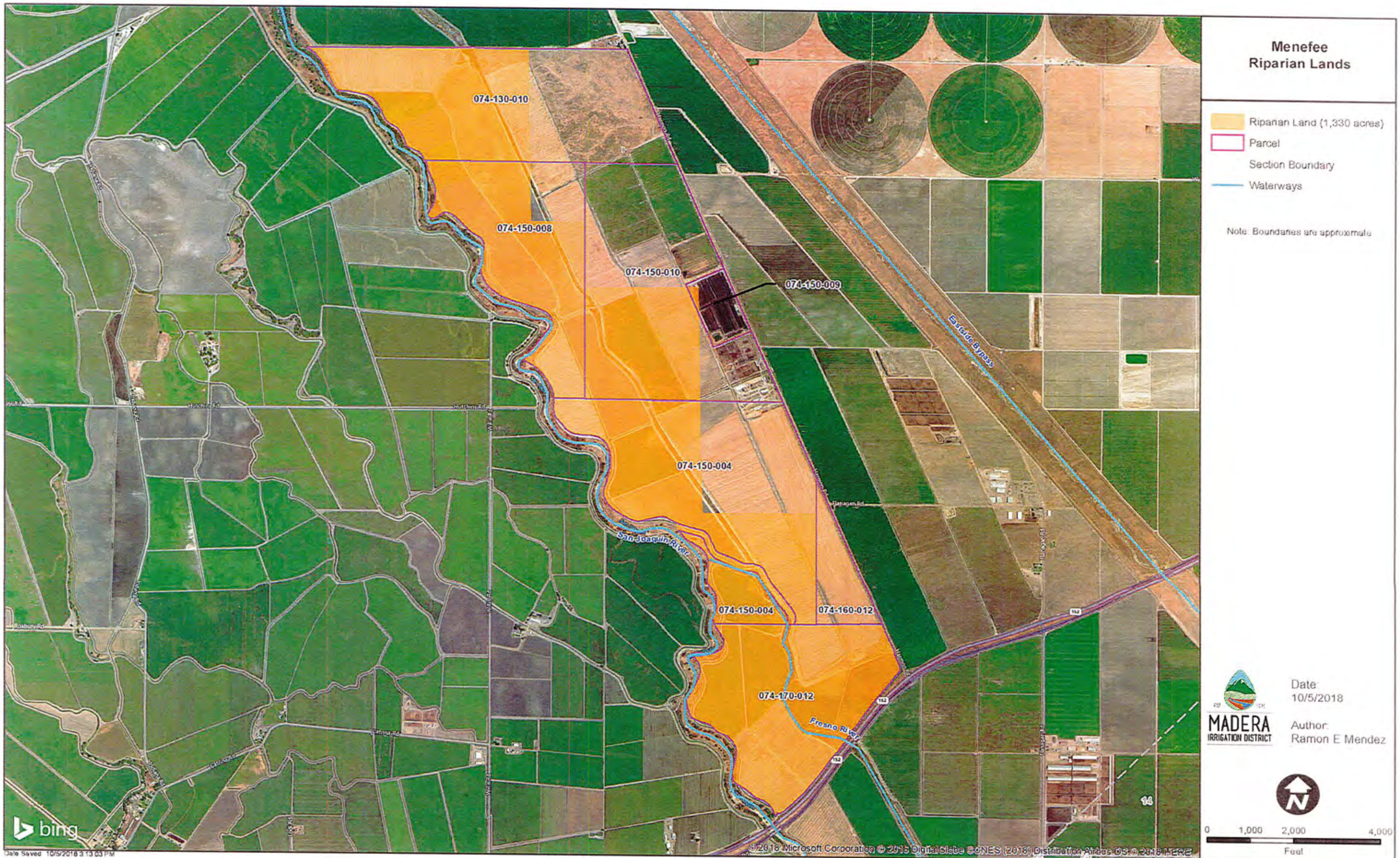

Date Saved: 10/5/2018 3:13:03 PM

Document Path: F:\ENGINEERING\Riparian\GIS\WJH Mapping\11 x 17 Maps.mxd

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Name: Menefee

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Riparian / Appropriative Acres 1,330

Crop / Land Use	Acres	Cover Crop	Irrigation Type
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
		Yes / No	Drip / Sprinkler / Surface / Other
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2. **ADJOURNMENT**

Date Submitted: 11/8/2019

Submitted By: Trent Ebaugh, Community Outreach Coordinator, Food Commons Fresno/Road 20 Farm

Address: Food Commons Fresno Office; 202 Van Ness Ave, Fresno, CA 93721
Road 20 Farm; 13886 Road 20, Madera, CA 93637

Phone Number/Email: (559) 674-2642 ext. 711
trent@foodcommonsfresno.org

Located in Groundwater Sustainability Agency (GSA) : MID

Affiliation: Irrigated Ag, Other: 501(c) 3

Chapter No./ Page No. of GSP: Chapter 4, page 8.

Comments: Road 20 Farm and Food Commons Fresno are against the potential of a land retirement policy for the implementation of demand reduction. Both Road 20 Farm and Food Commons Fresno are opposed to the potential measure because we acknowledge the potential for this measure to harm or cease our operations entirely. Additionally, are agricultural operations and management provide both a positive economic impact on the local community, as well as contribute greatly to the biological diversity and ecosystem health of Madera County. Road 20 Farm employs over 25 people, and based on the economic multiplier effect, contribute approximately 2.5-3 million to the local economy. Environmental benefits of our farm and land management include providing crucial habitat for pollinators, as well as increasing the biological diversity of madera county based on our crop and flora diversity, and regenerative practices.

OFFICE OF
FRESNO IRRIGATION DISTRICT

TELEPHONE (559) 233-7161
FAX (559) 233-8227
2907 S. MAPLE AVENUE
FRESNO, CALIFORNIA 93725-2208

YOUR MOST VALUABLE RESOURCE - WATER

November 8, 2019

Via U.S. Mail and E-Mail (E-Mail Address)

Ms. Stephanie Anagnoson, Director
Water and Natural Resources Department
Madera Subbasin GSA
C/O Madera County
200 W. 4th Street, Third Floor
Madera, CA 93637

Re: <u>Madera Subbasin Joint Draft Groundwater Sustainability Plan</u>

Dear Ms. Anagnoson:

The Fresno Irrigation District (FID) submits this letter to the County of Madera regarding the draft Joint Groundwater Sustainability Plan (GSP) prepared for purposes of the Sustainable Groundwater Management Act (SGMA).

Leading our region in water resources management, FID is a founding member of the North Kings Groundwater Sustainability Agency (NKGSA), which is adjacent to the Madera Subbasin. The NKGSA is one of the seven groundwater sustainability agencies (GSAs) within the Kings Subbasin. Other NKGSA members include the cities of Fresno, Clovis, and Kerman, Fresno County, Bakman Water Company, Biola Community Services District, International Water District, Garfield Water District, and the Fresno Metropolitan Flood Control District. FID makes up a significant portion of the NKGSA and consists of disadvantaged communities, private well owners, and other landowners. Since 1920, FID has proudly delivered water to agricultural and urban communities within Fresno County. Today, FID encompasses over 245,000 acres of prime farmland and municipal areas, including the cities of Fresno and Clovis. As one of the premier irrigation districts in the Central Valley, FID is extensively involved in a host of local, state and federal water issues.

FID appreciates the opportunity to comment on the Madera Subbasin Joint GSP. FID is concerned about the Madera Subbasin governing board adopting the draft GSP. Due to significant deficiencies as described below, FID urges the Madera Subbasin to delay adoption of the GSP and address the issues described below, and summarized as follows:

- The Madera Subbasin draft GSP indicates there is approximately 69,400 AF of historical and current inflow and with no project actions, the amount of inflow increases to 108,200 AF at 2040, which the GSP defines as the Subbasin's sustainability goal. With projects implemented and completed, the inflow is reduced to approximately 21,400 AF between 2040 and 2090.
- The GSP demonstrates the Madera Subbasin will not achieve the sustainable yield or groundwater sustainability within SGMA's mandatory 20-year period, primarily due to the Madera Subbasin miscalculating the annual overdraft deficit when accounting for the inflow and failing to address how the Subbasin will mitigate the overdraft deficit including starting mitigation during the first year of GSP implementation. The Madera County GSA does indicate they will initiate their demand management program in year one but the details are being finalized. This could result in a reduction in demand of about 2%, which does not account for the total boundary flow of approximately 69,400 AF.
- The Madera Subbasin GSP infers that the Madera Subbasin encroaches on approximately 69,400 AF of water per year within the NKGSA's boundary which drains into the Madera Subbasin.
- FID, including the other NKGSA member agencies and stakeholders, intends to capture and recapture water (as has been historically and currently occurring), whether surface water, groundwater, or recharge water, which the Madera Subbasin's draft GSP indicates is flowing into the Madera Subbasin and is a benefit to the Madera Subbasin through 2040. This practice is unlawful, inequitable and inappropriate by the Madera Subbasin.
- Time still remains to correct these deficiencies prior to the January 31, 2020, deadline for submitting the GSP to the California Department of Water Resources (DWR).

Ultimately, the Madera Subbasin GSP contains deficiencies arising to a definition of sustainability in the Madera Subbasin that is improperly reliant on boundary flows from FID and the NKGSA, which may vary but more importantly, that are not abandoned by FID nor the NKGSA nor its other member agencies or stakeholders. Accordingly, the Madera Subbasin GSAs must not make claim to that water.

FID and the NKGSA looks forward to continuing to collaborate with the Madera Subbasin GSAs on the correction of the concerns contained in this letter. Please contact me at (559) 233-7161 should you have any questions.

Sincerely,

William R. Stretch

Bill Stretch
General Manager

cc: Madera Irrigation District GSA
Root Creek Water District GSA
Madera County GSA
Gravelly Ford Water District GSA
City of Fresno - Michael Carbajal
County of Fresno – Bernard Jimenez

MADERA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN (GSP) COMMENT FORM

Please complete the following information to provide comments on the draft Madera Subbasin GSP. Type or print legibly for your comments to be considered.

Please return this form to (hand delivery, mail, or email accepted):

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637
Email: MaderaGSPComments@maderacounty.com

Date Submitted: November 8, 2019

Submitted By: Molly Thurman

Address: 301 East Main Street, Turlock, CA 95380

Phone Number / Email: (661) 204-0568 / mthurman@hnrg.com

APNs: ______

Located in Groundwater Sustainability Agency (GSA):
☒ Madera County ☐ MID ☐ City of Madera ☐ MWD ☐ Other ______

Affiliation: ☒ Irrigated Ag ☐ Non-Irrigated Ag ☐ Rural Residential
☐ Disadvantaged Community Member ☐ Agency/Government ☐ Other ______

Chapter No. / Page No. of GSP: General

Comments:
Hancock Farmland Services (HFS) would like to thank you for the momentous amount of work that has been put into the Draft Madera Subbasin Groundwater Sustainability Plan (GSP). We especially appreciate the acknowledgement of the vitality of the agriculture industry in the local economy. In an effort to bolster the Draft GSP we provide the following comments:

Chapter No. / Page No. of GSP: Section 4.4 & 4.4.4, Pages 4-30 & 4-40

Comments:

HFS applauds Madera County's efforts to work with stakeholders in developing specific details of a demand management policy. We encourage the GSAs in the basin to initiate a stakeholder-driven process to develop a methodology for establishing landowner-level allocations of native yield that are coordinated across the basin. The allocation methodology should be consistent with various legal considerations drawn from applicable case law and attempt to be consistent with groundwater rights, recognizing that GSAs do not have statutory authority to make a final determination of water rights. An equal-per-gross acre approach to allocations is not likely to be consistent with established water rights doctrine, which must recognize many equitable considerations, in addition to acreage owned, to determine a legally defensible allocation. Further information regarding allocation methodology can be found in Groundwater Pumping Allocations Under California's Sustainable Groundwater Management Act – EDF and NCWL, dated July, 2018.

Chapter No. / Page No. of GSP: Section 4.4.4.2, Page 4-41

Comments:

HFS encourages the development of a coordinated basin-wide data management system (DMS) that is capable of tracking groundwater and surface water use at the landowner, field, or parcel level, and a coordinated methodology for measuring landowner-level use of groundwater. The DMS should also include, or be capable of interfacing with, a groundwater market platform that allows for individual users to conduct transactions. Markets are essential in facilitating the highest and best use of a limited resource and will be most effective if there is trust in the accuracy of measurements and consistency in data sources, and flexibility available to allow for transactions across the basin.

Chapter No. / Page No. of GSP: Section 4.4.4.2, Page 4-41

Comments:

While HFS encourages the use of remote sensing to calculate crop evapotranspiration (ET) as a measurement of consumptive use, we also request the development of methodologies and quality assurance elements to allow for grower provided information to be included into the ET calculation and calibration. These methodologies should be developed in consultation with the vendor providing ET data to ensure it is applicable and useful in creating the best available data set. Additionally, GSAs should establish criteria and procedures to address apparent inaccuracies in the ET calculations. An obvious use of the procedure would be in instances where the grower can demonstrate that applied water, plus precipitation, is less than the calculated ET. In these instances, and subject to any requirements established by the GSA, the grower's use of groundwater should be reduced to the applied water total as the ET calculation should not be greater than applied water.

Chapter No. / Page No. of GSP: Section 4.4.4.2, Page 4-41

Comments:

The GSA should implement pumping restrictions only if necessary to achieve sustainability when supported by the best available data and appropriate analytical tools and implement such reductions by gradually ramping down pumping over the implementation period to avoid a sudden disruption in economic activity. The ramp down schedule should include an initial period where current levels of pumping can continue as data is gathered and potential water supply projects are pursued. As with native yield allocations, ramp down schedules should be developed in a coordinated manner across the basin. Any imposed pumping restrictions should be “eased” or “flexed” during drought periods provided that overdraft during those periods can be replenished.

Chapter No. / Page No. of GSP: Section 4.4.4.2, Page 4-41

Comments:

The GSP lacks sufficient detail in defining how potential reductions will be applied, measured, enforced and responded to if not met. These are critical details that must be addressed. For example, what is the baseline pumping period that the reductions will be applied to? At a minimum, the baseline period should be multiple years to avoid unnecessary and perhaps unintended penalization of lands in redevelopment or not yet in full demand due to planting schedules. Additionally, there is no significant discussion of how use will be measured and calculated, or of the costs to perform these activities.

Chapter No. / Page No. of GSP:

Comments:

MADERA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN (GSP) COMMENT FORM

Please complete the following information to provide comments on the draft Madera Subbasin GSP. Type or print legibly for your comments to be considered.

Please return this form to (hand delivery, mail, or email accepted):

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637
Email: MaderaGSPComments@maderacounty.com

Date Submitted: 10/22/19

Submitted By: James "Paul" Provenzano

Address: 30898 Donald Ave Madera, CA 93636

Phone Number / Email: 559-232-9249 provenzanopc@aol.com

APNs: 035-431-008

Located in Groundwater Sustainability Agency (GSA):
☒ Madera County ☐ MID ☐ City of Madera ☐ MWD ☐ Other ______

Affiliation: ☐ Irrigated Ag ☐ Non-Irrigated Ag ☒ Rural Residential
☐ Disadvantaged Community Member ☐ Agency/Government ☐ Other ______

Chapter No. / Page No. of GSP: 5-27 3D (Appendix)

Comments: - See attached -

Comments regarding the Madera County Groundwater Sustainability Plan

1. Section 2-57 The plan as drafted deletes all of the 2015 data from the San Joaquin Valley Water Year Index. The reason given is that the 1989 through 2014 data is more representative of the long term average as compared to the 1989 through 2015 data analysis of precipitation, unimpaired flows and CVP supplies. The problem with deleting the data is that the data actually occurred not once but twice in the data set (also in 1997) and there is near certainty that the event actually occurred. Generally deletion of data is reserved for cases where there is questionable data or a low degree of certainty that the event occurred. This deletion increases the amount of water thought to be available when in fact it is not really there.
2. The plan itself is heavily dependent on the purchase of available surface water and the construction of water recharge facilities. There is substantial risk of either the cost of water increases above a reasonable economic threshold or is simply not available. In recent years the amount of available surface water available for farming and recharge has been cut due to reallocations to environmental purposes. The plan also requires the construction of recharge facilities. These could quite possibly be delayed or face hurdles (environmental, economic, or governmental) that are quite literally impossible to overcome. In short there is a lot of uncertainty of the ability to implement this part of the plan.
3. The domestic well mitigation program is wholly inadequate it currently stands. In appendix 3D the cost of the domestic well program is slated to cost only $277,000 per year. The assumptions are an administrative cost of $150,000, a cost per well of $30,000 and an additional contingency of 30%. A total of 240 impacted wells (over the 20 year implementation period?) That would equal 12 per year on average (240 divided by 20). Upon query I was told that not all the wells would be reimbursed. This does not make sense. It would seem that all impacted wells would have to be replaced. In any case by my calculations there is only a budget for about 4 wells. The total available is $277,000 less $150,000 equals $127,000. Take the $127,000 divide it by $30,000 per well and you come up with 4.23 wells. I felt this might be a little low so I spoke with my own personal well driller who drilled 108 wells per year in the Ranchos area. While not all of these wells are replacements the vast majority are. In addition there are several other well drillers so the real number is substantially over 100 wells not 4.

   The data used to determine the number of wells impacted is faulty. Between 2012 and 2015 I drilled a new well along with two neighbors. We all used different licensed contractors. I attempted to locate these wells in the Department of Water Resources database and they could not be found. Alternate data needs to be used to determine the number of impacted wells such as the Madera County Environmental Health Department and even the well drillers themselves. When I built my own residence in 2000 the well was drilled to a depth of 300 feet with a water level of 120 feet. In November of 2014 I drilled a new well that was 600 feet deep because the original well was dry. The water level was recently measured by DWR and found to be 330 feet deep. This would indicate a groundwater level drop of 11 feet per year. I believe the actual number of impacted wells is far greater than the GSP analysis indicates and a budget of $277,000 will be inadequate to reimburse the impacted wells. In conclusion the data showing the well depths, water level and decline in water levels is inadequate and needs to be revised.

Sincerely Submitted,

J Paul Provenzano

30898 Donald Avenue

Madera CA 93636

Stephanie Anagnoson

From:	Jeannie Habben
Sent:	Wednesday, April 17, 2019 1:10 PM
To:	MaderaGSPComments
Subject:	Comment - Suggestion for the Madera Subbasin GSP - Chapter one
Follow Up Flag:	Follow up
Flag Status:	Flagged

Comment on Chapter One of the GSP – Madera Subbasin –
Section – List of Abbreviations:

- The list should appear with the abbreviation first, followed by the definition
- i.e.; ET – evapotranspiration

Reason: If a person is looking up the meaning of an abbreviation, they would not look it up by the meaning – they don't know what that is.

(it is currently written – definition/meaning first)

Jeannie Habben | Deputy Director of Water & Natural Resources
WATER AND NATURAL RESOURCES DEPARTMENT
200 W. 4th Street, Suite 4200, Madera, CA 93637
Office: 559-675-7703 Ext. 2358 | Cell: (559) 598-0421

November 8, 2019

Sent via email to MaderaGSPComments@maderacounty.com

Re: Comments on Draft Groundwater Sustainability Plan for Madera Groundwater Basin

To Whom It May Concern,

On behalf of the above-listed organizations, we would like to offer the attached comments on the draft Groundwater Sustainability Plan for the Madera Groundwater Basin. Our organizations are deeply engaged in and committed to the successful implementation of the Sustainable Groundwater Management Act (SGMA) because we understand that groundwater is a critical piece of a resilient California water portfolio, particularly in light of our changing climate. Because California's water and economy are interconnected, the sustainable management of each basin is of interest to both local communities and the state as a whole.

Our organizations have significant expertise in the environmental needs of groundwater and the needs of disadvantaged communities.

- The Nature Conservancy, in collaboration with state agencies, has developed several tools[1] for identifying groundwater dependent ecosystems in every SGMA groundwater basin and has made that tool available to each Groundwater Sustainability Agency.
- Local Government Commission supports leadership development, performs community engagement, and provides technical assistance dealing with groundwater management and other resilience-related topics at the local and regional scales; we provide guidance and resources for statewide applicability to the communities and GSAs we are working with directly in multiple groundwater basins.
- Audubon California is an expert in understanding wetlands and their role in groundwater recharge and applying conservation science to develop multiple-benefit solutions for sustainable groundwater management.
- American Rivers is committed to restoring damaged rivers and conserving clean water for people and nature.

[1] https://groundwaterresourcehub.org/

- Clean Water Action and Clean Water Fund are sister organizations that have deep expertise in the provision of safe drinking water, particularly in California's small disadvantaged communities, and co-authored a report on public and stakeholder engagement in SGMA[2].

Because of the number of draft plans being released and our interest in reviewing every plan, we have identified key plan elements that are necessary to ensure that each plan adequately addresses essential requirements of SGMA. A summary review of your plan using our evaluation framework is attached to this letter as Appendix A. Our hope is that you can use our feedback to improve your plan before it is submitted in January 2020.

This review does not look at data quality but instead looks at how data was presented and used to identify and address the needs of disadvantaged communities (DACs), drinking water and the environment. In addition to informing individual groundwater sustainability agencies of our analysis, we plan to aggregate the results of our reviews to identify trends in GSP development, compare plans and determine which basins may require greater attention from our organizations.

Key Indicators

Appendix A provides a list of the questions we posed, how the draft plan responds to those questions and an evaluation by element of major issues with the plan. Below is a summary by element of the questions used to evaluate the plan.

1. Identification of Beneficial Users. This element is meant to ascertain whether and how DACs and groundwater-dependent ecosystems (GDEs) were identified, what standards and guidance were used to determine groundwater quality conditions and establish minimum thresholds for groundwater quality, and how environmental beneficial users and stakeholders were engaged through the development of the draft plan.
2. Communications plan. This element looks at the sufficiency of the communications plan in identifying ongoing stakeholder engagement during plan implementation, explicit information about how DACs were engaged in the planning process and how stakeholder input was incorporated into the GSP process and decision-making.
3. Maps related to Key Beneficial Uses. This element looks for maps related to drinking water users, including the density, location and depths of public supply and domestic wells; maps of GDE and interconnected surface waters with gaining and losing reaches; and monitoring networks.
4. Water Budgets. This element looks at how climate change is explicitly incorporated into current and future water budgets; how demands from urban and domestic water users were incorporated; and whether the historic, current and future water demands of native vegetation and wetlands are included in the budget.
5. Management areas and Monitoring Network. This element looks at where, why and how management areas are established, as well what data gaps have been identified and how the plan addresses those gaps.
6. Measurable Objectives and Undesirable Results. This element evaluates whether the plan explicitly considers the impacts on DACs, GDEs and environmental beneficial users in the development of Undesirable Results and Measurable Objectives. In addition, it examines

[2] https://www.cleanwater.org/publications/collaborating-success-stakeholder-engagement-sustainable-groundwater-management-act

whether stakeholder input was solicited from these beneficial users during the development of those metrics.

7. Management Actions and Costs. This element looks at how identified management actions impact DACs, GDEs and interconnected surface water bodies; whether mitigation for impacts to DACs is discussed or funded; and what efforts will be made to fill identified data gaps in the first five years of the plan. Additionally, this element asks whether any changes to local ordinances or land use plans are included as management actions.

Conclusion

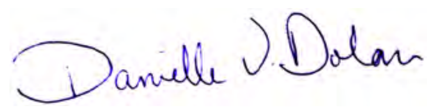
We know that SGMA plan development and implementation is a major undertaking, and we want every basin to be successful. We would be happy to meet with you to discuss our evaluation as you finalize your Plan for submittal to DWR. Feel free to contact Suzannah Sosman at suzannah@aginnovations.org for more information or to schedule a conversation.

Sincerely,

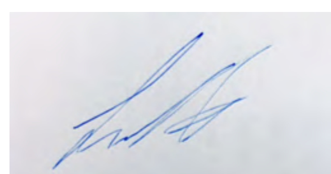
Jennifer Clary
Water Program Manager
Clean Water Action/Clean Water Fund

Samantha Arthur
Working Lands Program Director
Audubon California

Sandi Matsumoto
Associate Director, California Water Program
The Nature Conservancy



Danielle V. Dolan
Water Program Director
Local Government Commission



Lisa Hunt, Ph.D.
Director of California River Restoration Science
American Rivers

Groundwater Basin/Subbasin: Madera Subbasin (DWR 5-22.06)
GSA: City of Madera GSA, Madera County GSA, Madera Irrigation District GSA, and Madera Water District GSA
GSP Date: August 2019 Public Review Draft

1. Identification of Beneficial Users

Were key beneficial users identified and engaged?

Selected relevant requirements and guidance:
GSP Element 2.1.5, "Notice & Communication" (§354.10):
(a) A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.
GSP Element 2.2.2, "Groundwater Conditions" (§354.16):
(d) Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes.
(f) Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or the best available information.
(g) Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.
GSP Element 3.3, "Minimum Thresholds" (§354.28):
(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.

Review Criteria		Yes	No	N/A	Relevant Info per GSP	Location (Section, Page[1])
1. Do beneficial users (BUs) identified within the GSP area include:	a. Disadvantaged Communities (DACs)	X			"Disadvantaged communities: Fairmead Community and Friends, La Vina Residents, Líderes Campesinas, etc."	Table 2-5, page 79 - 80
	b. Tribes	X			"Federally Recognized Tribes and non-Federally Recognized Tribes with lands or potential interests in Madera Subbasin: • North Fork Rancheria of Mono Indians of California • Picayune Rancheria of Chukchansi Indians • North Fork Band of Mono Indians"	
	c. Small community public water systems (<3,300 connections)	X			"Small water systems" is listed in Table 2-5 Stakeholder Engagement Chart for GSP Development, but it is not clear what water systems are included, and how many connections they have.	
2. What data were used to identify presence or absence of DACs?	a. DWR DAC Mapping Tool[2]		X		The data source of identifying DACs is not specified.	
	i. Census Places			X		
	ii. Census Block Groups			X		
	iii. Census Tracts			X		
	b. Other data source	X			The draft GSP does not clearly show all the DACs within the GSP area. The data source of identifying DACs is not specified. The draft GSP states that	3.3.1.1, page 183

[1] Page numbers refer to the page of the PDF.
[2] DWR DAC Mapping Tool: https://gis.water.ca.gov/app/dacs/

					"Communications received from representatives of disadvantaged communities included a letter dated June 27, 2019 from the Leadership Council."	
3. Groundwater Conditions section includes discussion of:	a. Drinking Water Quality	**X**			"Maps of available groundwater quality data for a variety of constituents were prepared to characterize groundwater quality in the Subbasin. Key groundwater quality constituents discussed below include nitrate, total dissolved solids (TDS), and arsenic. … Nitrate presents health concerns at high concentrations and is regulated in public drinking water systems. The U.S. Environmental Protection Agency (USEPA) has established a maximum contaminant level (MCL) for nitrate (as nitrogen) of 10 mg/L under its National Primary Drinking Water Regulations; this MCL standard is established for public health reasons and is a requirement of all public drinking water systems…Arsenic is a naturally occurring chemical found in groundwater and has a primary MCL of 10 µg/L. … Most notably, maps of DBCP, EDB, 1,2,3-TCP, perchlorate, PCE, and BTEX concentrations all indicate areas with wells exceeding the respective drinking water MCLs."	2.2.2.3, page 96
	b. California Maximum Contaminant Levels (CA MCLs)[3] (or Public Health Goals where MCL does not exist, e.g. Chromium VI)	**X**				
4. What local, state, and federal standards or plans were used to assess drinking water BUs in the development of Minimum Thresholds (MTs)?	a. Office of Environmental Health Hazard Assessment Public Health Goal (OEHHA PHGs)[4]		**X**			
	b. CA MCLs[3]	**X**			"The cause of basin groundwater conditions that would result in significant and unreasonable degraded water quality is implementation of a GSP project or management action that causes concentrations of key groundwater quality constituents to increase to concentrations exceeding the minimum thresholds, which are set at the MCLs for drinking water for identified key constituents (10 mg/L for nitrate as nitrogen; 500 mg/L for TDS; 10 ug/L for arsenic) or when existing or historical concentrations for the key constituents already exceed the MCL, the minimum threshold is set at the recent concentration plus 20 percent. … Significant and unreasonable degradation of water quality occurs when beneficial uses for groundwater are adversely impacted by constituent concentrations increasing to levels above the drinking water MCLs for one of the key constituents (nitrate, arsenic, TDS) previously identified in Chapter 2 (Plan Area and Basin Setting) of the GSP at indicator wells in the representative groundwater quality monitoring network due to implementation of a GSP project or management action. When existing or historical concentrations for the key constituents already exceed the MCL, the minimum threshold is set at the recent concentration plus 20 percent." "The cause of basin groundwater conditions that would result in significant and unreasonable degraded water quality is implementation of a GSP project	3.3.4, page 191; 3.3.4, page 199

[3] CA MCLs: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html
[4] OEHHA PHGs: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html

				or management action that causes levels of key groundwater quality constituents to increase to concentrations exceeding the MCLs for drinking water. Municipal and domestic supply (MUN) is a designated beneficial use for groundwater in the Plan area; therefore, groundwater quality degradation is considered significant and unreasonable based on adverse impacts to this beneficial use. Locally defined significant and unreasonable conditions were determined based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives.”	
c. Water Quality Objectives (WQOs) in Regional Water Quality Control Plans		**X**			
d. Sustainable Communities Strategies/ Regional Transportation Plans[5]		**X**			
e. County and/or City General Plans, Zoning Codes and Ordinances[6]		**X**			
5. Does the GSP identify how environmental BUs and environmental stakeholders were engaged throughout the development of the GSP?	**X**			“The SMC presented in this chapter were developed using information from stakeholder and public input and correspondence with the GSAs, public meetings, hydrogeologic analysis, groundwater dependent ecosystem analysis, and meetings with GSA technical representatives. The general process for establishing SMC included: ● GSA public meetings that outlined the GSP development process and introduced stakeholders to the SMC ● Conducting GSP public meetings to present proposed methodologies to establish minimum thresholds and measurable objectives and receive additional public input. Two public meetings on SMC were held in the Plan area ● Reviewing public input on preliminary SMC methodologies with GSA staff/technical representatives. ● Providing a Draft GSP for public review and comment Establishing and modifying minimum thresholds, measurable objectives, and definition of undesirable results based on feedback from public meetings, public/stakeholder review of the Draft GSP, and input from GSA staff/technical representatives.” “The methodology to develop minimum thresholds for groundwater levels was based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, individual public/stakeholder input to various GSA representatives, and a meeting with DWR54.”	3, page 163 3.3.1.1, page 183
Summary/ Comments					

[5] CARB: https://ww2.arb.ca.gov/resources/documents/scs-evaluation-resources
[6] OPR General Plan Guidelines: http://www.opr.ca.gov/planning/general-plan/

The draft GSP states that the comments from representatives of DACs are considered, and examples of DACs are listed in the Table 2-5 Stakeholder Engagement Chart for GSP Development. However, the draft GSP does not provide a detailed description of how the DACs were identified, the names and locations of all of the communities, or any further details of the population in the communities or how they use groundwater. Without this information, it is not clear how the GSP can identify and consider the needs of these DAC beneficial users. It is recommended the GSP provide a map of all DAC areas; the DWR DAC Mapping Tool can be used to help identify the locations of these communities and their populations: https://gis.water.ca.gov/app/dacs/ . The GSP should also identify what community water systems are present in the subbasin, and describe the users and population that rely on these systems for drinking water supply.

The GSP should modify the stakeholder list associated with the Environmental and Ecosystem Uses category to include the appropriate agencies and list of environmental groups. To identify environmental users, the GSP should refer to the following:
- Natural Communities Commonly Associated with Groundwater dataset (NC Dataset) - https://gis.water.ca.gov/app/NCDatasetViewer/
- The list of freshwater species in the subbasin can be found here:
https://groundwaterresourcehub.org/sgma-tools/environmental-surface-water-beneficiaries/. The GSP should take particular note of the species with protected status.

2. Communications Plan

How were key beneficial users engaged and how was their input incorporated into the GSP process and decisions?

Selected relevant requirements and guidance:
GSP Element 2.1.5, "Notice & Communication" (§354.10):
Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:
(c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.
(d) A communication section of the Plan that includes the following:
(1) An explanation of the Agency's decision-making process.
(2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.
(3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.
(4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

DWR Guidance Document for GSP Stakeholder Communication and Engagement[7]

Review Criteria	Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Is a Stakeholder Communication and Engagement Plan (SCEP) included?	X			"To facilitate stakeholder involvement in the GSA process, a Stakeholder Communication and Engagement Plan (Appendix 2) was created for the GSAs in the Madera Subbasin … This plan was originally developed in June 2018 and has been updated several times since then." "Stakeholder Communication and Engagement Plan June 2018 (updated October 2018)"	2.1.5.1, page 78; Appendix 2.C
2. Does the SCEP or GSP identify that ongoing engagement will be conducted during GSP implementation?	X			"3.Management elements include GSP decision-making, funding, implementation and enforcement." "It is critical that stakeholders and beneficial users are provided regular opportunities for their input to be incorporated into GSA governance and decision-making processes, and that they understand exactly how they are able to contribute to the GSP planning and implementation processes. Stakeholder engagement opportunities include but are not limited to: … iii. Public workshop or roundtable content includes but is not limited to: … d) Opportunities for interested parties to participate in the development and implementation of the GSP (i.e., technical workshops on specific GSP components)"	Appendix 2.C;

[7] DWR Guidance Document for GSP Stakeholder Communication and Engagement
https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Guidance-Document-for-Groundwater-Sustainability-Plan---Stakeholder-Communication-and-Engagement.pdf

				"Madera Subbasin GSAs recognize that stakeholder input into the development and implementation of a GSP is critical for GSP acceptance and successful implementation, as well as a SGMA requirement. As such, Stakeholder Roundtables have been identified as the best method to incorporate Madera Subbasin stakeholder/beneficial user input into the GSP development and implementation process." "Administrative costs generally include coordination meetings, reporting, record keeping, bookkeeping, legal advice, continued outreach to stakeholders, and government relations. GSAs will also need to continue to monitor projects and management actions to assess their benefit, economic feasibility, and coordinate with stakeholders and other GSAs if modification of projects and management actions is necessary to ensure the Subbasin meets sustainability objectives." "However, GSAs expect to evaluate other project ideas proposed by stakeholders, assess cost-effectiveness of proposed projects, and evaluate the joint implementation of multiple projects to ensure the GSP continues to meet sustainability objectives."	 5.1.1, page 273; 5.1.4, page 275
3. Does the SCEP or GSP specifically identify how DAC beneficial users were engaged in the planning process?	X			"There were a number of different meetings at which the public had the opportunity to engage during the GSP development process: ● **GSA meetings**: Each of the seven GSAs in the Madera Subbasin held regular public meetings, generally on a monthly schedule and in many cases in conjunction with standing board meetings. ● **Coordination Committee meetings:** The intent of the Coordination Committee was to provide a forum to GSAs to share perspectives and participate in review and discussion of elements for GSP development. The Coordination Committee membership included representatives from each of the coordinating GSAs and meetings were often attended by representatives from the other GSAs in the subbasin. ● **Subbasin-wide technical workshops:** Subbasin-wide public workshops were held throughout the GSP development process to provide opportunities for the public to learn about the SGMA process and GSP components, receive updates about GSP planning activities, and provide input on GSP development. These "technical workshops" often included presentations by the GSP preparation consultants about technical aspects of GSP preparation, on topics such as basin setting, water budgets, and undesirable results. ● **County Advisory Committee**: The Madera County GSA was supported by an advisory committee which consisted of members from different demographic groups and communities. The Advisory Committee provided feedback on GSP development to the board of the Madera County GSA as well as relaying information back to the communities to which the committee members belong. The County Advisory Committee met quarterly in 2018 and bi-monthly in 2019. ● **MID Groundwater Committee**: MID GSA was supported by a groundwater committee comprised of two MID Board Members. The MID Groundwater	Section 2.1.5.3, page 80

				Committee was utilized to provide input and recommendations to the MID Board of Directors and the MID GSA on matters pertaining to the GSA and GSP planning process. The MID Groundwater Committee meetings were scheduled as needed in 2017-2019. **Figure 2-8** describes the GSP process steps, including topic development, technical review, and public meetings both at the Subbasin and individual level:" "There were also activities related to encouraging involvement and building capacity for engagement, including the following activities organized in coordination with Self-Help Enterprises and the Leadership Counsel for Justice and Accountability: ● **Capacity-building workshops**: Workshops encouraged and prepared community members to participate in GSP development by providing technical information as well as information about opportunities for engagement. ● **Pop-ups**: Information about SGMA and opportunities for engagement in Madera Subbasin GSP preparation were provided through pop-up information stations in locations such as the Madera County Library to invite people to attend workshops and meetings. ● **Educational tours**: Tours provided members of the public with additional opportunities to hear about the concerns of people with differing perspectives. Tours included stops in the community of Fairmead, La Vina, a farm, and at a groundwater recharge basin. **Presentations in communities**: Self-Help Enterprises and the Leadership Counsel for Justice and Accountability both encouraged participation in GSP preparation through presentations held in communities around the Subbasin."	 Section 2.1.5.3, page 81
4. Does the SCEP or GSP explicitly describe how stakeholder input was incorporated into the GSP process and decisions?	X			"The Madera Subbasin Coordinating GSAs shall be the primary decision-making bodies for the Madera Subbasin. These GSAs shall coordinate and develop recommendations for GSA decision-making through a Coordination Committee. GSAs and their staff representatives will engage with Subbasin stakeholders through the strategies outlined in this plan to help inform the GSAs' decisions, including public participation stakeholder roundtables, GSP workshops, and public comment during Coordination Committee meetings and GSA Board meetings. While the Coordination Committee provides recommendations on GSP development, the GSA Boards shall serve as the final decisionmakers for the Madera Subbasin. The following schematic (Figure 1) demonstrates the processes and opportunities for input that are intended to guide decision-making and stakeholder engagement in the Madera Subbasin." "The Engagement Matrix, in Appendix 2, provides details about the implementation of each of the communication methods outlined above. The matrix presents each communication strategy, as required by statute or laid out in the Madera Subbasin Communication and Engagement Plan, along with details about specific instances of that strategy. For example, each public GSP-related meeting is listed with information about the date, topic, and	Appendix 2.C; 2.1.5.4, page 83;

				location of the meeting as well as how it was publicized, to whom it was targeted, what opportunities for feedback were provided, and who participated. "The methodology to develop minimum thresholds for groundwater levels was based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, individual public/stakeholder input to various GSA representatives, and a meeting with DWR54. Stakeholder input has included substantial verbal and written comments from representatives of disadvantaged communities, which has been meaningfully considered in development of this GSP."	3.3.1.1, page 183

Summary/ Comments

The GSP describes the methods used to disseminate information and how stakeholder input was incorporated.

3. Maps Related to Key Beneficial Uses

Were best available data sources used for information related to key beneficial users?

<u>Selected relevant requirements and guidance:</u>
GSP Element 2.1.4 "Additional GSP Elements" (§354.8):
Each Plan shall include a description of the geographic areas covered, including the following information:
(a) One or more maps of the basin that depict the following, as applicable:
(5) The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information.

<u>GSP Element 3.5 Monitoring Network (§354.34)</u>
(b) Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:
(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:
(1) Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:
(A) A sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.
(4) Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.
(6) Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:
(A) Flow conditions including surface water discharge, surface water head, and baseflow contribution.
(B) Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.
(C) Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.
(D) Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.
(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:
(3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.

Review Criteria		Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Does the GSP Include Maps Related to Drinking Water Users?	a. Well Density	X			"The densities of domestic, irrigation, and public supply wells per section within the Madera Subbasin are shown in Figures 2-520,2-621, and 2-722 respectively."	2.1.1, page 66
	b. Domestic and Public Supply Well Locations & Depths	X			"Maps of the average depths of domestic, agricultural, and public supply wells by section are provided in Figures 2-44, 2-45, and 2-46."	2.2.1.5, page 88

	i. Based on DWR Well Completion Report Map Application[8]?	**X**			"Notably, the number of wells reported by section were determined from Well Completion Report (WCR) data provided by DWR. These numbers include only reported wells and may not reflect the total number of existing or active wells in the subbasin."	2.1.1, page 66
	ii. Based on Other Source(s)?		**X**			
2. Does the GSP include maps related to Groundwater Dependent Ecosystem (GDE) locations?	a. Map of GDE Locations	**X**			Figure 2-73a. GDE units and depth to groundwater in the Madera Subbasin Figure 2-73b. Fresno River Riparian GDE Unit Figure 2-73c. Sumner Hill potential GDE Unit, Friant Riparian GDE Unit, and upstream portion of San Joaquin River Riparian GDE Unit Figure 2-73d. San Joaquin River Riparian GDE Unit, downstream portion "GDEs may also occur in areas where regional groundwater levels are deeper than 30 feet but shallower perched groundwater exists atop bedrock or another type of aquitard; however, these types of GDEs would generally not be impacted by pumping of groundwater supply wells." The GSP discounts the perched water zones as derived from surface water, and therefore they were not considered in evaluation of GDEs. "A DTW cutoff of 30 feet was used in the initial screening of potential GDEs. The use of a 30-foot DTW criterion to identify potential GDEs is based on reported maximum rooting depths of California phreatophytes and is consistent with guidance provided by The Nature Conservancy (Rohde et al. 2018) for identifying potential GDEs."	Figures 2-73a-2-73d, page 68-71 in the Chpt 2 Figure package 2.2.2.6, page 100 2.2.2.6, page 100
	b. Map of Interconnected Surface Waters (ISWs)		**X**		The GSP provides maps of depth to groundwater contours (Figures 2-71 and 2071), but does not specify where the ISWs are located. As shown in Figures 2-71 and 2-72, depth to groundwater is greater than 100 feet in 2014 and 2016 across much of the Subbasin. However, areas in upstream reaches of the Fresno River and San Joaquin River show depths to groundwater within 20-30 feet in 2014. "A review of historical regional aquifer groundwater levels compared to stream thalweg (deepest portion of stream channel) elevations conducted for this study indicate that surface water – groundwater interactions are not a significant issue (i.e., regional groundwater levels are relatively far below creek thalweg elevations) along Berenda Creek, Dry Creek, the Fresno River, and Cottonwood Creek in Madera Subbasin." "It is likely that seepage from the San Joaquin River is the source of water combined with the presence of shallow clay layers, which serves to maintain shallow groundwater levels at these locations."	Figures 2-71-2-72, page 66-67 in the Chpt 2 Figure package 2.2.2.5, page 98 2.2.2.5, page 99
	i. Does it identify which reaches are gaining and which are losing?		**X**		See above. The GSP does not clearly describe the ISWs by stream segments or seasonality.	See above.
	ii. Depletions to ISWs are quantified by stream segments.		**X**			

[8] DWR Well Completion Report Map Application: https://www.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37

	iii. Depletions to ISWs are quantified seasonally.		X			
3. Does the GSP include maps of monitoring networks?	a. Existing Monitoring Wells	X			Figure 3.F-1 shows the Supplemental Groundwater Level Monitoring Network, which includes wells from CASGEM, DWR voluntary, and USBR. "The overall proposed monitoring network for groundwater levels, comprised of wells monitored for CASGEM, by GSAs, and by USBR is provided in Appendices 3.A and 3.F. … A map of the Plan area showing the overall groundwater level monitoring network is provided in Appendix 3.F, along with a table listing each well."	Figure 3.F-1, Appendix 3, Page 88 3.5.1.1, page 202
	b. Existing Monitoring Well Data sources: i. California Statewide Groundwater Elevation Monitoring (CASGEM)	X				
	ii. Water Board Regulated monitoring sites	X				
	iii. Department of Pesticide Regulation (DPR) monitoring wells		X			
	c. SGMA-Compliance Monitoring Network	X			"Figures 3-5 and 3-6 illustrate the locations of the wells selected as representative monitoring sites for monitoring of groundwater levels in the Upper and Lower aquifers, respectively (composite wells are included in Figure 3-1)." "The selected RMS for groundwater quality are listed in Table 3-7 and shown on Figure 3-2."	3.5.1.1, page 202; 3.5.1.4, page 207
	i. SGMA Monitoring Network map includes identified DACs?		X			
	ii. SGMA Monitoring Network map includes identified GDEs?		X			

Summary/ Comments

Providing maps of the monitoring network overlaid with location of DACs, domestic wells, community water systems, GDEs, and any other sensitive beneficial users will allow the reader to evaluate the adequacy of the network to monitor conditions near these beneficial users.

Based on the information presented in the draft GSP, it is not clear how representative the monitoring network is for domestic well users. The GSP should therefore explain how the proposed monitoring network is adequate to monitor conditions for these sensitive beneficial users.

The draft GSP proposes "a potential for future addition of up to 27 monitoring wells from the 2019 nested well installation program" but does not identify the location of these potential wells on maps (Section 3.5.1.1).The GSP should explicitly describe any future representative monitoring wells and identify the proposed locations and depths. When assessing the monitoring network data gaps, the GSP should consider the locations of beneficial users, including DACs, small water systems, and domestic wells.

The GSP should provide clear evidence of hydraulic disconnection where shallow groundwater is considered perched or identify hydraulic connection as a data gap. In addition, the GSP should consider perched water as a shallow aquifer, because even though it may not be pumped at present, it could be in the future.

Areas with depth to groundwater greater than 30 feet can serve as a water source to some plants, e.g. oak trees, in the dry part of the year. The depth criterion of 30 feet is presented as a criterion for inclusion, not a standalone criterion for exclusion. In other words, if groundwater is within 30 feet of the ground surface, then a GDE can be identified. If it is not, then further analysis must be conducted.

Figures 2-71 and 2-72: the GSP should provide more details on how depth to groundwater contour maps were developed.

- Are the wells used for interpolating depth to groundwater sufficiently close (<5km) to NC Dataset polygons to reflect local conditions relevant to ecosystems?

- Are the wells used for interpolating depth to groundwater screened within the surficial unconfined aquifer and capable of measuring the true water table?
- Is depth to groundwater contoured using groundwater elevations at monitoring wells to get groundwater elevation contours across the landscape? This layer can then be subtracted from land surface elevations from a Digital Elevation Model (DEM) to estimate depth-to-groundwater contours across the landscape. This will provide much more accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found. Depth to groundwater contours developed from depth to groundwater measurements at wells assumes that the land surface is constant, which is a poor assumption to make. It is better to assume that water surface elevations are constant in between wells, and then calculate depth to groundwater using a DEM of the land surface to contour depth to groundwater.

The GSP uses depth to water maps from 2014 and 2016; 2016 is after the SGMA benchmark date of January 1, 2015. It should focus on groundwater condition data prior to the SGMA benchmark date instead. The GSP should use depth to groundwater data from multiple seasons and water year types (e.g., wet, dry, average, drought) to determine the range of depth to groundwater around NC dataset polygons. It should refer to TNC's guidance on Identifying GDEs Under SGMA (https://groundwaterresourcehub.org/public/uploads/pdfs/TNC_NCdataset_BestPracticesGuide_2019.pdf) for best practices for developing depth to groundwater contours. If insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons in the GSP until data gaps are reconciled in the monitoring network.

The GSP should further explain how NC Dataset polygons adjacent to the San Joaquin River were retained or removed as potential GDEs. On Appendix 2.B, Figure 1 polygons are shown as removed based on depth to groundwater greater than 30 feet, but the groundwater depth contours (Figures 2-71 and 2-72) do not show enough detail to make this distinction. The GSP should also consider retaining all NC Dataset polygons adjacent to the San Joaquin River due to the essential ecosystem function that the riparian vegetation community performs for the critical habitat of the Chinook salmon. As shown on Appendix 2.B, Figure 1, it appears that there is one potential GDE unit in light green on the far western border of the Subbasin. The GSP should describe further and clarify if this is indeed a polygon from the NC Dataset that was kept as a potential GDE.
It is recommended that the GSP should obtain groundwater data before concluding that there are no adverse impacts to the GDE Unit and make plans to address this data gap in the Monitoring section of the GSP.

ISWs are best estimated by first determining which reaches are completely disconnected from groundwater. This approach would involve comparing groundwater elevations with a land surface DEM that could identify which surface waters have groundwater consistently below surface water features, such that an unsaturated zone would separate surface water from groundwater. Groundwater elevations that are always deeper than 50 feet below the land surface can be used to identify the above ground reaches as disconnected surface waters. The GSP should provide further evidence, such as a cross-sections or corresponding hydrographs, to show the relationship between the river channel and the depth to groundwater at wells near the Fresno River and San Joaquin river to improve ISW mapping. Where data gaps exist regarding the existence of ISWs, make plans to reconcile them in the Monitoring section. It should also provide estimates of current and historical surface water depletions for the San Joaquin River, quantified and described by reach, season, and water year type. Provide a discussion of the expected effect of the San Joaquin River Restoration Program (SJRRP) on flows, GDEs and ISWs along the San Joaquin River. To improve ISW mapping, it should reconcile data gaps (shallow monitoring wells, stream gauges, and nested/clustered wells) along surface water features in the Monitoring Network section of the GSP to address the temporal connectedness of ISWs with groundwater.

4. Water Budgets

How were climate change projections incorporated into projected/future water budget and how were key beneficial users addressed?

Selected relevant requirements and guidance:
GSP Element 2.2.3 “Water Budget Information” (Reg. § 354.18)
Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.

Projected water budgets shall be used to estimate future baseline conditions of supply, ***demand****, and aquifer response to Plan implementation, and to identify the uncertainties of these projected water budget components. The projected water budget shall utilize the following methodologies and assumptions to estimate future baseline conditions concerning hydrology, water demand and surface water supply availability or reliability over the planning and implementation horizon:*
(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:
(5) If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.
(6) The water year type associated with the annual supply, demand, and change in groundwater stored.
(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:
(1) Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, ***water demand****, and land use information.*

DWR Water Budget BMP[9]
DWR Guidance for Climate Change Data Use During GSP Development and Resource Guide[10]

Review Criteria	Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Are climate change projections explicitly incorporated in future/ projected water budget scenario(s)?	X			“Two primary projected water budget scenarios were considered: a projected without projects (no action) scenario, and a projected with projects scenario. Both these projected scenarios were also considered in the context of potential climate change effects on surface water supply and weather parameters.”	2.2.3.2, page 150
2. Is there a description of the methodology used to include climate change?	X			“To evaluate sensitivity to climate change, projected water budgets were also developed using: 1. Historical hydrologic data from water years 1965-2015 adjusted by DWR-provided 2030 mean climate change factors 2. Historical water supply data from 1989-2015 adjusted similarly by climate change factors, with additional adjustment of CVP supply based on projected alteration of available Friant Releases by the	2.2.3.2, page 118

[9] DWR BMP for the Sustainable <management of Groundwater Water Budget:
https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-4-Water-Budget.pdf
[10]DWR Guidance Document for the Sustainable Management of Groundwater Guidance for Climate Change Data Use During GSP Development:
https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Climate-Change-Guidance_Final.pdf

					San Joaquin River Restoration Program 3. 2017 land use adjusted for urban area projected growth from 2017 through 2070 (areas were held constant from 2071 through 2090)"	
3. What is used as the basis for climate change assumptions?	a. [DWR-Provided Climate Change Data and Guidance](https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Resource-Guide-Climate-Change-Guidance_v8.pdf)[11]	X			See above	2.2.3.2, page 118
	b. Other	X			See above	2.2.3.2, page 118
4. Does the GSP use multiple climate scenarios?			X			
5. Does the GSP quantitatively incorporate climate change projections?		X			"Water budgets were projected into the future to estimate future water demands under different future scenarios and to evaluate the potential effects of different management actions and implementation of different projects. Two primary projected water budget scenarios were considered: a projected without projects (no action) scenario, and a projected with projects scenario. Both these projected scenarios were also considered in the context of potential climate change effects on surface water supply and weather parameters …. The development of projected timeseries for precipitation, evapotranspiration, and surface water flows are briefly summarized in Tables 2-27 and 2-28 below." Table 2-33. Comparative Summary of Annual Supply, Demand, and Change in Storage by Water Year Type (Acre-Feet per Year) (23 CCR §354.18(b)(6)).	2.2.3.4, page 151 Table 2-33, page 157
6. Does the GSP explicitly account for climate change in the following elements of the future/projected water budget?	a. Inflows: i. Precipitation	X			Table 2-26. Comparative Summary of all Water Budget Scenarios, Annual Average Volumes by Flow Path (Acre-Feet). Table 2-27 Development of Projected Future Precipitation and Evapotranspiration Timeseries includes the climate change adjustments for precipitation.	Table 2-26, page 148 Table 2-27, page 152
	ii. Surface Water	X			Table 2-26. Comparative Summary of all Water Budget Scenarios, Annual Average Volumes by Flow Path (Acre-Feet). Table 2-28. Development of Projected Future Surface Water Supply Timeseries includes the climate change adjustments for surface water inflows.	Table 2-26, page 148 Table 2-28, page 152
	iii. Imported Water	X			Table 2-26. Comparative Summary of all Water Budget Scenarios, Annual	Table 2-26, page 148

[11] DWR Guidance Document for the Sustainable Management of Groundwater Guidance for Climate Change Data Use During GSP Development:
https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Climate-Change-Guidance_Final.pdf
DWR Resource Guide DWR-Provided Climate Change Data and Guidance for Use During GSP Development:
https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Resource-Guide-Climate-Change-Guidance_v8.pdf

						Average Volumes by Flow Path (Acre-Feet).	
		iv. Subsurface Inflow	X			Table 2-26. Comparative Summary of all Water Budget Scenarios, Annual Average Volumes by Flow Path (Acre-Feet).	Table 2-26, page 148
	b. Outflows:	i. Evapotranspiration	X			Table 2-26. Comparative Summary of all Water Budget Scenarios, Annual Average Volumes by Flow Path (Acre-Feet). Table 2-27 Development of Projected Future Precipitation and Evapotranspiration Timeseries includes the climate change adjustments for evaporation. Table 2-28. Development of Projected Future Surface Water Supply Timeseries includes the climate change adjustments for surface water diversions and bypasses.	Table 2-26, page 148 Table 2-27, page 152 Table 2-28, page 152
		ii. Surface Water Outflows (incl. Exports)	X				
		iii. Groundwater Outflows (incl. Exports)		X			
7. Are demands by these sectors (drinking water users) explicitly included in the future/projected water budget?	a. Domestic Well users (<5 connections)			X		The draft GSP does not specifically identify the amount of water demand associated with drinking water users separate from other groundwater pumping in the future water budget.	
	b. State Small Water systems (5-14 connections)			X			
	c. Small community water systems (<3,300 connections)			X			
	d. Medium and Large community water systems (> 3,300 connections)			X			
	e. Non-community water systems			X			
8. Are water uses for native vegetation and/or wetlands explicitly included in the current and historical water budgets?				X		Groundwater Extraction by Water Use Sector "Estimates of groundwater extraction by water use sector are provided in Figure 2-88 and Table 2-23. For agricultural and urban (urban, industrial, and semi-agricultural) lands, groundwater extraction represents pumping, while for native lands, groundwater extraction by riparian vegetation was considered to be negligible because of the depth to groundwater in the subbasin. Groundwater extraction is dominated by irrigated agriculture, varying substantially from year to year based on variability in surface water supplies and crop water demands. In the Land Surface System component of the water budget, ET is split into ET of applied water and ET of precipitation (Table 2-11). ET of groundwater is not included.	2.2.3.4, page 142 Table 2-11, page 112
9. Are water uses for native vegetation and/or wetlands explicitly included in the projected/future water budget?				X		"Estimates of groundwater extraction by water use sector are provided in Figure 2-88 and Table 2-23. For agricultural and urban (urban, industrial, and semi-agricultural) lands, groundwater extraction represents pumping, while for native lands, groundwater extraction by riparian vegetation was considered to be negligible because of the depth to groundwater in the subbasin."	2.2.3.2, page 142

Summary/ Comments

Given the uncertainties of climate change, it is appropriate to analyze the impacts of climate change for a range of scenarios (e.g., a mild effects scenario and a high (worst case) effects scenario). Therefore, it is recommended the GSP also includes the DWR-provided 2070 climate change factors to represent a high climate change scenario.

The GSP also does not provide specifics on drinking water demands separated by large urban water systems, domestic well users, or community water systems in the historical, current or future water budgets. This information should be provided for full transparency of the assumptions, data, and results of the water budgets. The GSP should include information on the methods used to estimate urban pumping including reported data (if any), population estimates used, per capita water use estimates used, and the areas and users of the subbasin represented by the urban pumping water budget component. The GSP should include information on how the changes in urban pumping were determined for the projected water budget and how these changes may impact small community water systems and domestic well users. The GSP should also discuss how the urban water demands presented in historical the water budget related to the historical water demands reported by the City of Madera in its Urban Water Management Plans. Due to the presence of GDEs in the Madera Subbasin, the GSP should quantify the evapotranspiration from groundwater by riparian vegetation. It should also include ET of groundwater in the water budget or explain where it is included.

5. Management Areas and Monitoring Network

How were key beneficial users considered in the selection and monitoring of Management Areas and was the monitoring network designed appropriately to identify impacts on DACs and GDEs?

Selected relevant requirements and guidance:
GSP Element 3.3, "Management Areas" (§354.20):

(b) A basin that includes one or more management areas shall describe the following in the Plan:
(2) The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.
(3) The level of monitoring and analysis appropriate for each management area.
(4) An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable.
(c) If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas.

CWC Guide to Protecting Drinking Water Quality under the SGMA[12]
TNC's Groundwater Dependent Ecosystems under the SGMA, Guidance for Preparing GSPs[13]

Review Criteria	Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Does the GSP define one or more Management Area?		X		The draft GSP identifies that Management Areas would be discussed in Section 2.2.4 (Table 1-6), but there is no Section 2.2.4 in the GSP. It is assumed there is no Management Area defined explicitly in the draft GSP.	
2. Were the management areas defined specifically to manage GDEs?			X		
3. Were the management areas defined specifically to manage DACs?			X		
a. If yes, are the Measurable Objectives (MOs) and MTs for GDE/DAC management areas more restrictive than for the basin as a whole?			X		
b. If yes, are the proposed management actions for GDE/DAC management areas more restrictive/ aggressive than for the basin as a whole?			X		
4. Does the GSP include maps or descriptions indicating what DACs are located in each Management Area(s)?			X		
5. Does the GSP include maps or descriptions indicating what GDEs are located in each Management Area(s)?			X		
6. Does the plan identify gaps in the monitoring network for DACs and GDEs?		X		Data gaps are not discussed in regards to DAC locations. "Data gaps relative to GDEs can be characterized as incomplete information	3.5.4.2, page 216

[12] CWC Guide to Protecting Drinking Water Quality under the SGMA: https://d3n8a8pro7vhmx.cloudfront.net/communitywatercenter/pages/293/attachments/original/1559328858/Guide_to_Protecting_Drinking_Water_Quality_Under_the_Sustainable_Groundwater_Management_Act.pdf?1559328858
[13] TNC's Groundwater Dependent Ecosystems under the SGMA, Guidance for Preparing GSPs: https://www.scienceforconservation.org/assets/downloads/GDEsUnderSGMA.pdf

				on the extent to which the vegetation composing the Fresno River Riparian and San Joaquin River Riparian GDE units may be impacted by occurrence of temporary short-term declines in shallow groundwater levels below historical lows. Additionally, uncertainty exists with respect to the source of shallow groundwater supporting the wetlands and vegetation composing the Sumner Hill potential GDE Unit and its potential to be affected by changes in future groundwater conditions. Biological monitoring, recommended every five years, will be used to evaluate potential beneficial or adverse effects on GDEs that may be related to changes in future groundwater conditions during the Implementation and Sustainability Periods."	
a. If yes, are plans included to address the identified deficiencies?	X			"Temporal data gaps will begin to be filled by more regular collection of data as part of the GSP, and installation of transducers in new nested monitoring wells." "Biological monitoring, recommended every five years, will be used to evaluate potential beneficial or adverse effects on GDEs that may be related to changes in future groundwater conditions during the Implementation and Sustainability Periods.	3.5.4.2, page 216

Summary/ Comments

Tables 1-1 and 1-6 identify that management areas are discussed in Section 2.2.4. However, Section 2.2.4 does not appear to be included in the GSP and there is no other section discussing management areas. Therefore, it is assumed that the GSAs have not identified any management areas.

If management areas are defined in the future, care should be taken so that they and the associated monitoring network are designed to adequately assess and protect against impacts to all beneficial users, including GDEs and DACs.

There are no upper aquifer or composite RMS wells located in the northern, central or southeastern portions of the subbasin, indicating that current monitoring network lacks adequate coverage for domestic wells in those areas, including those in the communities of Fairmead and Chowchilla (both DACs), Storey, Lake Madera Country Estates, and the area north of Madera. Therefore, based on the information presented in the draft GSP, it is not clear how representative the monitoring network is for domestic well users. The GSP should therefore explain how the proposed monitoring network is adequate to monitor conditions for these sensitive beneficial users.

The GSP should discuss whether there are data gaps in the monitoring networks for DACs and provide maps showing the monitoring network in relation to locations of the DACs and GDEs, so that the public may review the adequacy of the monitoring network to monitor for impacts to these beneficial users.

6. Measurable Objectives, Minimum Thresholds, and Undesirable Results

How were DAC and GDE beneficial uses and users considered in the establishment of Sustainable Management Criteria?

<u>Selected relevant requirements and guidance:</u>
GSP Element 3.4 "Undesirable Results" (§ 354.26):
(b) The description of undesirable results shall include the following:
(3) Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results

GSP Element 3.2 "Measurable Objectives" (§ 354.30)
(a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.

Review Criteria	Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Are DAC impacts considered in the development of Undesirable Results (URs), MOs, and MTs for groundwater levels and groundwater quality?		X		WL MO "Measurable objectives for groundwater levels were calculated as the model-derived average groundwater levels over the Sustainability Period from 2040 to 2090, modified if necessary, to account for occasional offsets between historically observed and modeled groundwater levels." WQ MO "Measurable objectives for groundwater quality are established to not exacerbate adverse impacts on all beneficial uses of groundwater resulting from implementation of GSP projects or management actions. Measurable objectives for the groundwater quality sustainability indicator are intended to assure that GSP projects and management actions do not cause groundwater quality conditions to become unsuitable for any beneficial use, especially municipal and domestic supply uses since these are the most restrictive from a water quality standpoint. The groundwater quality measurable objectives 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. … The measurable objective concentrations for wells with existing or historical water quality results are the average of the recent concentrations for each of the key constituents rounded up to the nearest full integer of concentration for arsenic (in units of µg/L) and nitrate (in units of mg/L as nitrogen) and rounded up to the nearest interval of 50 mg/L for TDS." WL MT "The development of minimum thresholds for chronic lowering of groundwater levels included review of the hydrogeologic conceptual	3.2.1.1, page 166; 3.2.4.1, page 173; 3.3.1, page 180; 3.3.4, page 191;

				model, climate, current and historical groundwater conditions including groundwater level trends and groundwater quality, land subsidence, and the water budget discussed in previous sections of this GSP." WL UR "The chronic lowering of groundwater levels undesirable result is a quantitative combination of groundwater elevation minimum threshold exceedances. A minimum threshold exceedance for a given RMS is two consecutive Fall measurements (assumed to be collected in October) that are both below the minimum threshold level. For the Plan GSAs, a groundwater elevation undesirable result is defined to occur when greater than 30% of the representative monitoring sites each exceed the groundwater level minimum thresholds for the same two consecutive Fall readings." WQ UR "The cause of basin groundwater conditions that would result in significant and unreasonable degraded water quality is implementation of a GSP project or management action that causes concentrations of key groundwater quality constituents to increase to concentrations exceeding the minimum thresholds, which are set at the MCLs for drinking water for identified key constituents (10 mg/L for nitrate as nitrogen; 500 mg/L for TDS; 10 ug/L for arsenic) or when existing or historical concentrations for the key constituents already exceed the MCL, the minimum threshold is set at the recent concentration plus 20 percent." "Therefore, an undesirable result for degraded groundwater quality occurs when groundwater quality exceeds an established MCL and minimum threshold 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 minimum threshold 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 minimum threshold for a given constituent related to GSP actions."	3.4.1, page 197; 3.4.4, page 199
2. Does the GSP explicitly discuss how stakeholder input from DAC community members was considered in the development of URs, MOs, and MTs?	X			"The methodology to develop minimum thresholds for groundwater levels was based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, individual public/stakeholder input to various GSA representatives, and a meeting with DWR. Stakeholder input has included substantial verbal and written comments from representatives of disadvantaged communities, which has been meaningfully considered in development of this GSP."	3.3.1.1, page 183;

				"Municipal and domestic supply (MUN) is a designated beneficial use for groundwater in the Plan area; therefore, groundwater quality degradation resulting from a GSP project or management action is considered significant and unreasonable based on adverse impacts to this beneficial use. Locally defined significant and unreasonable conditions were determined based on discussion with GSA staff and technical representatives, and input received from interested stakeholders and the public through public meetings and through individual stakeholder input to various GSA representatives." "Locally defined significant and unreasonable conditions were determined based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives."	3.3.4, page 191; 3.4.1, page 196; 3.4.4, page 199
3. Does the GSP explicitly consider impacts to GDEs and environmental BUs of surface water in the development of MOs and MTs for groundwater levels and depletions of ISWs?		X		The GSP does not explain how GDEs were considered in the development of MOs and MTs.	3.2.1.1, page 166-171 3.2.5, page 176-179
4. Does the GSP explicitly consider impacts GDEs and environmental BUs of surface water and recreational lands in the discussion and development of Undesirable Results?		X		Section 3.4 Undesirable Results This section only describes undesirable results relating to human beneficial uses of groundwater and neglects environmental beneficial uses that could be adversely affected by chronic groundwater level decline. Table 3-8 Summary of MTs, MOs, and Undesirable Results "The undesirable result for groundwater levels is defined as more than 30 percent of RMS exceeding their minimum thresholds for the same two consecutive Fall readings. The 30 percent criterion was selected to balance the interest of beneficial use with the practical aspect of groundwater management uncertainty. Given a total of 37 RMS sites, a total of 12 or more the initial RMS would need to exceed MTs as defined above to constitute an undesirable result for chronic lowering of groundwater levels."	3.4, page 195-196 Table 3-8, page 196 3.4.1, page 197
5. Does the GSP clearly identify and detail the anticipated degree of water level decline from current elevations to the water level MOs and MTs?	X			There are more than forty separate hydrograph figures in Appendix 3 showing the MTs/MOs compared to measured water levels. This could be presented more clearly in an overview figure, instead of over forty hydrograph figures. Table 3-6. Summary of Groundwater Level Minimum Thresholds for Representative Monitoring Sites	Figures, Appendix 3, page 5-45 Table 3-6, page 181
6. If yes, does it include: b. Is this information presented in table(s)?		X		Although Table 3-6 presents Groundwater Level Minimum Threshold values, it does not tabulate the current groundwater level or the anticipated water level decline if MTs are reached.	
c. Is this information presented on map(s)?		X			
d. Is this information presented relative to the locations of DACs and domestic well users?		X			
e. Is this information presented relative to the		X			

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		locations of ISW and GDEs?					
2.	Does the GSP include an analysis of the anticipated impacts of water level MOs and MTs on drinking water users?			X		A limited analysis is performed and identified in Appendix 3, but little detail on the methodology or results of the analysis is provided. No maps identifying the location of impacted wells are included. "Overall agricultural land use and users will be significantly impacted in terms of increased costs to design and construct recharge projects and in terms of reduced crop yields from required reductions in consumptive use for irrigation. While conversion of current agricultural lands to urban areas that may occur in the future will tend to reduce per acre water demands, it is likely that urban water users will need to continue water conservation efforts due to limited water supplies. Domestic well owners can generally expect declining groundwater levels during the initial 10 to 15 years of the Implementation Period, followed by stabilization of water levels during the latter portion of the Implementation Period and some potential recovery in groundwater levels after 2040. However, significant adverse impacts to domestic wells from declining groundwater levels are expected to be addressed through a temporary domestic well mitigation program currently under consideration by the GSAs (Appendix 3.D)." Appendix 3.D provides the cost benefits of two scenarios, one is the baseline without SGMA (meaning no projects or management actions) and baseline with SGMA ("assuming that the GSP already implements water supply and recharge projects as soon as practical, the analysis focuses on demand management implementation as a possible means to speed the trajectory toward sustainable yield."). It is not clear how MTs and MOs will play a role in either of the scenarios.	3.3.1.4, page 186 Appendix 3.D, page 77-84
3.	If yes:	a. On domestic well users?		X		"315 domestic wells are impacted in the without-SGMA analysis, but 87 of those appear to be impacted prior to the 2020 implementation start (DTW is greater than minimum depth to top perforation)." The GSP does not clearly assess the well impacts associated with MOs and MTs. The GSP does not describe how MTs and MOs affect domestic well users.	Appendix 3, page 78;
		b. On small water system production wells?		X		Impacts of the MOs and MTs on small water system production wells are not discussed.	
		c. Was an analysis conducted and clearly illustrated (with maps) to identify what wells would be expected to be partially and fully dewatered at the MOs?		X		No maps or descriptions are provided.	
		d. Was an analysis conducted and clearly illustrated (with maps) to identify what wells would be expected to be partially and fully dewatered at the MTs?		X		No maps or descriptions are provided.	
		e. Was an economic analysis performed to assess	X			"The conclusions of the economic impact analysis of an accelerated	Appendix 3.C,

	the increased operation costs associated with increased lift as a result of water level decline?				demand reduction program are as follows: • Immediate implementation of demand reduction to avoid further lowering of groundwater levels would cause direct farm revenue losses of $182 million per year and require fallowing an average of 40,000 acres per year." "For purposes of this analysis, a replacement cost of $25,000 per well is used. This cost is triggered when the groundwater level in the section the well is located in falls below the minimum depth to top perforation of the domestic wells in that cell." … Most (218) of the replacements are estimated to occur between 2021 and 2067, and the present value (at 2020) of replacement costs for wells is $3.39 million. In the with-SGMA analysis, the number of impacted wells drops from 228 to 43, at a present value cost of $0.77 million. Many of those 43 wells would stay in production longer than in the without-SGMA scenario, so the replacement cost is delayed, further reducing the present value of replacement. Most (185 out of 228) of the wells impacted in the without- SGMA scenario would not require replacement in the draft GSP implementation plan, and the present value of avoided replacement cost is $2.62 million ($3.39 minus $0.77)	Section 6, page 73 Appendix 3.D, section 2.1.1, page 78

Summary/ Comments

Based on the presented information, domestic well uses are considered under URs and for the development of water level MOS and MTs, but DAC members are not explicitly considered. More detail and specifics regarding DAC members, including those that rely on smaller community drinking water systems, not only domestic wells, is necessary to demonstrate that these beneficial users were adequately considered.[14]

If water levels reach the MOs, water levels would *increase* by an average of approximately 22 feet across all RMS wells in the subbasin compared to current conditions (2016), with localized water decreases as much as 72 feet *below* current conditions. At the MTs, water levels at the RMS wells would *decrease* by an average of approximately 64 feet from current conditions. In several communities, this decline is estimated to be over 100 feet from current conditions (COM RMS-2, MCE RMS-2, MWD RMS-1, COM RMS-1). Given that the subbasin is in critical overdraft, the GSP should explain how the projected additional water level declines of over 64 feet on average and over 100 feet near groundwater-dependent communities will result in sustainable conditions for beneficial users.

The draft GSP sets the MTs for water quality constituents as the MCLs or the recent concentration plus 20 percent when existing or historical concentrations already exceed the MCL. However, Table 3-7 shows the MT values for all wells as MCLs, and includes a note that "Values will be confirmed and/or adjusted as needed based on results from initial sampling for constituents. If existing levels exceed the MCL, then the MT is set at the existing concentration plus 20 percent" even for the existing RMS wells. This appears to be

[14] Community Water Center and Stanford School of Earth, Energy, and the Environmental Sciences, *Groundwater Quality in the Sustainable Groundwater Management Act (SGMA): Scientific Factsheet on Arsenic, Uranium, and Chromium,* https://d3n8a8pro7vhmx.cloudfront.net/communitywatercenter/pages/293/attachments/original/1560371896/CWC_FS_GrndwtrQual_06.03.19a.pdf?1560371896; Community Water Center, *Guide to Protecting Drinking Water Quality Under the Sustainable Groundwater Management Act,* https://d3n8a8pro7vhmx.cloudfront.net/communitywatercenter/pages/293/attachments/original/1559328858/Guide_to_Protecting_Drinking_Water_Quality_Under_the_Sustainable_Groundwater_Management_Act.pdf?1559328858.

inconsistent with the MT methodology described in Section 3.3. Therefore, it is not clear what the GSAs intend to use as water quality MTs, and thus how sustainability for water quality is defined for the subbasin.

The draft GSP defines the undesirable result for groundwater levels is defined as more than 30 percent of RMS exceeding their minimum thresholds for the same two consecutive Fall readings. The use of 30 percent to define an undesirable result does not allow for the occurrence of low water levels in one area, such as near a GDE, to be an Undesirable Result, which may impact an environmental beneficial use.

The GSP should present a thorough, robust, and transparent analysis, supported by maps, that identifies: (1) which domestic wells are likely to be impacted at the MTs and at the MOs, and (2) the location of the likely impacted wells with respect to DACs and other communities and systems dependent on groundwater; (3) how small water system production wells will be affected by MOs and MTs; and (4) clearly identify the increased well operation costs for domestic well users and public water systems associated with water level MOs and MTs..

The GSP should similarly analyze the potential impacts of setting minimum thresholds that exceed water quality objectives on domestic wells and community water systems.

The draft GSP should include more detailed information about the potential impacts on sensitive drinking water users, such as 1) where the likely impacted wells are located, 2) what communities are most affected (including DACs), 3) an estimate of the size of the population that relies on these domestic wells, or 4) if the creation a new or expanded community water system could address some or all of the population affected by the loss of domestic wells.

The GSP should add “potential adverse impacts to GDEs” to the list of potential undesirable results presented in Table 3-8 and consider the use of separate management areas for the GDE Units, so that Sustainable Management Criteria protective of GDEs can be established for the GDE Units. It should also elaborate on how the exceedance criteria (30% of RMSs) for chronic lowering of groundwater levels would be applied in a way that is protective of significant and unreasonable harm to GDEs.

The GSP should also discuss any potential undesirable results from degradation of water quality that may impact GDEs and freshwater species in the area.

7. Management Actions and Costs

What does the GSP identify as specific actions to achieve the MOs, particularly those that affect the key BUs, including actions triggered by failure to meet MOs? What funding mechanisms and processes are identified that will ensure that the proposed projects and management actions are achievable and implementable?

Selected relevant requirements and guidance
GSP Element 4.0 Projects and Management Actions to Achieve Sustainability Goal (§ 354.44)
(a) Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.
(b) Each Plan shall include a description of the projects and management actions that include the following:
(1) A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action.

Review Criteria	Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Does the GSP identify benefits or impacts to DACs as a result of identified management actions?		X			
2. If yes: f. Is a plan to mitigate impacts on DAC drinking water users included in the proposed Projects and Management Actions?	X			Appendix 3D is identified as an Economic Analysis and Framework for Potential Domestic Well Mitigation Program. However, the economic analysis does not clearly explain what the "with SGMA" scenario analyzed actually includes (e.g., water levels at MOs, water levels at MTs, or some other assumptions) and the "Draft Outline for Madera Well Mitigation Program" lacks details and specificity. The draft GSP identifies this as a possible program, but does not clearly say that one will be implemented. "This section provides a general outline of a domestic well mitigation program for Madera County (Madera Subbasin). 3.2.1 Well mitigation program policy/purpose statement Define the mission of the program. For example, the purpose of the Madera County Well Mitigation program is to address any unreasonable adverse effects of groundwater pumping on domestic wells in the county. 3.2.2 Definition of unreasonable adverse effects Program should clearly define the types of impacts to domestic wells that will, and will not, be mitigated. 3.2.3 Register domestic wells Develop a database and registration system and allow domestic well owners to sign up (if not already permitted/in the system) 3.2.4 Mitigation measures Define mitigation measures. Other well mitigation programs suggest the following examples: • Domestic wells where municipal water service is not expected to exist in the near future (deepen or replace well) • Domestic wells near existing municipal water service (correct to municipal service)	Appendix 3D Section 3.2
g. Does the GSP identify costs to fund a mitigation program?	X				
h. Does the GSP include a funding mechanism to support the mitigation program?	X				

						• Domestic wells impacted within a small geographic area (develop municipal system to serve the impacted community 3.2.5 Define mitigation costs Define how mitigation fund will pay for each type of impacted domestic well. Other well programs suggest the following examples: • Establish payment of $xx/ft to deepen wells. If well cannot be deepened, establish standard cost to replace well $xx/well • Decide how to compensate well owners that can connect to municipal system • Establish "rapid response" approach for situations when wells go dry 3.2.6 Establish review process Develop a board to review and approve well mitigation claims consistent with the guidelines specified under (1 – 4). Establish process for expedient review. 3.2.7 Financing Program financing through groundwater extraction fees (see above for estimated costs)."	
4.	Does the GSP identify any demand management measures in its projects and management actions?		X			"A demand management (water use reduction) program is described for the Madera County GSA, though the other GSAs within the Subbasin may implement similar programs if needed to attain sustainability. The Madera County GSA's demand management program provides groundwater users a flexible way to meet any future pumping restrictions. … The gross yield across all projects at full implementation (2040) is estimated to generate an average annual yield of over 200,000 AF. This includes the Madera County demand management program (management action) implemented by the Madera County GSA that reduces net groundwater pumping by about 90,000 acre-feet per year by 2040 from current pumping estimates."	4, page 219
5.	If yes, does it include:	a. Irrigation efficiency program		X			
		b. Ag land fallowing (voluntary or mandatory)	X			"Madera County would identify potential easement programs and other sources of funding to incentivize fallowing of irrigated lands." It is not clear whether the land fallowing will be voluntary or mandatory.	4.4.4.2, page 258
		c. Pumping allocation/restriction	X			"Madera County would implement a groundwater allocation program that would directly relate to the overall demand reduction goals necessary to achieve anticipated reductions by 2040. Allocations could be tied to a crop-type or historic use, or could be evenly distributed among existing irrigators or over all lands. Various approaches have differing effects on grower flexibility, County management and administration, and perceptions of equality."	4.4.4.2, page 258
		d. Pumping fees/fines		X			
		e. Development of a water market/credit system	X			"Madera County would establish a local groundwater credit system and allow trading of those credits among groundwater users. The program would establish a full accounting of available groundwater supply, allocation of that water supply to local stakeholders, and a record-keeping system that facilitates and records all trades. Additional conditions on location and timing of the use of traded credits may be needed, and in fact, are likely to be required in many areas."	4.4.4.2, page 258
		f. Prohibition on new well construction		X			

	g. Limits on municipal pumping		X			
	h. Limits on domestic well pumping		X			
	i. Other	X			"Madera County has identified areas within Madera Subbasin where an invasive plant called Arundo donax (Arundo) could be controlled or removed, potentially saving a significant amount of consumptive water use. Arundo is a non-native, fast growing, and dense reed that purportedly has high water consumption. It currently grows primarily in stream channels."	4.4.5.1, page 262;
6. Does the GSP identify water supply augmentation projects in its projects and management actions?		X				
7. If yes, does it include:	a. Increasing existing water supplies	X			"The MWD surface water purchase program provides in-lieu recharge benefits by providing growers with additional surface water supplies imported from inside or outside of the Subbasin. The program is an extension of current MWD practices of purchasing surface water when it is available, but access to surface water has been limited by the diversion facilities currently available to MWD. As part of the GSP development process, MWD has been investigating the ability to access additional surface water supplies." "NSWD GSA has an appropriative water right along the Chowchilla Bypass (referred to as Eastside Bypass/Chowchilla Canal in its water rights permit number 19615) of 15,700 acre-feet/year. Currently, NSWD does not use this water right. With the implementation of SGMA, NSWD intends to fully use the water right and bring 15,700 AF of surface water into NSWD. The water is expected to be available during times of flood flows in the Chowchilla Bypass, about one year out of three. The water may be recharged directly or used for irrigation, thereby providing in-lieu groundwater recharge." "The fourth source of water available for projects is water acquired from willing sellers. This supply is constrained by the capacity to move it from its source to a location of use in Madera County, via existing natural channels or the Madera Canal. Imported water could be purchased from any willing seller anywhere in the Central Valley provided the water can be delivered to Madera County using existing or proposed conveyance facilities, including via exchanges involving three or more parties"	4.1.1, page 222; 4.6.1, page 266; 4.8.4, page 272
	b. Obtaining new water supplies	X			"Madera County would directly acquire or facilitate the acquisition of new surface water supplies that would be available for diversion from Millerton Lake or other sources during the irrigation season. Madera County estimates that 3,500 to 9,000 acre-feet could be acquired in one year, but on average the project would provide about 3,600 acre-feet per year in in-lieu recharge."	
	c. Increasing surface water storage		X			
	d. Groundwater recharge projects – District or Regional level	X			"MID has identified five (5) individual groundwater recharge projects that it has already developed or will develop under the GSP. This includes one rehabilitation project where MID refurbished existing recharge basins that have been underutilized and were in a state of disrepair. MID developed three new recharge basins, including the Ellis Basin, Berry Basin, and Allende Basin. Finally, MID will acquire land and develop approximately 90 acres of new recharge basins by 2030 and another 260 acres by 2040, if needed. Locations	4.2.1.1, page 228;

					and sizes of these new basins will be selected based on land uses, access to delivery facilities, and soils having appropriate percolation rates. Recharge basins are generally distributed throughout the MID service area.” “Through modifications to its existing CVP contract, Madera County would request CVP Section 215 flood water when available, either on its own or partnered with another contractor (Reclamation has previously indicated 215 water would be available in 10,000 acre-foot blocks). Between 2,000 and 10,000 acre-feet per month would be targeted for acquisition when available in wet and above normal years. A total of 20,000 acre-feet would be targeted during wet years, and the expected benefit, averaged over all year types, is about 7,000 acre-feet per year.” “GFWD will develop recharge basins. Water will be diverted from Cottonwood Creek into basins where it will percolate into the deep aquifer. The size, location, and performance of the recharge basins depends on site-specific characteristics that are currently being assessed by GFWD.”	 4.4.2.1, page 251; 4.5.1, page 264
	e. On-farm recharge	X			“MID is developing an On-Farm Recharge Program (referred to as Flood Managed Aquifer Recharge, Flood-MAR, by DWR). This program diverts flows that would have otherwise left the basin onto farms and fields of willing participants (growers) to percolate into the aquifer and provide recharge benefits for the Subbasin. It requires that the GSA has capacity to capture and divert water to growers and requires willing growers to participate in the program. The MID On-Farm Recharge project assumes that growers would operate existing irrigation systems on their fields when MID is able to provide water.”	4.2.2, page 233
	f. Conjunctive use of surface water	X			“The MWD surface water purchase program provides in-lieu recharge benefits by providing growers with additional surface water supplies imported from inside or outside of the Subbasin. The program is an extension of current MWD practices of purchasing surface water when it is available, but access to surface water has been limited by the diversion facilities currently available to MWD. As part of the GSP development process, MWD has been investigating the ability to access additional surface water supplies.” “MID will evaluate programs to encourage more MID growers to utilize surface water supplies instead of groundwater. MID will be conducting studies to identify potential incentive structures and assess the relative costs and benefits of different alternatives. The project benefits MID by reducing groundwater pumping.”	4.1.1, page 222 4.2.3.1, page 240
	g. Developing/utilizing recycled water		X			
	h. Stormwater capture and reuse		X			
	i. Increasing operational flexibility (e.g., new interties and conveyance)	X			MID Pipeline Project and WaterSMART Pipeline Project	
	j. Other	X			“Drywells have been installed in various areas of Madera County. Located on private residential property, dry wells are typically constructed 2 feet in diameter and 50 feet in depth and have served to recharge areas with running	4.4.5.3, page 262

				and standing water. In recent tests, the drywell size was increased to 3 feet in diameter by 75 feet deep in order to increase the recharge capacity and potentially reduce the unit cost of recharge."	
8. Does the GSP identify specific management actions and funding mechanisms to meet the identified MOs for groundwater quality and groundwater levels?	X			Table 4-1. Projects/Management Actions and Water Sources Considered in the Madera Subbasin. Table 4-2. Madera Subbasin Projects and Management Actions. Tables 4-1 and 4-2 lists many projects and management actions to meet the MOs for groundwater levels and their costs. "MWD will finance capital costs of the projects using cash reserves and, as needed, borrowing. Debt service on any borrowed funds plus ongoing O&M will be paid by MWD landowners. MWD imposes an annual assessment and charges its growers volumetrically for water. MWD holds a public hearing each year to set the annual water rate. MWD has also been building its cash reserves to pay for the cost of physical improvements to MWD facilities. If needed, MWD will also go through the Proposition 218 process to request an increase in land-based assessments." "Pursuant to GSP Regulations § 354.44 and § 354.6, MID has evaluated and described the ability to cover project costs. Some projects are complete and other projects are still being assessed, and feasibility studies are being refined or developed, a general description of how MID will cover project costs is presented. MID will conduct economic and fiscal feasibility studies as part of its ongoing planning efforts to better understand willingness and ability to pay for the projects included in the GSP." "MID will pursue available state and federal grants or loans to help construct projects. This may include grant funding for planning studies to support the development of proposed management actions, including its On-Farm Recharge program and incentives to increase surface water deliveries within the district. Operation and maintenance costs will be paid using revenues raised through water rates and/or fees and assessments. MID will conduct the necessary studies and decision processes (including Proposition 218 elections if necessary) to approve rates, fees, or assessments to provide the required funding. MID water users have, in the past, approved assessments to fund projects." Section 4.4.5.3 "Because drinking water quality is of critical importance, Madera County is working with the Regional Water Quality Control Board to develop a process for evaluating the potential of deeper injection wells." "To be useful in meeting sustainability goals, any dry well project would need to demonstrate a right to the water source and that the source is new to the subbasin (e.g. not just recharging water already present that would otherwise recharge through other means)." It is not clear whether the proposed projects and management actions will meet the MOs for water quality.	Table 4-1, page 220 Table 4-2, page 221 4.1.2, page 227 4.2.4, page 244 4.4.5.3, page 263
9. Does the GSP include plans to fill identified data gaps by the first	X			"Some of the spatial data gaps will be filled with installation of the nested	3.5.4.2, page

five-year report?				monitoring wells by 2020 -particularly for the Upper Aquifer and extreme western portion of the Lower Aquifer. Temporal data gaps will begin to be filled by more regular collection of data as part of the GSP, and installation of transducers in new nested monitoring wells. …Biological monitoring, recommended every five years, will be used to evaluate potential beneficial or adverse effects on GDEs that may be related to changes in future groundwater conditions during the Implementation and Sustainability Periods." "Data gaps have been presented in the groundwater level, groundwater storage, land subsidence, and groundwater quality monitoring networks. The following steps will be taken to address these data gaps: ● Madera County is in process of adding seven new nested monitoring well sites with up to three well completions at each site (total of up to 27 new monitoring wells) within the subbasin. These new wells will address many of the data gaps described in the Upper and Lower Aquifers for groundwater level and quality data (Figures 3-1 and 3-2). ● The GSAs will install sampling taps (as needed) on groundwater level wells designated for groundwater quality monitoring. These wells will then be sampled for both groundwater elevation data and groundwater quality data. ● Sampling events will be coordinated with well owners to prevent pumping and access issues. In addition to these steps, the monitoring networks will be evaluated on a yearly and five-year basis. If additional data gaps arise, the GSA will consider the implications of these gaps, associated costs, and importance to the continued implementation of the GSP and take appropriate actions to address the gaps."	216; 3.5.4.3, page 217
10. Do proposed management actions include any changes to local ordinances or land use planning?		X			
11. Does the GSP identify additional/contingent actions and funding mechanisms in the event that MOs are not met by the identified actions?		X			
12. Does the GSP provide a plan to study the interconnectedness of surface water bodies?		X		"The assessment of surface water flows and groundwater levels indicate that there are not interconnected surface waters in the Plan area."	3.3.1.2, page 184
13. If yes: a. Does the GSP identify costs to study the interconnectedness of surface water bodies?			X		
b. Does the GSP include a funding mechanism to support the study of interconnectedness surface water bodies?			X		

14. Does the GSP explicitly evaluate potential impacts of projects and management actions on groundwater levels near surface water bodies?		X		"MID will implement a series of projects to improve operations and better manage ground and surface water supply within its service area. This includes capital projects, some of which are partially funded through grants and many of are completed or are currently under development, as well as new programs to evaluate incentives and other changes to better manage surface water within MID." MID is planning to utilize surface water more efficiently and therefore reduce groundwater pumping, but it is not clear that how these projects will affect the groundwater level near surface water bodies.	4.2.3, page 238

Summary/ Comments

The draft GSP states that a temporary domestic well mitigation program is under consideration to address groundwater level declines that are expected to occur during the GSP implementation period. Appendix 3D of the draft GSP presents an economic analysis of the effects of implementing the GSP, including estimated costs to replace domestic wells that will be dewatered "with [Sustainable Groundwater Management Act] SGMA" and "without SGMA." According to the draft GSP, 87 domestic wells will be impacted prior to 2020, 43 more will be impacted under GSP implementation, and an additional 185 domestic wells would be impacted if the GSP was not implemented (i.e., if there were no changes as a result of SGMA). The draft GSP does not, however, present the results of this impact analysis in a clear and transparent manner, illustrating for example, 1) where the likely impacted wells are located, 2) what communities are most affected (including DACs), 3) an estimate of the size of the population that relies on these domestic wells, or 4) if the creation a new or expanded community water system could address some or all of the population affected by the loss of domestic wells. Several of these aspects are listed as potential mitigation measures under Section 3.2.4 of Appendix 3D and thus are important not only for the public to understand and review, but for the GSAs to understand in the development of their domestic well mitigation program.

The likely benefits and impacts to DAC members by the proposed projects and management actions are not clearly identified in the GSP. A discussion should be added for each project or management action to clearly identify the benefits to DAC drinking water users and potential impacts to the water supply. For all potential impacts, the project/management action should include a clear plan to monitor for, prevent, and/or mitigate against such impacts.

The GSP should evaluate any potential impacts of projects and management actions on groundwater levels near surface water bodies.

[Sent via email]

Madera Irrigation District Groundwater Sustainability Agency Members
David Loquaci
Richard Cosyns
Brian Davis
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Madera County Groundwater Sustainability Agency Members
Brett Frazier
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Santos García
Donald E. Holley

Madera Water District GSA
Eric Abrahamsen

November 8th, 2019

Re: Comments on Madera Joint Draft Groundwater Sustainability Plan

Dear Board Members of the Madera Subbasin GSAs,

Leadership Counsel for Justice and Accountability works with low-income communities of color in the San Joaquin Valley and the Eastern Coachella Valley. As is most relevant here, we work in partnership with community leaders in the communities of La Viña and Fairmead to advocate for local, regional and state government entities to address their communities' needs for the basic elements that make up a safe and healthy community, including safe and affordable drinking water, affordable housing, effective and safe transportation, efficient and affordable energy, green spaces, and clean air.

We have been engaged in the Sustainable Groundwater Management Act (SGMA) implementation process because most of the communities with which we work are wholly dependent on groundwater for their drinking water supplies, and many have already experienced groundwater quality and supply issues. The communities where we work have not been included in decision-making about their precious water resources, and their needs are not prioritized in such decisions. In 2012, California recognized the Human Right to Water for domestic purposes, and required that state agencies consider this human right in their activities. State law also requires that GSAs avoid disparate impacts on protected classes.[1] SGMA's requirements for a transparent and inclusive process present an opportunity in the context of groundwater management to meaningfully include disadvantaged communities in decision-making, and to create groundwater management plans that understand their unique vulnerabilities, are sensitive to their drinking water needs, and avoid causing disparate negative impacts on low-income communities of color.

We submit these comments to elevate our concerns that the Madera Subbasin Draft Joint Groundwater Sustainability Plan (Draft GSP) is incomplete, does not adequately analyze drinking water impacts, does not consider drinking water impacts in its policy decisions about groundwater management, lacks basic elements required under SGMA, and does not include projects and management actions to prevent protected groups from suffering severe and widespread drinking water impacts. Our review shows that the Draft GSP neither adequately analyzes nor incorporates input from disadvantaged communities and domestic well users, and will create a disparate impact on protected classes unless significantly modified to protect drinking water resources for disadvantaged communities. We include herein our comments with respect to deficiencies in the Draft GSP as well as recommendations for improvements.

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[1] Gov. Code § 11135; Gov. Code § 65008; Government Code §§ 12955, subd. (l).

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The Draft GSP is Incomplete, and Must Include Additional Information For the Public to Evaluate the GSP

The Draft GSP omits critical data regarding the description of the plan area, assumptions and data necessary to accurately calculate the water budget, an accurate evaluation of the drinking water impacts of the proposed plan, and a clear plan for avoiding significant and unreasonable impacts to the GSP area's most vulnerable drinking water users. The Draft GSP also fails to demonstrate how its proposed policies and activities will achieve its sustainability goal, which SGMA requires.[2]

First, the description of the plan area, which is required to describe "the consideration given to the applicable county and city general plans" and all "relevant county plans"[3] omits relevant and crucial policies from the County and City General Plans which will affect water use.[4] Furthermore, the GSP should cite to and consider community plans and SB 244 analysis that outlines the known, existing groundwater vulnerabilities of communities in the Subbasin.[5] The GSAs should also supplement gaps in information on disadvantaged communities omitted in existing SB 244 analyses. For example, Madera County's SB 244 analysis omits the community of La Vina and its water needs.[6]

Second, as described below in our section on groundwater levels, the GSP's analysis of drinking water impacts is inaccurate, and must be redone. The GSAs must redo this analysis to reach an accurate conclusion regarding the number of wells that could be dewatered or contaminated due to the GSAs' proposed policies and activities, including the proposed sustainable management criteria, demand reduction schedule, and projects like on-farm recharge that could threaten groundwater quality.

Third, as detailed further in our comments regarding Projects and Management Actions, the domestic well mitigation program is missing from the projects section, and the details that are included in Appendix 3D are missing key information regarding the program's operationalization and scope.

Fourth, as explored below, the GSP's description of the water budgets lacks the necessary data, assumptions and approaches used to determine the water budgets, maps of the basins, and in some cases there have been sections left empty.

Last, the Draft GSP fails to show how it will achieve its sustainability goal with the proposed policies and activities, which it is required to do under SGMA.[7] Given that the GSAs' proposed projects will still leave 90,000 acre feet of overdraft per year, and the GSP has no clear strategy for management actions such as demand reduction, the GSAs have not shown how they will "balance long-term groundwater system inflows with outflows based on a 50-year period representative of average historical hydrologic conditions" and "ensure no undesirable results of significant and unreasonable economic, social, or environmental impacts occur."[8]

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[2] Water Code sec. 10727.2(b)(2)
[3] Water Code sec. 10727.2 (g)
[4] The Draft GSP fails to mention policy 3.C.11 of the Madera County General Plan to "encourage water conservation by farmers." Madera County General Plan Pg. 50
[5] "Domestic water supply reliability has been an issue in the past, particularly if one or multiple components of the system has failed. This last occurred in the summer of 2007, prompting the County to transport water to the community by truck for an extended period of time." Fairmead Neighborhood Mobility and Revitalization; Strategy Opticos Design, Inc. January 2011. Pg. 2-5.
[6] Madera County General Plan Background Report, p. 1-36.
[7] Water Code sec. 10727.2(b)(2)
[8] Madera Subbasin Draft GSP, p. 3-3.

The Draft GSP cannot be adopted until all of the above information is made available to the public for public review during a new review period.

The Madera Subbasin GSAs Are Responsible for the Disproportionate and Disparate Impacts That Its Policies and Activities Will Have on Disadvantaged Communities Belonging to Protected Groups

The Madera Subbasin GSAs must prioritize drinking water as an essential pillar of the proposed groundwater sustainability plan. Under SGMA, the GSAs are tasked with managing groundwater in a way that does not cause "significant and unreasonable impacts" to the beneficial uses and users of groundwater in the subbasin. The GSAs' activities cannot avoid impacts only on certain types of beneficial users; under SGMA they must "consider the interests of" an enumerated list of all types of beneficial users, including disadvantaged communities on domestic wells and community water systems.[9] Furthermore, state law provides that no person shall, on the basis of race, national origin, ethnic group identification, and other protected classes, be unlawfully denied full and equal access to the benefits of, or be unlawfully subjected to discrimination under, any program or activity that is conducted, operated, or administered by the state.[10] In addition, the state's Fair Employment and Housing Act guarantees all Californians the right to hold and enjoy housing without discrimination based on race, color, or national origin.[11] Lastly, the Department of Water Resources is required to consider the Human Right to Water in its evaluation of the GSAs' proposed Groundwater Sustainability Plan, so the drinking water impacts of the GSP are of utmost importance in its approval.[12]

Disadvantaged communities in the Madera Subbasin have the most to gain and the most to lose from SGMA implementation in the region. Communities like Fairmead[13] and La Vina[14] are majority Latino and depend on small community water systems and domestic wells for their drinking water supply. Because residents in disadvantaged communities do not have the financial means to dig deeper wells and install drinking water treatment infrastructure, they are more likely to be severely impacted by lowering groundwater levels and groundwater contamination. As a particularly vulnerable group, their critical drinking water needs must be considered and meaningfully protected by the GSP. The Madera Subbasin GSAs have not adequately done so in

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[9] Water Code § 10723.2.

[10] Gov. Code § 11135 ["No person in the State of California shall, on the basis of sex, race, color, religion, ancestry, national origin, ethnic group identification, age, mental disability, physical disability, medical condition, genetic information, marital status, or sexual orientation, be unlawfully denied full and equal access to the benefits of, or be unlawfully subjected to discrimination under, any program or activity that is conducted, operated, or administered by the state or by any state agency, is funded directly by the state, or receives any financial assistance from the state."]; Gov. Code § 65008 [Any discriminatory action taken "pursuant to this title by any city, county, city and county, or other local governmental agency in this state is null and void if it denies to any individual or group of individuals the enjoyment of residence, land ownership, tenancy, or any other land use in this state…"]; Government Code §§ 12955, subd. (l) [unlawful to discriminate through public or private land use practices, decisions or authorizations].

[11] Gov. Code § 12900 et seq.

[12] Water Code § 106.3.

[13] U.S. Census Bureau (2017). *American Community Survey 5-year estimates.* Retrieved from *Census Reporter Profile page for Fairmead, CA*<http://censusreporter.org/profiles/16000US0623210-fairmead-ca/>

[14] U.S. Census Bureau (2017). *American Community Survey 5-year estimates.* Retrieved from *Census Reporter Profile page for La Vina, CA*<http://censusreporter.org/profiles/16000US0640872-la-vina-ca/>

this Draft GSP; as described below, the current Draft GSP is likely to cause 63% of wells to go dry in the subbasin and puts domestic wells at risk of contamination from many unmonitored drinking water contaminations, with little funding allocated to help address drinking water impacts. Our recommendations below show how the GSA could improve its GSP to avoid disparate impacts on protected groups and ensure that it is treating all beneficial users equitably.

Inadequate Consideration of Public Input Undermines the Value and Efficacy of the Draft GSP

SGMA requires that a GSA "shall consider the interests of all beneficial uses and users of groundwater," which expressly includes "[h]olders of overlying rights" and "[d]isadvantaged communities, including, but not limited to, those served by private domestic wells or small community water systems."[15] The emergency regulations similarly require that a Draft GSP summarize and identify "opportunities for public engagement and a discussion of how public input and response will be used."[16] The GSA thus must engage "diverse social, cultural, and economic elements of the population within the basin."[17]

Our organization and community partners have been grateful to work in collaboration with staff and consultants for the Subbasin by connecting them with residents in communities where clean drinking water access is threatened by the overuse of water surrounding their communities. Where staff has not been able to meet with residents directly, our organization has continually acted as a liaison by providing feedback to staff, GSAs, the advisory committee, and the coordination committee via public comment on residents' behalf. While we commend staff's good faith efforts at coordinating with Self Help Enterprises and our organization to conduct outreach to some of the disadvantaged communities in the Subbasin, we acknowledge that significant gaps in outreach continue to exist and some stakeholders have still not been reached or considered, and what feedback staff and consultants have received has not been integrated into the plan with equal consideration. Additionally, the Advisory Committee to the GSA boards has not adequately represented the needs of beneficial users in the subbasin, and Coordination Committee meetings have not been properly transparent in accordance with the Brown Act.

First, although staff has put forth observable effort into considering the interests of all beneficial users, some beneficial users of groundwater still have not been considered in the formation of the Draft GSP. For example, small, sustainable farms and socially disadvantaged farmers have not been incorporated into the public conversation surrounding SGMA or Plan proposals for the subbasin. In fact, advocates and outreach workers at organizations who specialize in partnering with small, sustainable farmers report recent encounters with farmers in the Subbasin who had never heard of SGMA. Instead, the agricultural interests most involved in the GSP formation process through outreach and representation at advisory committee meetings have been those of powerful, large-scale cultivators who use the most groundwater. Small-scale farmers must also be meaningfully incorporated into the GSP formation process as stakeholders due to SGMA's requirements to consider the interests of all beneficial users. Furthermore, the GSA should

[15] Water Code § 10723.2.
[16] 23 CCR 354.10(d).
[17] Guidance Document for Groundwater Sustainability Plan; Stakeholder Communication and Engagement, p. 1.

include these farmers in policymaking because their practices are often less water-intensive and, if supported, could lead to more sustainable water use across the region, and help comply with SGMA and achieve the sustainability goal of the subbasin.

Second, the GSAs have incorporated input from large-scale agricultural interests significantly more than they have incorporated feedback from drinking water users. One example of this unequal consideration arises from the GSAs' decisions regarding sustainable management criteria for groundwater quality. Our organization and community partners have repeatedly voiced in public comment at the County GSA and MID GSA meetings, at technical workshops, advisory committee meetings, in writing via our comment letter dated June 27, 2019, and directly in conversation with staff and consultants that groundwater quality criteria must take all primary drinking water contaminants into account, as well as constituents that could increase due to GSA actions such as uranium and manganese that are currently present in parts of the aquifer and which could migrate with concentrated overpumping. However, upon review of the Administrative Draft GSP, we noted that the only constituent added to the sustainability management criteria since the date of our comments was TDS, a constituent which would only have severe impacts on the use of water for irrigation. The decision to incorporate TDS while continuing to disregard feedback that would protect drinking water users from drinking water contamination serves as a prime example of how the Draft GSP prioritizes the interests of irrigators over those of drinking water users, given that many primary drinking water contaminants are still not being considered by the draft plan.

Additionally, our organization has consistently asked for the GSP groundwater levels minimum thresholds to protect against severe drinking water impacts to disadvantaged communities, but the GSA refused to do so, citing the economic impact that such a policy would have on agriculture. In fact, Appendix 3D, the initial draft for a well mitigation program, explicitly states that the GSA considers the economic impact of a more robust demand reduction schedule to the agricultural industry to be "greater" than the human right to water of the Subbasin's residents.[18] Furthermore, the plan's overall prioritization of protection of the agricultural industry over protection of the human right to drinking water puts the GSP at risk of scrutiny from State agencies responsible for implementation of the Human Right to Water.[19]

Third, the Advisory Committee has not been equally representative of all beneficial users present in the subbasin. The Advisory Committee has contained far more representation from large-scale farming interests than it does from disadvantaged communities, socially disadvantaged farmers, or from stakeholders from areas in the Subbasin with significant threats to drinking water access who rely on groundwater solely for residential use. The Madera County GSA has recently voted to restructure this committee, which is a step in the right direction. However, the past structure of the Advisory Committee created a significant power imbalance which biased the policies,

[18] "Considering the cost of replacement relative to the cost of agricultural demand management (Table 1), it is fairly clear to conclude that accelerating the demand management (and so approaching sustainable management faster between now and 2040) would not avoid enough well replacement cost to be cost-effective from a subbasin-wide perspective" (Appendix 3.D. pages 2 and 3).
[19] Water Code § 106.3.

demand reduction schedules, and management actions that the committee recommended to the GSA.

Fourth, the Subbasin Coordination Committee must make all Coordination Committee meetings (including ad hoc meetings) fully accessible and transparent to the public, since "each GSA's governing body members consider the Committee's recommendations when making policy decisions for their individual GSAs" (1-15). Given the procedural weight of the Coordination Committee's decisions and recommendations in the GSP formation process, meetings of the Coordination Committee should follow all of the requirements of the Brown Act.[20] Members of the public must be notified via email to the interested parties list, online at the Madera Subbasin web page, and through other forms of affirmative outreach when these meetings are to take place, and these meetings must be made open to the general public and recorded like any other SGMA-related meeting in the Subbasin. Interpretation and translated materials must also be provided as needed, and meeting minutes and agendas must be published and meeting materials must be made available to the public upon request.[21] These changes must be made immediately to ensure that the Coordination Committee is a transparent, public meeting.

To address concerns over public engagement, transparency, and inclusivity, the GSAs must:

- Ensure inclusion of all stakeholder groups in GSP development and implementation, including small-scale farmers.
- Ensure that feedback from drinking water users and disadvantaged communities is reflected in GSP policies and activities.
- Ensure that drinking water beneficial use is prioritized over economic beneficial use, in compliance with state law.
- Immediately ensure that Coordination Committee meetings comply with the requirements of the Brown Act.

The Water Budget is Inadequate

Under SGMA, the water budget must contain an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored.[22] Based on our technical analysis, the Draft GSP does not conform to this regulation. The description of the water budget in the draft GSP is not fully transparent, and it is not clear how drinking water users will be protected when sustainable yield allocations are implemented.

The Draft GSP does not contain information on the methods, data, and assumptions used to estimate urban water use and urban pumping or what users are represented by the urban pumping totals reported (e.g., cities, small community water districts, disadvantaged communities, domestic well users, etc.). The draft GSP states that groundwater pumping was calculated as the water budget "closure" term, meaning it is the difference between all other inflows and outflows

[20] Gov Code § 54952.
[21] Gov Code §§ 54954.1- 54954.3.
[22] 23 CCR § 354.18.

for each water use category.[23] This method is common for agricultural pumping, but may not be appropriate for urban pumping. Annual urban pumping is reported in Table 2-23, but this table does not show what methods, data and assumptions were used to create these numbers.[24] Annual average historical urban pumping is reported to be 5% of the agricultural pumping.[25] The GSP must include information on the methods used to estimate urban pumping including reported data, population estimates used, per capita water use estimates used, and the areas and users of the subbasin represented by the urban pumping water budget component. The GSP must include information on how the changes in urban pumping were determined for the projected water budget and how these changes may impact small community water systems and domestic well users.

The implementation and sustainability periods of the projected water budget use repeating periods of hydrology and water supply information, but the rationale for the periods used is not described. The projected future water budget was developed using the Groundwater Flow Model that incorporated planned projects and management actions and the effects of climate change.[26] The projected future water budget is comprised of an implementation period (2020-2039)[27] and a sustainability period (2040- 2090).[28] The precipitation, evapotranspiration timeseries, and water supply hydrologic periods used for the projected water budget are reported in Tables 2-27 and 2-28.[29] The GSP must include additional details on how the hydrologic and water supply periods used for the projected water budget were selected and why the selected period are anticipated to be representative of future conditions.

The reported urban pumping exhibits more variability than would be expected in an urban environment, and the Draft GSP does explain the reason for this variability. This variability does not necessarily coincide with climatic conditions. For example, the years 1995—1998 were all considered wet years based on the San Joaquin River Basin water year type.[30] However, urban water use during this period ranges from 11,123 AF (1995) to 27,067 (1997).[31] The GSP must provide information on the cause of this variability so the public can determine if it is reasonable. The GSP must also discuss how the urban water demands presented in historical water budget are related to the historical water demands reported by all Urban Water Management Plans within the subbasin.

The water budget information presented in the draft GSP does not provide information needed to determine when sustainability is achieved and, it is not clear if the subbasin will have achieved sustainable conditions by the end of the implementation period in 2040. Table 2-26 presents a summary comparison of water budget components for the historical, current, and projected (without and with projects) water budgets.[32] The table presents average annual values and shows

[23] Madera Subbasin Joint GSP Public Review Draft p.2-65, dated August 2019
[24] Madera Subbasin Joint GSP Public Review Draft p.2-85, dated August 2019
[25] Madera Subbasin Joint GSP Public Review Draft p.2-99, dated August 2019
[26] Madera Subbasin Joint GSP Public Review Draft Appendix 6E p.33, dated August 2019
[27] Madera Subbasin Joint GSP Public Review Draft Appendix 6E p.33-35, dated August 2019
[28] Madera Subbasin Joint GSP Public Review Draft Appendix 6E p.35-38, dated August 2019
[29] Madera Subbasin Joint GSP Public Review Draft p.2-94, dated August 2019
[30] Madera Subbasin Joint GSP Public Review Draft p.2-57, dated August 2019
[31] Madera Subbasin Joint GSP Public Review Draft p.2-85, dated August 2019
[32] Madera Subbasin Joint GSP Public Review Draft p.2-90 to 2-91, dated August 2019

an average annual decline in groundwater storage for the projected period (2040-2090) for the scenario without projects, but shows an average annual increase in storage over that time period for the scenario with projects.[33] The GSP must clearly present the water budget results for the intended conditions in 2040 so that the public can evaluate whether sustainable conditions will be achieved by 2040.

The Draft GSP is also missing an explanation of how the sustainable yield will be allocated to the seven GSAs in the subbasin. Preliminary sustainable yield was estimated using three methods based on both the historical and projected water budgets including an estimate of the uncertainty in the sustainable yield estimates, and the magnitude of the various sustainable yield estimates is very similar, but the GSP does not contain any information on how this yield is allocated between the GSAs. The GSP should include information on how the sustainable yield will be allocated to the GSAs and how it will impact the water budget in these GSAs. The GSP should also clearly identify how the allocation of sustainable yield will be protective of drinking water users, including domestic well users and small public water systems.

The water budget is central to establishing effective policies for sustainable groundwater management in the GSAs area. Before it can submit a valid GSP, the Madera Subbasin GSAs must redo its water budget calculations to correct the above issues.

The Draft GSP's Sustainable Management Criteria for Groundwater Levels are not Adequate

The sustainable management criteria for groundwater levels must be made after considering the interests of all beneficial user groups, including disadvantaged communities on domestic wells and community water systems.[34] These policy decisions must also avoid disparate impacts on protected groups pursuant to state and federal law.[35]

The GSA has not shown how is has considered the interests of beneficial users including domestic well owners and disadvantaged communities. The resulting impact from the proposed sustainable management criteria will likely lead to disparate impacts on protected groups pursuant to state and federal law.

Furthermore, the Draft GSP does not show how the sustainable management criteria for groundwater levels will comply with the sustainability goal of assuring that "balanc[ing] long-term groundwater system inflows with outflows based on a 50-year period representative of average historical hydrologic conditions" and ensuring that "no undesirable results of significant and unreasonable economic, social, or environmental impacts occur as a result of GSP activities."[36]

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[33] Madera Subbasin Joint GSP Public Review Draft p.2-90 to 2-91, dated August 2019

[34] Water Code § 10723.2.

[35] Gov. Code § 11135; Gov. Code § 65008; Government Code §§ 12955, subd. (l).

[36] Water Code sec. 10727.2(b)(2) requiring GSPs to contain a description of how proposed policies and objectives will obtain the sustainability goal; Madera Subbasin Draft GSP, p.3-3.

The Proposed Undesirable Result for Groundwater Levels is Inadequate

Undesirable results are the point at which "significant and unreasonable" impacts on beneficial users caused by declining groundwater levels. The SGMA regulations require GSAs to justify their undesirable results by including the "[p]otential effects on the beneficial uses and users of groundwater."[37] GSAs must also describe the "processes and criteria relied upon to define undesirable results."[38]

The undesirable results for groundwater levels is defined as 30% of wells falling below minimum thresholds for two consecutive Fall measurements. It is not clear how this will avoid significant and unreasonable impacts on domestic well users, and the GSAs have not included an analysis of how many wells could go dry from those undesirable results, or what constitutes a significant and unreasonable amount of dry wells. Therefore it is evident that the GSAs have not considered the interests of this beneficial user group, or provided an adequate description of the potential effects on beneficial users, or described the process or criteria relied upon to define these undesirable results.

To comply with its legal obligations regarding undesirable results under SGMA, the GSA should do the following:

- The GSA must conduct an analysis of the effects of reaching the undesirable result on disadvantaged communities, and include this analysis in the GSP.
- Establish a public process to allow all beneficial users to provide feedback on the undesirable result. The undesirable result should be taken out to all beneficial user groups for feedback, and shaped using their input about what is a significant and unreasonable impact to their groundwater needs. The GSA must collaborate with local community-based organizations to reach disadvantaged community beneficial users. The GSA must include this process in the GSP.
- To protect drinking water resources for disadvantaged communities, the undesirable result must be set at when any drinking water wells is at risk of being dewatered

The Proposed Measurable Objectives for Groundwater Levels are Inadequate

The SGMA regulations require the GSA to set measurable objectives that "achieve the sustainability goal for the basin within 20 years of Plan implementation and...continue to sustainably manage the groundwater basin over the planning and implementation horizon."[39] In determining the measurable objectives, the GSA must consider the interests of all beneficial user groups and avoid disparate impacts on groups protected under state civil rights law.[40]

[37] 23 CCR § 354.26.
[38] 23 CCR § 354.26.
[39] 23 CCR § 354.30(a)
[40] Water Code § 10723.2; Gov. Code § 11135; Gov. Code § 65008; Government Code §§ 12955, subd. (l).

According to our Focused Technical Review, 24% of domestic wells (or approximately 570 wells) within a 1.5-mile radius of the representative monitoring wells will go fully dry, and another 18% would be partially dewatered. This projected impact is significantly different than the drinking water impact analysis in Appendix 3D, which estimates that only 130 domestic wells will be impacted by implementation of the proposed GSP. This impact is likely to be felt most by disadvantaged communities, which contain a higher number of individuals identifying as Latino and having Mexican nationality. Therefore the proposed policy will likely cause a disparate impact based on nationality, and has not considered the impact on beneficial users living in disadvantaged communities. The GSA must redo its drinking water impacts analysis in light of these results, and change its measurable objective to avoid this disparate impact and significant and reasonable impacts on disadvantaged communities in the subbasin.

Additionally, the GSP's measurable objectives were not created to avoid significant and unreasonable impacts on beneficial users in the subbasin. Instead, the GSA based its measurable objectives on what could be achieved by the proposed projects and management actions. The GSAs state that the measurable objectives for each representative monitoring site are the average groundwater levels for each site between 2040 and 2090 based on the implementation of the projects and management actions in the GSP.[41] Since this target is based on what the GSAs are willing to do in its projects and management actions, and not on what will avoid a significant and unreasonable impact on beneficial users, these measurable objectives not comply with the spirit or the letter of the law.

It is also unclear how the measurable objectives will achieve the sustainability goal, which is required under the GSP regulations.[42] The GSAs must clarify how achieving the measurable objectives at all representative monitoring wells will cumulatively result in attaining the sustainability goal for the GSP area.

The GSA must include the following in its Draft GSP to bring its measurable objectives into compliance with law:

- The GSA must show how its measurable objectives will achieve the sustainability goal.
- The GSA must redo its analysis of how many wells will be fully or partially dewatered at the groundwater elevation of the proposed measurable objectives.
- Consult directly with disadvantaged communities to obtain feedback on whether this would create a significant and unreasonable impact on their drinking water needs, and if so, what level of impact is not significant and unreasonable.
- Consider drinking water impacts in shaping measurable objectives, and ensure that protected groups are protected from disparate and disproportionately negative impact.
- The GSA must show how it has considered the needs of all beneficial users, including drinking water users, in setting its measurable objectives, by publishing the above analysis in the GSP and showing how it consulted with domestic well users and

[41] Madera Subbasin Joint GSP Public Review Draft p.3-5, dated August 2019
[42] 23 CCR § 354.30(a).

disadvantaged communities to set measurable objectives that avoid significant and unreasonable impacts to their beneficial user groups.

- Provide a robust drinking water warning system and drinking water protection program to prevent impacts to drinking water users and mitigate drinking water impacts that occur (see section below on Projects and Management Actions for more recommendations regarding these programs).

The Proposed Minimum Thresholds for Groundwater Levels are Inadequate

The groundwater levels sustainable management criteria set by a GSA must be the point that, "if exceeded, may cause undesirable results."[43] Therefore it must have the purpose of avoiding "significant and unreasonable" impacts on beneficial users caused by declining groundwater levels.[44] The GSA's determination of what is "significant and unreasonable" must consider the impacts on all types of beneficial users, including disadvantaged communities.[45] For groundwater levels specifically, GSAs must place minimum thresholds for each monitoring site at the level "that may lead to undesirable results."[46] Under the SGMA regulations, the GSA should provide a description of "the information and criteria relied upon to establish minimum thresholds," an explanation of how the proposed minimum thresholds will "avoid undesirable results," and "how minimum thresholds may affect the interests of beneficial uses and users of groundwater."[47] The GSA must also consider that drinking water use has been recognized as the "highest use of water" by the California legislature, and should consult with stakeholders to ensure that the minimum threshold is set is such a way as to guarantee the human right to drinking water to all individuals in the subbasin.[48]

The Draft GSP does not avoid significant and unreasonable impacts on disadvantaged communities on domestic wells, is likely to cause a disparate impact on protected groups from its minimum thresholds, and has not meaningfully considered these impacts in crafting its minimum thresholds. The Madera Subbasin Draft GSP proposes to set minimum thresholds based on water levels at the end of a projected 10-year drought, the lowest water level between 2019-2090 projected by the model, and adjustments for other sustainability indicators. As the attached Focused Technical Report shows, approximately 63% of the domestic wells within 1.5 miles of representative monitoring wells in the GSA area (or approximately 1,600 wells) will be dewatered at the minimum thresholds proposed in the Draft GSP, with 13% more that could be partially dewatered.[49] Since domestic well users are de minimis pumpers and are not part of this aquifer-depleting pumping, this will cause a disproportionately negative impact on domestic users, the majority of whom belong to a group protected by state civil rights law. This therefore will cause a disparate impact in violation of state civil rights law.

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[43] 23 CCR § 354.28.
[44] 23 CCR § 354.26.
[45] Water Code § 10723.2.
[46] 23 CCR § 354.28.
[47] 23 CCR § 354.28.
[48] Water Code § 106.
[49] Madera Subbasin Draft GSP Focused Technical Review

The Madera Subbasin GSAs must set minimum thresholds that consider the interests of drinking water beneficial users and do not create a disparate impact on protected groups by doing the following:

- Redo its analysis of how many wells will be fully or partially dewatered at the groundwater elevation of the proposed measurable objectives. Use publicly available OSWCR and local data and take into account well screen depth, and the increased pumping costs associated with the increased lift at the projected water levels.
- Consider drinking water impacts in shaping minimum thresholds, and ensure that protected groups are protected from disparate and disproportionately negative impact.
- Consult directly with disadvantaged communities to obtain feedback on whether this would create a significant and unreasonable impact on their drinking water needs, and if so, what level of impact is not significant and unreasonable.
- The GSA must show how it has considered the needs of all beneficial users, including drinking water users, in setting its minimum thresholds, by publishing the above analysis in the GSP and showing how it consulted with domestic well users and disadvantaged communities to set thresholds that avoid significant and unreasonable impacts to their beneficial user groups.
- In order to protect drinking water users, the GSAs should place the minimum threshold at a level above where the shallowest domestic well is *screened* in each Threshold Area.
- Provide a robust drinking water warning system and drinking water protection program to prevent impacts to drinking water users and mitigate drinking water impacts that occur (see section below on Projects and Management Actions for more recommendations regarding these programs).

The Draft GSP Fails to Adequately Address Groundwater Quality

SGMA charged GSAs with the responsibility to protect water quality from further degradation due to groundwater management practices, and requires GSAs to establish sustainable management criteria to prevent degraded groundwater quality.[50] SGMA charged GSAs with the responsibility to protect water quality through groundwater management,[51] and requires that the GSA consider the interests of all beneficial users including domestic well users and disadvantaged communities.[52] This Draft GSP fails to clearly define its undesirable results, minimum thresholds or measurable objectives for groundwater quality, so the public and DWR cannot evaluate their impact on beneficial users in the GSA area.

GSA activities and policies could cause increased contamination in many ways. For example, the proposed timeline for implementation of demand reduction may allow for continued pumping which may create an increase in naturally occurring contaminants and/or migration of

[50] Water Code § 10721(w)(4); 23 CCR § 354.28(c)(4).
[51] Water Code § 10721(w)(4); 23 CCR § 354.28(c)(4).
[52] Water Code §§ 10727.2(d)(2); 10721(x)(4)

contaminant plumes. The proposed on-farm recharge projects across the basin could also have severe impacts on groundwater quality by facilitating water percolation on land contaminated with years of pesticide, herbicide, fungicide, and fertilizer application. A groundwater market is likely to cause geographic concentrations of pumping that increase the likelihood of contaminant plume migration, putting drinking water resources at risk. The GSA's sustainable management criteria should ensure that such increased contamination does not occur.

The Proposed Minimum Threshold for Groundwater Quality is Inadequate

GSAs must place groundwater quality minimum thresholds for each monitoring site at the level "that may lead to undesirable results."[53] Under the SGMA regulations, the GSA should provide a description of "the information and criteria relied upon to establish minimum thresholds," an explanation of how the proposed minimum thresholds will "avoid undesirable results," and "how minimum thresholds may affect the interests of beneficial uses and users of groundwater."[54] The GSA must also consider that drinking water use has been recognized as the "highest use of water" by the California legislature,[55] and should consult with stakeholders to ensure that the minimum threshold is set is such a way as to guarantee the human right to drinking water to all individuals in the subbasin.

The Draft GSP states that the GSA will only monitor for arsenic, nitrate and total dissolved solids.[56] As written, the groundwater quality minimum threshold puts all drinking water at risk of contamination from drinking water contaminants that are not included in this list of contaminants of concern. The impacts of this contamination will be particularly felt by domestic wells, which are most vulnerable to drinking water contamination, and are not going to be monitored for compliance with any drinking water contamination that may result from the GSA's groundwater management activities. The GSA should monitor for compliance with all established primary drinking water standards, hexavalent chromium, and PFOSs/PFOAs, at *all* representative monitoring wells, as well as contaminants that are known to increase with groundwater management activities, such as uranium.[57] The GSA must monitor for compliance with these contaminants in all areas where drinking water wells are present, including domestic wells.

The minimum threshold is not sufficiently protective of groundwater quality for drinking water users, particularly disadvantaged communities which are less able to pay for expensive drinking water treatment infrastructure. The Draft GSP states that the minimum threshold for nitrates and arsenic will be the Maximum Contaminant Level "or existing level plus 20% (whichever is greater)."[58] Allowing the contamination of either of these contaminants to increase by 20% could have severe health impacts on drinking water users. The GSA must do an analysis of the health

[53] 23 CCR § 354.28.
[54] 23 CCR § 354.28.
[55] Water Code § 106.
[56] Madera Subbasin Joint GSP Public Review Draft p.3-12, dated August 2019.
[57] Smith et al., "Overpumping Leads to California Arsenic Threat," Nature Communications (June 2018) [arsenic discharge from clay correlated with overpumping]; Jurgens et al., "Effects of Groundwater Development on Uranium" (November 2010) [strong correlation between high bicarbonate irrigation and recharge water and leaching of uranium from shallow sediments to groundwater].
[58]pages ES-10 and 3-35.

impact of letting arsenic and nitrates increased by 20% in all of the wells where this will be there minimum threshold, and consult with disadvantaged community residents to determine whether this contamination will be significant and unreasonable.

Furthermore, setting some minimum thresholds at the MCLs could cause violations of the MCLs by allowing contamination to increase until that point. Where levels have not reached the public health goals for contaminants, the GSAs should consider using the public health goals for these constituents in lieu of the MCLs. Using the public health goals as the MCL will effectively protect the health of Subbasin residents reliant on groundwater for drinking water, and will prevent MCLs from being violated for drinking water users.

To bring the groundwater quality minimum thresholds into compliance with SGMA and state civil rights law, the GSA must:

- Monitor for compliance with all established primary drinking water standards, hexavalent chromium, and PFOSs/PFOAs, at *all* representative monitoring wells, as well as contaminants that are known to increase with groundwater management activities, such as uranium.
- Ensure that all representative monitoring wells are measuring for concentrations of the contaminants of concern, including all drinking water contaminants, every month.
- Ensure that minimum thresholds will be triggered after one test shows a violation of the MCL, and clarify this trigger process in the GSP.
- Immediately plan for, fund and construct new representative monitoring wells or evaluate existing wells to ensure that representative monitoring wells are monitoring for impacts to domestic well users outside of the cities of Tulare and Visalia.
- Implement a Drinking Water Observation Plan to trigger GSA action when contamination spikes occur. Please see more information about the types of projects that could be implemented when a Drinking Water Observation Plan is triggered in our comments about Projects and Management Actions.
- Implement a Drinking Water Protection Program that would be implemented when the Drinking Water Observation Plan is triggered, to prevent and mitigate drinking water impacts from the GSA's policy decisions and groundwater management activities. Please see our comments on the Projects and Management Actions for more description of what this program could look like.

The Proposed Undesirable Result for Groundwater Quality is Inadequate

Undesirable results are the point at which "significant and unreasonable" impacts on beneficial users caused by degraded groundwater quality. The SGMA regulations require GSAs to justify their undesirable results by including the "[p]otential effects on the beneficial uses and users of groundwater."[59] GSAs must also describe the "processes and criteria relied upon to define

[59] 23 CCR § 354.26.

undesirable results."[60] The undesirable result cannot have a disparate impact on protected groups pursuant to state civil rights law.

The Draft GSP proposes to define undesirable results for groundwater quality as 10 percent of wells being above the minimum threshold for the same constituent, based on an average of the most recent three year period. This undesirable results definition would allow communities across the subbasin to ensure multiple years of drinking water contamination before the GSP has failed. This is a significant and unreasonable impact on drinking water users, particularly those communities of color living in disadvantaged communities who cannot afford expensive drinking water treatment infrastructure. This could therefore lead to a disparate impact on protected groups.

In order to comply with SGMA and state civil rights law, the GSA must:

- Consider the impact of its undesirable impact on all types of beneficial users in the GSA area by evaluating the potential groundwater quality impact to beneficial users.
- Consult with drinking water users, particularly disadvantaged communities, to determine what is a significant and unreasonable impact on their drinking water resources.
- Publish this analysis in the GSP, and show how it was used to define the undesirable results.
- Ensure that this undesirable result does not cause a disparate impact on protected groups under state civil rights law.

The Proposed Measurable Objectives for Groundwater Quality are Inadequate

The Draft GSP proposes to define the measurable objectives for groundwater quality as the current level of constituents. The GSP states that "[m]easurable objectives for the groundwater quality sustainability indicator are intended to assure that GSP projects and management actions do not cause groundwater quality conditions to become unsuitable for any beneficial use, especially municipal and domestic supply uses since these are the most restrictive from a water quality standpoint."[61]

In the SGMA context, it is key to prevent further degradation of groundwater quality to protect drinking water. An appropriate standard in the context of groundwater protection is the state's anti-degradation policy, which is used by the SWRCB and regional water boards, and does not allow for further contamination of groundwater based on the best quality of the water since 1968 [62] the year the anti-degradation policy became effective. Another rule commonly used in environmental law is the *precautionary principle*, which prohibits activities that could cause harm when the amount of potential harm is unknown. Given that SGMA became law in 2015,

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[60] 23 CCR § 354.26.
[61] Pg. 3-12 of Madera Subbasin Draft GSP
[62] *Asociacion de Gente Unida por el Agua v. Central Valley Regional Water Quality Control Bd.* (2012) 210 Cal.App.4th 1255, 1268.

the GSA should, at a minimum ensure the better of highest quality of water achieved since 2015, or the MCL, whichever reflects a lower level of water contamination. Additionally, the GSA should state in the GSP that it will strive to achieve the public health goals for all drinking water contaminants, wherever possible.

Land Subsidence Sustainable Management Criteria

As per Water code sec. 10721.(x)(5), the state defines significant and unreasonable land subsidence as land subsidence that substantially interferes with surface land uses. The GSA must consider the interests of all beneficial user groups, including domestic well users and disadvantaged communities, in determining its undesirable result for land subsidence.

The Draft GSP does not include sustainable management criteria for subsidence, citing that, to date, subsidence has not impacted critical infrastructure. However, the plan acknowledges "the potential for future subsidence related to continued decreases in groundwater levels during the early to middle portions of the Implementation Period."[63] For this reason, the GSAs should incorporate criteria regarding the impacts and undesirable results that should be avoided by GSA actions over the course of the implementation period.

The decision to wait until avoidable and potentially irreversible impacts have occurred in order to set sustainability management criteria is not compliant with the spirit of SGMA or with the definitions therein of undesirable results and measurable objectives.

In order to avoid significant and unreasonable land subsidence that substantially interferes with surface land uses, the GSAs must establish clear undesirable results, measurable objectives, and minimum thresholds now for subsidence, rather than waiting until the GSAs implementation timelines cause those impacts.

The Monitoring Network is Inadequate With Respect to Groundwater Levels and Groundwater Quality

GSAs must monitor impacts to groundwater for drinking water beneficial users,[64] including disadvantaged communities on domestic wells,[65] and must avoid disparate impacts on protected groups pursuant to state law.[66] The GSA's monitoring network does not comply with SGMA regulations, and fails to capture drinking water impacts to disadvantaged communities and domestic wells. The GSAs have therefore not considered the interests of this beneficial user group and is likely to cause a disparate impact on protected groups who are dependent on domestic wells in the GSAs area.

Groundwater Level Monitoring

The SGMA regulations state that monitoring networks must include a sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated

[63] Madera Subbasin Joint GSP Public Review Draft p.3-29, dated August 2019.
[64] 23 CCR § 354.34
[65] Water Code § 10723.2.
[66] Gov. Code § 11135; Gov. Code § 65008; Government Code §§ 12955, subd. (l).

intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.[67] The GSA must also make decisions about the monitoring network in a way that considers the interests of all beneficial users..[68] The representative monitoring network for groundwater levels does not show how it will be monitoring impacts to disadvantaged communities and domestic well users. Therefore, the monitoring network for groundwater levels is not in compliance with SGMA regulations.

First, it is not clear how the groundwater levels monitoring network will detect representative impacts to domestic well users. The majority of domestic wells in the subbasin are less than 400 feet deep,[69] and therefore are in the upper aquifer. However, there are no upper aquifer or composite representative monitoring wells located in the northern, central or southeastern portions of the subbasin.[70] As reflected in our Focused Technical Review, the current monitoring network therefore lacks adequate coverage for roughly 2,700 domestic wells, including those in the communities of Fairmead and Chowchilla, Storey, Lake Madera Country Estates, and the area north of Madera.

If monitoring networks contains data gaps, draft GSPs must describe the steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.[71] In regards to data gaps in the monitoring network, the Draft GSP is unclear as to when and where additional monitoring wells will be installed. Without this information, the Draft GSP is not complying with SGMA regulations.

The draft GSP identifies 37 representative monitoring wells to monitor water levels.[72] The draft GSP then proposes "a potential for future addition of up to 27 monitoring wells from the 2019 nested well installation program"[73] but does not identify the location of these potential wells on maps.[74] The draft GSP further identifies the general areas lacking in monitoring wells are "the Upper Aquifer in the northern portion of the Plan area, and the Lower Aquifer in the south central and extreme eastern and western portions of the Plan area," and that "some of the spatial data gaps will be filled with installation of the nested monitoring wells by 2020 -particularly for the Upper Aquifer and extreme western portion of the Lower Aquifer."[75] However, it is not clear whether these future nested wells would be additional representative monitoring wells for which minimum thresholds and measurable objectives will be established.

To ensure the monitoring network is monitors groundwater levels of all beneficial users the GSAs must make the following changes:

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[67] 23 CCR § 354.34(c)(1)(A)
[68] 23 CCR § 354.34(b)(2)
[69] Madera Subbasin Joint GSP Public Review Draft Figure 2-5., dated August 2019
[70] Tables 3-9 through Table 3-11 give the location of key drinking water users as indicated above, along with the proposed water level representative monitoring wells, and which aquifers the representative monitoring wells are monitoring. Madera Subbasin Joint GSP Public Review Draft pg. 3-42, 3-43, 3-44, dated August 2019
[71] 23 CCR § 354.38(d)
[72] Madera Subbasin Joint GSP Public Review Draft pg. 3-40, dated August 2019
[73] Madera Subbasin Joint GSP Public Review Draft pg. 3-45, dated August 2019
[74] Madera Subbasin Joint GSP Public Review Draft Section 3.5.1.1, dated August 2019
[75] Madera Subbasin Joint GSP Public Review Draft Section 3.5.4.2, dated August 2019

- Ensure the proposed monitoring network is adequate to monitor conditions for disadvantaged communities and domestic well users.
- Explicitly describe any future representative monitoring wells and identify the proposed locations. When assessing the monitoring network data gaps, the GSP must prioritize installing new monitoring wells in locations where disadvantaged communities, small water systems, and domestic well users reside.
- All new monitoring wells must then be added to the representative monitoring network.

Groundwater Quality Monitoring

SGMA regulations require that GSPs create a groundwater quality monitoring network that will "collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues."[76] As the GSP is currently written, there are issues with the contaminants selected for monitoring, as well as incomplete information about the monitoring network. Without addressing these concerns, the GSAs are at risk of submitting a plan that is not in compliance with SGMA regulations.

The GSAs have a responsibility to monitor for all known water quality issues. In the draft GSP nitrate, TDS, and arsenic are identified as contaminants of concern because they "have greater potential for presenting broader regional groundwater quality concerns extending beyond localized or site-specific contamination cases and are likely to reflect a range of potential contamination sources".[77] However, as the groundwater quality maps in Appendix 2E show, there are other groundwater contaminants within the subbasin present at concentrations exceeding MCLs, including DBCP, EDB, 1,2,3-TCP, PCE, perchlorate, BTEX, and pesticides.[78] Without at minimum monitoring for all the other contaminants present in the basin, the GSAs are not complying with SGMA requirements.

Based on our Technical Analysis, it appears that there will be limited monitoring conducted in areas with high densities of domestic well users, which may constitute significant data gaps in the monitoring network. In Table 3-7[79] and Table 3-12,[80] the draft GSP identifies the water quality monitoring network and the monitoring frequency. The draft GSP identifies methods to fill data gaps, and one is that "The GSAs will install sampling taps (as needed) on groundwater level wells designated for groundwater quality monitoring. These wells will then be sampled for both groundwater elevation data and groundwater quality data".[81] However, it is not clear based on the information presented in the draft GSP how many additional sampling taps will be added to the network, where these wells will be located, and whether these wells will be included as groundwater quality representative monitoring network and evaluated with respect to minimum thresholds and measurable objective. This is critical information considering the GSAs will

[76] 23 CCR § 354.34(c)(4)
[77] Madera Subbasin Joint GSP Public Review Draft Section 2.2.2.3, dated August 2019
[78] Madera Subbasin Joint GSP Public Review Draft Appendix 2.E.c. Groundwater Quality Maps, dated August 2019
[79] Madera Subbasin Joint GSP Public Review Draft p. 3-31 to 3-32, dated August 2019
[80] Madera Subbasin Joint GSP Public Review Draft p.3-50 to 3-51, dated August 2019
[81] Madera Subbasin Joint GSP Public Review Draft p. 3-56, dated August 2019

already be relying on a very small representative monitoring network for groundwater quality, it being composed of only 12 wells out which only 2 domestic wells,[82] and these additionally wells will be necessary to fill data gaps and insure that the groundwater quality of all beneficial users is being monitored.

To ensure that the representative wells within the monitoring network accurately monitor impacts to groundwater management for drinking water beneficial users, we make the following recommendations:

- The GSAs must monitor for compliance with all of the following constituents of concern: all established primary drinking water standards, hexavalent chromium, and PFOSs/PFOAs, as well as contaminants that are known to increase with groundwater management activities, such as uranium.[83]
- Ensure that the groundwater quality monitoring network adequately captures increases in the extent and concentration of all known contaminants in the GSA area that are harmful to human health.
- Ensure that the groundwater quality monitoring network will detect impacts from groundwater quality on all types of beneficial users, most importantly drinking water users who have limited financial ability to treat their drinking water sources. To this end, the GSA should ensure that existing representative wells are in or near such communities or domestic wells, or that it has a concrete plan for installing new monitoring wells that will detect these impacts or working with domestic well users to regularly test their wells and incorporate that data into its monitoring network.
- Explicitly describe future representative monitoring wells and identify the proposed locations. When assessing the monitoring network data gaps, the GSP `must prioritize installing new monitoring wells in locations where disadvantaged communities, small water systems, and domestic well users reside.

Projects and Management Actions

The GSA must consider the interests of all beneficial users including domestic well owners and disadvantaged communities[84] and avoid disparate impacts on protected groups.[85] The GSP must also concretely outline how each objective and the overall sustainability goal will be achieved.[86] The projects and management actions set forth in the Draft GSP do not demonstrate a path

[82] Madera Subbasin Joint GSP Public Review Draft p. 3-46, dated August 2019
[83] Smith et al., "Overpumping Leads to California Arsenic Threat," Nature Communications (June 2018) [arsenic discharge from clay correlated with overpumping]; Jurgens et al., "Effects of Groundwater Development on Uranium" (November 2010) [strong correlation between high bicarbonate irrigation and recharge water and leaching of uranium from shallow sediments to groundwater].
[84] Water Code § 10723.2.
[85] Gov. Code § 11135; Gov. Code § 65008; Government Code §§ 12955, subd. (l).
[86] Water Code § 10727.2(b)(2).

towards achieving sustainability goals in the plan, and do not adequately account for the needs of disadvantaged communities pertaining to protected groups under state law.

Current Projects and Management Actions are Inadequate

The Madera Subbasin joint GSP is incomplete with regards to management actions, given that the GSAs have not decided which demand management strategy(ies) or enforcement mechanism(s) they will utilize in order to achieve the demand reduction targets outlined in the Draft GSP.[87] The remaining indecision regarding the mechanisms and structures that will be used to achieve and/or enforce these demand reduction targets leave residents with very little confidence that the targets will be met. As a result, until GSAs formalize and operationalize concrete enforcement mechanisms for demand reduction, vulnerable, de minimis groundwater users in the Subbasin can only assume that the targets will not be met and that the impacts will be greater than what the Draft GSP predicts. Furthermore, the Subbasin risks submitting a Plan that cannot be approved by the Department of Water Resources due to incompleteness.

The Draft GSP is also incomplete with regards to projects, since (a) it is unclear how the Subbasin will achieve acquisition of additional surface water for irrigation and recharge projects, (b) the well mitigation program, as drafted in Appendix 3D, is not yet complete and does not appear in the projects section of the Draft GSP, and (c) the GSAs have not yet decided how demand reduction will be achieved.

First, the GSAs propose that bringing in additional surface water from sources like CVP contracts will provide a source of water for projects like recharge basins. However, given that this action— acquiring more CVP water— is cited in nearly every Subbasin GSP in the Central Valley, it remains unclear how the GSAs can depend on a water supply that is (a) already fully allocated to its purchasers, (b) finite, and (c) dependent year-to-year on weather patterns (e.g. snowpack and rainfall).

Second, as highlighted previously in this letter, the Domestic Well Mitigation Program must swiftly be fully planned and operationalized, especially considering the severe drinking water impacts of this plan as drafted. The project is one of the only projects that the Madera County GSA has considered to date to specifically protect the drinking water resources of its constituents, and is currently listed as part of an appendix and given very general parameters. The program should be moved to the Projects and Management Actions section and expanded to include a concrete structure, funding plan, and implementation timeline.

Third, the Projects and Management Actions component of the Plan is incomplete given that the GSAs have not decided how the demand reduction schedule to which they purport to adhere will be enforced or achieved. The Draft GSP provides no commitments or decisions regarding the

[87]"Starting in 2020 and continuing through 2025, average annual groundwater pumping will be reduced by 2% (of the total demand reduction amount) per year, for a total cumulative reduction of 10% by 2025. Groundwater pumping will be reduced by 6% per year starting in 2026 and continuing through 2040" (4-41).

mechanisms that will be used to operationalize and enforce demand reduction in the Subbasin. Rather, it highlights a few options (allocations, a water market, and a land fallowing program) that are still under consideration and not yet planned. As a result, the management actions of the subbasin remain unplanned, giving residents, DWR, and other stakeholders no assurance that the proposed demand reduction goals will be met.

In order to prevent disparate impacts on protected groups, and show that it has considered the interests of all beneficial users including domestic well users and disadvantaged communities, the GSA should consider the following projects and management actions:

The GSA Must Clearly Commit to a Drinking Water Protection Program for the Madera Subbasin

The GSP contains a potential program to assist domestic well owners and small water systems obtain solutions to drinking water issues in the GSA area. This is a step in the right direction, but needs a more solid commitment and a defined scope and proposed activities. However, this plan remains incomplete, leaving the most vulnerable beneficial users of groundwater in the subbasin at continued risk of losing their human right to water. For example, the draft well mitigation plan estimates that the annual program cost will be $277,000, to be funded by an acre foot-based fee to "all pumpers." However, the draft plan does not sufficiently clarify how the fee will be assessed and charged to pumpers without metering. The plan also fails to specify how the total annual cost of $277,000 was determined, given that-- after considering administrative costs for operating the program-- this amount leaves only enough funding for 3 or 4 well replacements, according to the $25,000 estimate per well used in the draft. The draft also fails to concretely explain how residents in the Madera Subbasin will access these funds, and how the Madera County GSA will make determinations surrounding priority for well mitigation.

Appendix 3D also does not present a concrete plan for the scope of the program, or how such a program will be implemented. The draft well mitigation program plan also fails to consider the need for assistance for drinking water contamination when domestic wells or small community water systems become contaminated due to GSA-related activities.

We recommend the following parameters for a potential program, and are glad to work with the GSA on shaping an effective program for preventing drinking water impacts from declining groundwater levels, increased groundwater contamination, and subsidence.

We recommend that the GSA consider the following factors in approving such a program:

- Eligible activities: Assistance in connecting to larger water systems; drilling of new wells or deepening wells if homes' wells go dry due to declining groundwater levels; lowering of well pumps; short term and long term treatment of drinking water; provision of all permitting, planning and labor needs and all other costs associated with the mitigation; increased energy costs from pumping from deeper depths;[88] and emergency

[88] Recent research has concluded that "in the Tulare Lake area, with an average well depth of 120 feet, pumping would require 175 kWh per acre-foot of water. In the San Joaquin River and Central Coast areas, with average well depths of 200 feet, pumping would require 292 kWh per acre-foot of water." Wilkinson and Kost, *An Analysis of the*

bottled water or alternate water sources while mitigation measures are being implemented. Wherever possible, and whenever it is the community's preference, the GSA should strive to assist residents on domestic wells and small community water systems with connecting to larger drinking water systems. If consolidation is not possible, the GSAs should support the deepening of wells, installation of treatment facilities or POE/POU treatment in homes and offset the increased energy costs for pumping water from a lower level. In the interim, the GSA should collaborate with local and state agencies to provide emergency bottled water for consumption and sanitary purposes.

- Leadership by program beneficiaries: Any project funded by the program must be guided by the residents or communities that are recipients of program benefits. Community input into a project will ensure project success, by learning from resident experience and knowledge to shape a project that will best suit their drinking water needs.

- Access to the program: The GSA must ensure that the program is accessible for all residents who may need its assistance. The program should work with local agencies and organizations to spread information about the program, should not require residents to opt in to the program, and the GSA must provide translated materials regarding the program. [89]

- Such a program must be proactive, rather than reactive: We recommend that the Madera Subbasin GSAs implement a ***Drinking Water Observation Plan (DWOP)*** that will serve as a warning system so that the GSA is aware of when wells are going dry, or when wells are going to become contaminated from groundwater management activities, so it can take action to prevent drinking water impacts before they occur. This DWOP should trigger proactive measures wherein the GSA should act before wells lose production capacity or before wells become contaminated, to ensure that community members are not left without access to safe and reliable drinking water.

Recharge In or Near Disadvantaged Communities and Domestic Well Clusters

The Madera Subbasin GSAs should implement or incentivize recharge basins or other recharge activities throughout the subbasin wherever DACs and clusters of domestic wells exist. The GSAs should encourage these kinds of recharge projects with health co-benefits over on-farm recharge, which is likely lead to accelerate groundwater contamination.

Establish Pumping Buffer Zones That Protect Disadvantaged Communities and Clusters of Domestic Wells

For areas vulnerable to declining water levels and loss of production capacity, the Madera Subbasin GSAs should adopt management actions that establish geographical protection areas (buffer zones) by establishing bans, pumping limitations or community-specific management areas around disadvantaged communities and domestic well clusters. This buffer must be

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Energy Intensity of Water in California: Providing a Basis for Quantification of Energy Savings from Water System Improvements, 2006, ACEEE Summer Study on Energy Efficiency in Buildings, p. 12-123.

[89] Gov. Code, §§ 7293, 7295

protective enough to ensure that disadvantaged communities and residents reliant on domestic wells do not experience localized impacts from nearby pumping activities. This action should not be used to allow more pumping elsewhere in the subbasin, and needs to be coupled with a strong demand reduction policy across the basin.

Warning Against a Groundwater Market

We also strongly recommend against a groundwater market in the Madera Subbasin. Groundwater markets raise concerns from the perspective of domestic well users and disadvantaged communities, and residents of Fairmead and La Vina. Such a scheme will likely negatively impact critical drinking water resources, as more financially powerful groundwater users are able to purchase more groundwater resources and diminish the drinking water supplies of nearby community water systems and domestic well users.

Multi-benefit projects

The GSAs should implement and incentivize multi-benefit projects such as wetlands restoration or stormwater drainage ponds that would eliminate flooding and increase groundwater recharge in disadvantaged communities.

Funding of Projects and Management Actions

Although there are multiple short-term funding sources to leverage for SGMA-related projects, the Madera GSAs' operating budgets must be a reliable source of funding over the long-term of GSP implementation, and the GSAs cannot rely on grant funding for long-term projects and programs that benefit disadvantaged communities. The GSAs themselves must be responsible for addressing the drinking water issues caused by the GSAs' policy decisions and activities. Furthermore, any proposed assessments that will pay for projects may not place a disproportionate financial burden on disadvantaged communities. Small disadvantaged communities like Fairmead and La Vina should not be required to pay fees for GSP implementation.

Plan Implementation Section is Incomplete Because it Does not Contain Adequate Plans for Community Engagement,

GSPs must include a planning and implementation horizon,[90] and GSP implementation must continue to consider the interests of all beneficial user groups and engage a diversity of stakeholders. The proposed plan implementation is insufficient in regards to public engagement/outreach and does not contain adequate information regarding annual reporting or the potential to make amendments to the GSP.

The Draft GSP does not show how it will include the public in its sections on its five-year updates or its annual updates. It mentions that both will require substantial stakeholder engagement,[91] but does not specify how stakeholders will weigh in on the process. While the

[90] Water Code § 10727.2.(c)
[91] Madera Subbasin Joint GSP Public Review Draft p. 5-2, dated August 2019.

GSA has published its extensive communications and engagement guidelines,[92] it is unclear how stakeholders will be engaged moving forward as critical decisions are made about projects, management actions, and adaptive management through modified sustainable management criteria. Specifically, the summary of engagement milestones beginning on page 25 does not have any plans for engaging the public in such decisions. Furthermore, the GSP cost breakdowns do not contain a line item for stakeholder engagement or outreach, so it is unclear how much funding will be allocated for public engagement.[93]

To ensure that the GSP is implemented properly, the Madera Subbasin GSAs must do the following:

- Include details about how public outreach will be conducted as part of their annual reporting and five-year updates. Establish a clear processes by which GSAs will seek and incorporate feedback from the public on an ongoing basis through direct outreach to disadvantaged communities and public workshops that are held at convenient locations and times and accessible in multiple languages. Proposed policy changes and decisions about projects and management actions must be publicly noticed and circulated for public review and comment prior to final adoption.

- Clarify in the GSP that the plan may be modified as data becomes available, and that the GSAs will seek and accept feedback from the public on an ongoing basis throughout plan implementation.

- Clarify that any modification to the GSP must be in writing, noticed and provide sufficient time for public review and feedback.

Other Legal Considerations

The Draft GSP Threatens to Infringe on Water Rights

In enacting SGMA, the legislature found and declared that "[f]ailure to manage groundwater to prevent long-term overdraft infringes on groundwater rights."[94] The test of SGMA further notes that "[n]othing in this part, or in any groundwater management plan adopted pursuant to this part, determines or alters surface water rights or groundwater rights under common law or any provision of law that determines or grants surface water rights."[95] As discussed in detail above, the Draft GSP allows continued overdraft above the safe yield of the basin, such that drinking water wells (especially domestic wells) will continue to go dry, infringing on the rights of overlying users of groundwater. The GSP must be revised to protect the rights of residents of disadvantaged communities and/or low-income households who hold water rights to groundwater.

[92] Madera Subbasin Joint GSP Public Review Draft Appendix 2.C.b., dated August 2019.
[93] Madera Subbasin Joint GSP Public Review Draft p. 5-4, dated August 2019.
[94] AB 1739 (2014).
[95] Water Code § 10720.5(b).

The Draft GSP Conflicts with the Reasonable And Beneficial Use Doctrine

The "reasonable and beneficial use" doctrine, to which SGMA expressly must comply,[96] is codified in the California Constitution. It requires that "the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare." (Cal Const, Art. X § 2; *see also United States v. State Water Resources Control Bd.* (1986) 182 Cal.App.3d 82, 105 ["…superimposed on those basic principles defining water rights is the overriding constitutional limitation that the water be used as reasonably required for the beneficial use to be served."].)

The reasonable and beneficial use doctrine applies here given the negative impacts of the Draft GSP on groundwater supply and quality, which are likely to unreasonably interfere with the use of groundwater for drinking water and other domestic uses. As the Draft GSP authorizes waste and unreasonable use, it conflicts with the reasonable and beneficial use doctrine and the California Constitution.

The Draft GSP Conflicts with the Public Trust Doctrine

The "public trust" doctrine applies to the waters of the State, and establishes that "the state, as trustee, has a duty to preserve this trust property from harmful diversions by water rights holders" and that thus "no one has a vested right to use water in a manner harmful to the state's waters."[97]

The "public trust" doctrine has recently been applied to groundwater where there is a hydrological connection between the groundwater and a navigable surface water body.[98] In *Environmental Law Foundation*, the court held that the public trust doctrine applies to "the extraction of groundwater that adversely impacts a navigable waterway" and that the government has an affirmative duty to take the public trust into account in the planning and allocation of water resources.[99] The court also specifically held that SGMA does not supplant the requirements of the common law public trust doctrine.[100] In contrast to these requirements, the Draft GSP does not consider impacts on public trust resources, or attempt to avoid insofar as feasible harm to the public's interest in those resources.

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The Madera Subbasin GSP must protect the most vulnerable drinking water users in the GSA area. We welcome the opportunity to discuss our recommendations with the Madera Subbasin

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[96] Water Code § 10720.1(a).

[97] *United States v. State Water Resources Control Bd.* (1986) 182 Cal.App.3d 82, 106; *see also Nat'l Audubon Soc'y v. Superior Court* (1983) 33 Cal.3d 419, 426 ["before state courts and agencies approve water diversions they should consider the effect of such diversions upon interests protected by the public trust, and attempt, so far as feasible, to avoid or minimize any harm to those interests."].

[98] *Environmental Law Foundation v. State Water Resources Control Bd.* (2018) 26 Cal.App.5th 844, 844.

[99] *Id.* at 856-62.

[100] *Id.* at 862-870.

GSA boards, staff and consultants to ensure compliance with state law. We are also in communication with the Department of Water Resources about current GSP development activities in the San Joaquin Valley, and hope to successfully work with GSAs, communities and DWR to ensure that groundwater management is equitable and sufficiently protective of vital drinking water resources.

Sincerely,

/s/

Madeline Harris, Nataly Escobedo Garcia and Amanda Monaco

Leadership Counsel for Justice and Accountability

CC:

Amanda Peisch-Derby

Senior Engineer

Department of Water Resources

Encl:

Technical Review, October 2019 Madera Subbasin Groundwater Sustainability Agencies Draft Groundwater Sustainability Plan (GSP)

LEADERSHIP COUNSEL FOR JUSTICE & ACCOUNTABILITY

[Sent via email]

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June 27, 2019

Re: Concerns and Recommendations to Ensure that the Madera Subbasin Joint GSP Protects Vulnerable Drinking Water Users

Dear Madera Irrigation District and Madera County GSA members,

Our organization works alongside low income communities of color in the San Joaquin Valley and the Eastern Coachella Valley to advocate for local, regional and state government entities to address their communities' needs for the basic elements that make up a safe and healthy community, including clean, safe, reliable and affordable drinking water, affordable housing, effective and safe transportation, efficient and affordable energy, green spaces, clean air, and more. We have been engaged in the Sustainable Groundwater Management Act (SGMA) implementation process because many of the communities with whom we work are dependent on groundwater for their drinking water supplies, and often have already experienced groundwater quality and supply issues. Historically, the communities we work with have not been included in decision-making affecting their access to water, and their needs have not been at the forefront of such decisions. In 2012, California recognized the Human Right to Drinking Water as a statewide goal. Now, because of SGMA's requirements for a transparent and inclusive process, groundwater management under the new law has the opportunity to include disadvantaged communities in decision-making and create groundwater management plans that understand their unique vulnerabilities and are sensitive to their drinking water needs.

We are concerned that drinking water impacts and disadvantaged community input have not been adequately analyzed and incorporated into the draft joint GSP for the Maddera Subbasin, and recommend the following actions to ensure that drinking water is protected, especially for the communities whose drinking water is severely at risk from groundwater management activities, and who are the least able to pay for solutions for clean and reliable drinking water.

Development of Sustainable Management Criteria

As you are aware, SGMA requires Groundwater Sustainability Agencies ("GSAs" herein) to "*consider the interests of*"[1] disadvantaged communities and to prioritize drinking water access in developing sustainable management criteria. GSAs must also "*encourage the active involvement of diverse social, cultural, and economic elements of the population within the groundwater basin prior to and during the development and implementation of the groundwater sustainability plan.*"[2] In order to effectively do so, GSAs must engage residents of disadvantaged communities to understand their groundwater issues and needs, meaningfully seek their input on how to shape sustainable management criteria, analyze the impact of preliminary minimum thresholds on drinking water access, and address the impacts of the six sustainability indicators before establishing minimum thresholds.

Under SGMA, ***all sustainable management criteria must be based on the GSA's determination of what will cause a "significant and unreasonable" impact on each of the six sustainability indicators.*** [3] This determination of what is "significant and unreasonable" must be based on the needs of all beneficial users.[4] Without first consulting beneficial users, including disadvantaged communities, to understand what groundwater impacts those individuals and communities want to avoid, the GSAs cannot make a valid determination of what is "significant and unreasonable", and thus cannot set valid sustainable management criteria.

In the Madera subbasin, the GSAs' Consultants have sought out preliminary feedback from disadvantaged communities through direct outreach and collaboration with organizations such as Self Help Enterprises and Leadership Counsel in order to make initial assessments regarding the needs of disadvantaged communities. As a result, the GSAs and Consultants are aware of the unique vulnerabilities of low-income domestic well users and communities that rely on small water systems for drinking water.

On behalf of the communities with whom our organization partners, we are grateful for these outreach and engagement efforts aimed at obtaining substantive feedback from disadvantaged communities. That said, the GSAs must not merely seek out this feedback for the sake of practicing community engagement in and of itself; rather, the GSAs must meaningfully *implement* the feedback they obtain from disadvantaged communities when establishing sustainable management criteria. In other words, the SGMA requirement to "consider the interests" of disadvantaged communities and prioritize access to drinking water is not sufficiently fulfilled merely through stand-alone outreach, but rather through substantive consideration for their needs when establishing the sustainability management criteria of the Madera Subbasin joint plan. Unfortunately, the proposed minimum thresholds for groundwater levels and groundwater quality do not demonstrate that the GSAs have meaningfully considered input

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[1] Water Code sec. 10723.2

[2] Water Code sec. 10727.8

[3] CCR sec. 352.28(a), 354.30(b), 354.26(a)

[4] CCR sec. 352.28(b)(4)

from disadvantaged communities nor are there adequate measures in place to ensure that GSAs consider input from disadvantaged communities throughout the process.

The current minimum threshold proposal for groundwater levels falls far below the depths of most domestic wells. Rather than protect communities who rely on shallow wells for drinking water from losing access to this vital resource in the first place, the Madera County and MID GSAs have instead proposed an inaccessible mitigation plan that may allow communities to endure long periods of time without access to water. Additionally, the proposed groundwater quality minimum threshold only considers two contaminants. While common, they do not represent the full scope of groundwater quality hazards present in the subbasin.

In order to "consider the interests of" all beneficial users effectively, the advisory committee and GSA board must analyze how preliminary sustainable management criteria will affect drinking water users before reaching proposed final sustainable management criteria.[5] Before making decisions on sustainable management criteria, committees and GSA boards must be equipped with information about how potential minimum thresholds will impact access to drinking water for domestic well owners and communities on small community water systems. To date and to the best of our knowledge, there has been no analysis conducted to demonstrate how drinking water will be impacted by the groundwater quality and groundwater levels minimum thresholds proposed by consultants. Specifically, we request that the GSAs ensure that an analysis be done of the impact to domestic well users and small community water systems from the proposed minimum thresholds for groundwater quality and groundwater levels. With this drinking water impact analysis, the advisory committee can be better equipped with the necessary information to determine whether impacts from these proposed minimum thresholds will be "significant and unreasonable."

As previously mentioned, the joint GSP development process must be representative of the interests of all beneficial users named in the Act. When board members do not come from disadvantaged communities or understand the unique groundwater needs of such communities, as is the case more often than not, ***it is imperative for the agency to reach out to disadvantaged community members for input*** before making key decisions such as recommending or proposing draft sustainable management criteria. The Madera Subbasin consultants have worked with Leadership Counsel and Self-Help to do outreach to disadvantaged communities for workshops. We are grateful that the consultants actively reach out to us for suggestions on how to do such outreach, and hope that our organizations have been able to help the GSAs and consultants learn how to do more effective outreach to disadvantaged communities in the area. However, the advisory committee meetings where decisions about sustainable management criteria are being made must be fully accessible to all beneficial users, including to low-income and working people. It is our understanding that the Madera Subbasin Advisory Committee meetings were recently rescheduled to 2:30pm, and our organization has heard from community members that they are unable to

[5] California Department of Water Resources, Sustainable Management Criteria Best Management Practices, p. 9. The GSP must discuss how groundwater conditions at a selected minimum threshold could affect beneficial uses and users. This information should be supported by a description of the beneficial uses [of] groundwater and identification of beneficial uses, which should be developed through communication, outreach, and/or engagement with parties representing those beneficial uses and users, along with any additional information the GSA used when developing the minimum threshold.

attend these meetings to share their input due to work schedule, yet stated that they would attend such meetings were they held in the evenings. Since most community residents' schedules prevent them from coming to Advisory Committee meetings, Leadership Counsel and Self-Help Enterprises help provide feedback on GSP development on behalf of community residents based on our conversations with them. As the GSAs develop their sustainable management criteria and projects and management actions, the agencies must ***show that they are meaningfully implementing the input*** that they are receiving from disadvantaged communities and disadvantaged community advocates regarding their drinking water needs.

Groundwater Quality Minimum Threshold Recommendation

Groundwater quality has been a particularly complex issue for GSAs throughout the state. In determining how GSAs statewide will set their sustainable management criteria for groundwater quality, they have considered many factors, including the state Maximum Contaminant Levels (MCLs), the presence of other agencies monitoring and regulating groundwater contaminants in the region, areas where MCLs are already exceeded, and ways that groundwater management could impact the concentration and movement of groundwater contaminants.

We understand the complexity of setting groundwater quality sustainability management criteria that are accurate, attainable and measurable, and we are eager to work with the Madera subbasin GSAs to ensure that groundwater management does not increase groundwater contamination, especially where groundwater is being used as a drinking water source. As mentioned, consultants for the Madera subbasin have stated they would only be monitoring for nitrates and arsenic. Given the need for a concrete minimum threshold that strongly protects the human right to drinking water, we recommend that the Madera County GSA instead implement the following minimum thresholds:

- Minimum thresholds for water quality should be set at the best water quality since 2015 for each constituent, or at the Maximum Contaminant Level (MCL), whichever of the two reflects the better quality of water (lower contamination level).
- Where the minimum threshold exceeds the public health goal for any constituent, the GSP should, at a minimum, include a policy to strive for improvements to water quality to the point of meeting the relevant public health goal(s).
- The scope of minimum thresholds for water quality should include all potential water contaminants in order to prioritize ensuring access to safe drinking water.

The reasoning behind these minimum thresholds is that the GSAs are tasked with avoiding any undesirable results, and contamination of groundwater and other drinking water sources is a "significant and unreasonable" impact to the resource that we all need to drink, cook, bathe, grow food, and more. Accordingly, minimum thresholds must ensure protection from and prevention of contamination of groundwater and other drinking water sources. DWR instructs GSAs to look to existing groundwater regulatory programs and water quality standards.[6] Many GSAs have proposed incorporating the existing MCLs into their minimum thresholds, however reliance on an MCL is not sufficiently protective of drinking water sources, and does not prevent contamination of our critical resources.

An appropriate standard in the context of groundwater protections is the state's anti-degradation policy, which is used by the SWRCB and regional water boards, and does not allow for further contamination of groundwater based on the best quality of the water since 1968[7] the year the anti-degradation policy became effective. Given that SGMA became law in 2015, the GSA should, at a minimum ensure the better of highest quality of water achieved since 2015, or the MCL, whichever reflects a lower level of water contamination. Additionally, GSAs must ensure that the project and management actions they are proposing do not cause or exacerbate groundwater contamination, and in fact improve drinking water quality for the near and long term. For example, it is our understanding that GSAs within the Madera Subbasin Joint GSP plan to rely on on-farm recharge. Our organization has expressed concern that recharge on current or retired farmland where toxic pesticides and fertilizers have been applied threaten to significantly contaminate groundwater.

Another rule commonly used in environmental law is the precautionary principle, which prohibits activities that could cause harm when the amount of potential harm is unknown. We urge the GSAs to use these two rules, combined with seeking to remediate groundwater to the public health goal, as laid out above, to ensure that groundwater management does not cause degradation of groundwater quality.

Thirdly, GSAs should monitor all primary drinking water contaminants, as well as chrome-6[8], which is known has significant health effects but is undergoing a new process to set the MCL because of procedural flaws. It is widely known that the San Joaquin Valley experiences widespread water quality issues from nitrates[9], DBCP[10] [11], 123-TCP[12] and other contaminants, and the GSA's groundwater management activities could impact the concentration and location of those contaminants. Where relevant, GSAs should also consider monitoring for PFOA and PFOS as the EPA has established a Lifetime Health Advisory for them due to their potential impacts on drinking water systems.[13] GSAs

[6] California Department of Water Resources, Sustainable Management Criteria Best Management Practices, p. 15.

[7] *Asociacion de Gente Unida por el Agua v. Central Valley Regional Water Quality Control Bd.* (2012) 210 Cal.App.4th 1255, 1268.

[8] Hausladen, Debra M., et al. "Hexavalent chromium sources and distribution in California groundwater." *Environmental science & technology* 52.15 (2018): 8242-8251.

[9] *Addressing Nitrate in California's Drinking Water: With a Focus on Tulare Lake Basin and Salinas Valley Groundwater: Report for the State Water Resources Control Board Report to the Legislature.* Center for Watershed Sciences, University of California, Davis, 2012.

[10] Peoples, S. A., et al. "A study of samples of well water collected from selected areas in California to determine the presence of DBCP and certain other pesticide residues." *Bulletin of environmental contamination and toxicology* 24.1 (1980): 611-618.

[11] Loague, Keith, et al. "A case study simulation of DBCP groundwater contamination in Fresno County, California 2. Transport in the saturated subsurface." *Journal of Contaminant Hydrology* 29.2 (1998): 137-163.

[12] Burow, Karen R., Walter D. Floyd, and Matthew K. Landon. "Factors affecting 1, 2, 3-trichloropropane contamination in groundwater in California." *Science of The Total Environment* 672 (2019): 324-334.

[13] "Drinking Water Health Advisories for PFOA and PFOS." *EPA*, Environmental Protection Agency, www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos.

should also monitor contaminants that are proven to increase from groundwater management, such as arsenic and uranium,[14] increased contamination from recharge,[15] movement of contaminant plumes from groundwater pumping, and other groundwater management activities.[16]

Current Madera Subbasin Groundwater Levels Minimum Threshold

The GSAs' proposed groundwater quality minimum threshold does not fully protect the human right to water because it only considers arsenic and nitrates. Madera County's most recent SB244 analysis of drinking water deficiencies in disadvantaged communities throughout the Subbasin, however, has identified the presence of other harmful contaminants in communities' drinking water, (including, though not limited to, uranium, manganese, iron, and gross alpha, for instance) in communities' drinking water.[17] GSAs should also consider potential contaminants such as hexavalent chromium, TCP and other pesticides, (both those used in the region historically and those still in use). Our organization and Self-Help Enterprises have voiced concerns with these minimum thresholds, both substantively and methodologically. Substantively, these minimum thresholds do not protect communities relying on shallow wells from losing drinking water access or from drinking contaminated water due to the projects and management actions to be implemented by the GSAs. Rather, GSAs should consider all existing and potential groundwater contaminants in order to effectively plan groundwater management and prevent further degradation of groundwater quality as the result of those management actions. Methodologically, the proposed minimum threshold was not based on feedback from vulnerable beneficial users in the subbasin about what constitutes "significant and unreasonable" impacts to drinking water. Despite this feedback provided to the Madera County GSA from our organization and from Self-Help Enterprises, the GSAs have not altered these proposed minimum thresholds to more meaningfully consider and prioritize the human right to water.

Water Quality Considerations for Groundwater Management Actions

To establish causality between groundwater management activities and groundwater contamination, GSAs should look to (1) whether there has been a correlation in groundwater management activities and an increase in contamination that could result from groundwater management activities, (2) relevant scientific studies that show proven mechanisms by which causation can be established between groundwater management activities and groundwater contamination, and (3) data and samples collected showing a causal nexus in the case at hand.

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[14] Jurgens, Bryant C., et al. "Effects of groundwater development on uranium: Central Valley, California, USA." Groundwater48.6 (2010): 913-928.; *also see* "Groundwater Quality in the Sustainable Groundwater Management Act (SGMA): Scientific Factsheet on Arsenic, Uranium, and Chromium," found at https://d3n8a8pro7vhmx.cloudfront.net/communitywatercenter/pages/293/attachments/original/1559328800/Groundwater_Quality_in_SGMA_Scientific_factsheet_on_arsenic__uranium__and_chromium.pdf?1559328800

[15] Ground Water Recharge Using Waters of Impaired Quality (1994) https://www.nap.edu/read/4780/chapter/3

[16] Moran, T., & Belin, A. (2019). *A GUIDE TO WATER QUALITY REQUIREMENTS UNDER THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT*. Retrieved from https://purl.stanford.edu/dw122nb4780.

[17] Madera County. SB 244 Disadvantaged Unincorporated Communities Amendments, Madera County General Plan. 2015. Found at: https://www.maderacounty.com/home/showdocument?id=10798

Finally, in order to effectively protect drinking water resources, GSAs should establish Management Areas in areas that are more vulnerable to groundwater contamination, such as communities with many shallow wells and communities that cannot afford to install drinking water filters or treatment facilities.

Groundwater Levels Minimum Threshold Recommendation

GSAs must protect drinking water, and must consider the needs of disadvantaged communities and domestic well users in creating their GSPs. The California legislature has stated that the use of water for domestic purposes is the highest use of water,"[18] and passed the Human Right to Drinking Water in 2012.[19] After the passage of SGMA, GSAs now have the responsibility to protect drinking water through groundwater management. If they choose to allow individuals to keep pumping at the expense of severe drinking water impacts, that is a groundwater management decision that violates their obligation to protect drinking water resources. GSAs must therefore have strong minimum thresholds that protect all drinking water wells from dewatering.

Minimum thresholds are the most pivotal measure for how a GSA will prevent impacts from a sustainability indicator. This is the point that GSAs must avoid, and could necessitate state intervention. There is some flexibility, however; for groundwater levels, DWR shows in its Sustainable Management Criteria Best Management Practices guide that it will allow GSAs to dip below its minimum threshold for groundwater levels in some cases, as long as its GSP will ensure that it comes back up and towards its measurable objective. Therefore, GSAs should strive to set minimum thresholds at levels that they seek to avoid.

GSAs should set minimum thresholds for groundwater levels at the level of the shallowest existing wells in use, with a buffer above the depth depth of the top of the screen. If GSAs choose not to do so, they must take on the responsibility for the wells that do go dry from this policy choice. If proposed minimum thresholds allow wells to go dry, a GSA must conduct a drinking water impact analysis to evaluate how many drinking water wells will go dry, set management areas for shallower minimum thresholds where there are more concentrated shallow domestic wells, and ensure that drinking water is protected by implementing preventive actions such as digging deeper wells and assisting with consolidation projects. It is important to note that prevention, not mitigation, is the only way to effectively protect drinking water resources.

Currently, the Madera County GSA and Madera Irrigation District GSA are not equitably considering domestic well users' needs or prioritizing the human right to water in setting the sustainable yield for the subbasin. It is our understanding that the proposed minimum threshold for groundwater levels in the subbasin is far below the depths of most domestic wells, severely jeopardizing drinking water access for the most vulnerable beneficial users. Rather than establish minimum thresholds that protect

[18] Water Code sec. 106.

[19] Water Code sec. 106.3

shallow wells from running dry, we understand that the GSA has suggested relying entirely on mitigation efforts. We also understand that Staff, Consultants, and the County GSA have proposed total reliance on the Safe and Affordable Drinking Water Fund as the sole funding mechanism for these mitigation efforts, and have noted that potential beneficiaries would need to opt in to such a mitigation fund far before they may ever need to access it.

Furthermore, it is our understanding that the modeling used to provide baseline assumptions about groundwater conditions in the Madera Subbasin did not take climate change into account. SGMA requires groundwater modeling that fully considers the effects of climate change.[20] As a result, the preliminary assumptions used in determining this minimum threshold do not fulfill the requirements of SGMA. This faulty basis for the groundwater levels minimum threshold therefore calls into question the validity and compliance of the minimum threshold itself.

Our organization has voiced concerns to the Madera County and MID GSAs over this proposed minimum threshold and mitigation plan. Given the requirements to consider disadvantaged communities and prioritize the human right to water, it is unacceptable to establish a minimum threshold that will allow domestic wells to go dry-- especially considering the devastating effects that dry wells have has on communities and individuals without the means to deepen or replace their wells. Our organization works in collaboration with communities like Fairmead, where drinking water users suffered long periods of time without access to water due to domestic well dewatering. We also believe that reliance on the Safe and Affordable Drinking Water Fund is an insufficient and unacceptable response to the current problem of critical overdraft in the Subbasin, and that the responsible groundwater management solution lies in establishing sustainability management criteria that prevent well dewatering among other threats to the human right to water.

Rather than allow for domestic wells to run dry and rely solely on an external mitigation fund, we request that the GSAs set all minimum thresholds at a level to provide a buffer above the depth of the top of the screen of the shallowest well. The buffer must be adequate to ensure that the shallowest well does not go dry due to a short or medium-term exceedance of the minimum threshold. The GSAs should only disregard wells that they can prove are not in use.

In setting groundwater levels minimum thresholds, GSAs should also set minimum thresholds high enough as to avoid groundwater contamination from overpumping. They should also set minimum thresholds that ensure that rural communities have equitable access to drinking water resources, and have enough for current needs and future growth. GSAs must also factor in the increased costs of pumping and installing new wells if groundwater levels decrease, and avoid additional costs in groundwater access for low-income communities dependent on groundwater for drinking water resources. GSAs should also set minimum thresholds for groundwater levels that will prevent subsidence from occurring and disrupting infrastructure that is critical to the health and safety of vulnerable communities, such as private wells, roads, and homes.

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[20] 23 CCR §354.18(e): Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow.

Monitoring Network

Broadly, the GSAs must develop actionable steps to fill data gaps and monitor groundwater levels and groundwater quality. We are pleased that the Madera Subbasin is working to bolster its existing network of monitoring wells, and that GSA consultants are working to uniquely consider severely disadvantaged communities in doing so. Monitoring networks should provide close vigilance of the impacts on drinking water during the implementation period and beyond. Particularly, regarding water quality, GSAs should monitor for contaminant concentrations quarterly, and increase monitoring to every month if a water quality test detects higher contamination concentration than the previous water quality test. Testing should also robustly monitor plume migration especially given the high number of water users in the Madera subbasin.

As a result, the GSP should fund a water quality testing program for strategically identified domestic wells to complement data from small water systems and disadvantaged communities in order to fill existing data gaps as well as begin to identify contaminant plumes. To track these concerns the GSAs should place monitoring wells near DACs and clusters of domestic wells.

We look forward to providing further recommendations on the monitoring network in the future.

Transparency and Inclusivity

As public agencies, GSAs are subject to the requirements of the Ralph M. Brown Act, which requires transparency of public agencies through notice of meetings and prior posting of agendas, posting of meeting minutes after meetings, and public access to meeting materials upon request by a member of the public. In addition to Brown Act requirements, GSAs must also adhere to the specific public participation and inclusivity requirements for GSP development laid out in SGMA. SGMA expands the public participation requirements of GSAs to also *"encourage the active involvement of diverse social, cultural, and economic elements of the population within the groundwater basin prior to and during the development and implementation of the groundwater sustainability plan."*[21] To assist in GSAs complying with this requirement, DWR has published guidance on public notice and engagement, highlighting good practices for effective engagement. Both the letter and spirit of SGMA communicate that GSAs must conduct GSP development in an open and inclusive way.

A best practice to ensure authentic, meaningful input as required by SGMA is to post meeting materials before the meeting, so that these materials are available to the public for feedback and engagement. The Brown Act requires these materials to be made available after the meeting upon written request of the public. Paired with SGMA's requirements for robust community engagement, the most effective way to ensure that the public is aware of what will be talked about at meetings, and to access critical GSP development information despite not being able to attend one meeting, is to post all meeting materials online before the meeting. The Madera Subbasin GSAs send out meeting notices with an agenda, and have an easily navigable website that contains meeting agendas, presentations and minutes for each meeting. However, the GSAs would facilitate more effective public engagement at the meetings

[21] Water Code sec. 10727.8

if they were to post meeting presentations ahead of time, so that attendees could view the discussion items and data before the meeting. Additionally, we recommend that the GSAs separately agendize each SGMA-related discussion question and potential policy decision, so as to allow for public comment before each decision. We would also like to remind the GSAs of their responsibility to meaningfully consider the public comment provided at GSA meetings, rather than immediately vote without consideration for the feedback provided from the public.

GSAs should also ***dedicate sufficient funding to ensure meaningful, effective, and accessible engagement of the public.*** We, along with Self-Help Enterprises, have worked with the Madera subbasin GSAs' consultants to improve outreach to disadvantaged communities. We have helped provide input on several workshops, and have helped conduct outreach for those workshops. We have also kept community residents informed about GSP developments at community meetings. Providing food at evening meetings is key to ensuring that residents who have worked all day are able to attend meetings, so we recommend that GSAs allocate funding for food at public workshops. Given the type of outreach that is necessary in order to engage disadvantaged communities, the GSAs should also hire bilingual staff or consultants who can help conduct door-to-door outreach, attend community meetings, translate materials, and interpret at all GSA meetings. In creating annual operating budgets, GSAs should prioritize funding for these necessary outreach activities.

Projects and Management Actions

Projects and Management Actions are a crucial part of the GSP, since they demonstrate how the GSA plans on attaining the sustainability goals that they have set out. Therefore, GSAs should set specific timelines and triggers for projects. They should also propose projects that will not threaten the human right to water, as highlighted by the concerns we have raised over potentially hazardous projects like on-farm recharge. GSAs should also include projects specifically to benefit drinking water for disadvantaged communities.

We look forward to commenting further on recommendations for projects and management actions that will protect drinking water for the most vulnerable groundwater users.

Groundwater Markets

We have engaged in many discussions around the state about groundwater markets, and continue to warn against them. Commoditizing precious drinking water resources is dangerous and inequitable, since it lets those with more purchasing power have access to more water, and more likely than not will lead to concentrations of over-pumping by large agribusinesses, leaving nearby communities without drinking water. Furthermore, given all GSAs' severe lack of data on domestic wells and water use in their service areas, and our region's lack of understanding of how a market could impact groundwater use and subsurface groundwater flows, implementing groundwater markets now would be precipitous and reckless.

We know that Madera subbasin GSAs are considering a groundwater market, and we encourage the GSAs to take time to gather extensive data on existing groundwater resources and drinking water needs and analyze the potential impacts to drinking water before considering implementation of a groundwater market. We look forward to giving more feedback on the potential of developing a groundwater market in the Madera subbasin in the future if the subbasin decides to consider such an action.

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We look forward to speaking more in depth with consultants and the GSA members about our recommendations. We hope that the Madera County and Madera Irrigation District GSAs will consider the above recommendations, and hope to collaborate with the GSAs to ensure that the joint GSP protects the subbasin's most vulnerable drinking water users.

We are also in communication with the Department of Water Resources about current GSP development activities in the San Joaquin Valley, and hope to successfully work with GSAs, communities and DWR to ensure that groundwater management is equitable and sufficiently protective of vital drinking water resources.

Sincerely,

Madeline Harris
Policy Advocate
Leadership Counsel for Justice and Accountability
~~~~~~~

MADERA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN (GSP) COMMENT FORM

Please complete the following information to provide comments on the draft Madera Subbasin GSP. Type or print legibly for your comments to be considered.

Please return this form to (hand delivery, mail, or email accepted):

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637
Email: MaderaGSPComments@maderacounty.com

Date Submitted: November 8, 2019

Submitted By: Madera Valley Water Company by Gregory E. Rodgers General Manager

Address: 18454 Road 26 Madera CA 93638

Phone Number / Email: 559-674-2407 maderavalleywater@onemain.com

APNs: Multiple

Located in Groundwater Sustainability Agency (GSA):
■ Madera County ☐ MID ☐ City of Madera ☐ MWD ☐ Other ____________________

Affiliation: ☐ Irrigated Ag ☐ Non-Irrigated Ag ☐ Rural Residential
■ Disadvantaged Community Member ☐ Agency/Government ☐ Other ________________

November 8, 2019

Section 1: Comments on issues directly affecting MVWC service area.

1. Madera Valley Water Company (MVWC) is the third largest municipal water supplier in the Madera Basin, providing slightly less water than the City of Chowchilla and about half of the water delivered by the City of Madera. We provide potable water to residents in our service area, all of which is groundwater. However, there is no discussion of MVWC service and operations

anywhere in the text of the GSP (with the exception of brief statement in Chapter 2 that we conduct water quality testing). This omission appears to be because we are not a GSA and are lumped in with the County GSA in the “white areas” of the basin. However, our service population of approximately 8,900 is entirely dependent on our ability to provide drinking water of adequate quantity and quality. Our ability to provide this service is being negatively impacted by hydrogeologic conditions documented in the GSP. It appears likely that MVWC will need to incorporate infrastructure projects in the future to react to the changing hydrogeologic conditions in the Basin, and funding availability for many of these projects is likely to be contingent on the MVWC’s inclusion in the GSA/GPS. Therefore, we request that the MVWC be specifically identified in the early chapter(s) of the GSP, as a distinct entity within the County GSA’s area along with the included agencies. We provide the following summary text for inclusion in the plan.

“Madera Valley Water Company is located in the County of Madera north of the City of Madera and was constructed in 1956. Located north of Avenue 17 between Road 26 and Road 27. It encompasses approximately 1,600 acres. The population served is estimated at 8,900. The majority of the connections are residential. The lot sizes range from ¼ acre to 1 acre. There are approximately 50 commercial properties which consist mainly of small retail stores, restaurants, offices, and several gas stations. The water system has 5 wells ranging in depth of 543 feet to 770 feet and a 1.5-million-gallon elevated water storage tank. Each of the wells has a liquid chlorination unit for emergency chlorination. There are approximately 40 miles of pipeline in the system.”

2. Declining water levels and well yield. It is acknowledged in the GSP that agricultural production is by far the largest user of groundwater in the Basin. In recent years there has been a substantial increase in the amount of groundwater used in the area surrounding the MVWC as agricultural acreage been converted from historical seasonal crops to crops that require more water such as almond and other orchards without the availability of surface water. The planting of new orchards immediately adjacent to and surrounding the MVWC service area for nut farming has accelerated since the passage of SGMA. Our service area is now bounded on three sides by recently installed deep agricultural wells. When these ag well pumps are turned on, MVWCs static water levels decline over 40 feet, and the resulting drawdown when we operate MVWC wells is significantly greater than any recorded drawdown in the MVWC’s history. This results in total dynamic head pumping conditions that do not correspond to the pump design curve, resulting in pumping inefficiency, greater electricity costs, and likely ultimately necessitating the replacement of pumps before their design life has been reached. In September 2019, production in Well 5 decreased from 1,700 gpm to 1,300 gpm overnight when the ag well pumps were turned on. The standing water level dropped 40 feet and the pumping water level dropped 100 feet. Because MVWC serves 8,900 residents has been impacted in the last 3-5 years with unprecedented declines in water levels we believe that at least one SGMA-specific monitoring well should be included in or immediately adjacent to our service area.
3. Subsidence. To the extent that subsidence is discussed in the GSP, it is essentially stated that it is not a significant enough issue that it needs to be specifically addressed. However, subsidence is one of the six undesired results listed in SGMA as requiring actions to prevent undesired results. Since 2013 MVWC has already had to repair three well casing fractures caused by subsidence affecting two of our existing wells at a cost of approximately $500,000.00. It appears likely that subsidence-related damage to our wells over the course of the SGMA planning horizon

(through 2040) will require engineering projects to repair or replace damaged wells. Chapter 4 of the GSP states that no plan to address subsidence is necessary, and that subsidence of up to 0.25 feet per year does not require mitigation. Subsidence of 0.25 feet/year is equivalent to subsidence of 5 feet through 2040, which is significant. Having already experienced infrastructure issues due to subsidence to date, and anticipating additional engineering projects may be required in response to additional subsidence, MVWC believes that subsidence is an undesired result of increased groundwater usage that needs to be specifically addressed in greater detail in the GSP.

4. Change in Water Quality. Over the more than 60 years that MVWC has provided drinking water to our service area, there has not been an issue with delivered water exceeding either primary or secondary drinking water quality standards until recently. As discussed in comment #2, static and operating water levels elevations have declined substantially in recent years concurrent with increased agricultural pumping due to a lack of availability of surface water for agriculture use. As a result, MVWC now appears to be drawing groundwater from different and/or deeper geologic strata than we were previously. Simultaneous with these new hydrogeologic conditions, for the first time we have recently observed concentrations of iron and manganese (a secondary drinking water standard, affecting taste and odor) in groundwater pumped from MVWC wells. If this water quality issue persists or expands in area/wells, it may ultimately require well head treatment to maintain the delivered water quality that our service area has historically enjoyed. The GSP should address the impacts of the lowering groundwater levels on groundwater quality in greater detail and identify the possible mitigation of groundwater quality issues over the planning horizon of the GSP.
5. MVWC Projects. Although it is stated in the GSP that agricultural pumping is the dominant use of groundwater in the Basin, MVWC understands that we have to do our part to reduce groundwater usage. We have recently successfully received recognition as a disadvantaged community (DAC) from the state, which will allow us to pursue additional funding sources for future projects. We are currently pursuing state funding sources to implement flow meter installation for each connection in our service area. We anticipate that once we establish water use for each residence, we can pursue potential management actions such as conservation programs and tiered rate structures that will result in a decrease in per capita groundwater consumption in our service area. We anticipate that these actions will result in a decrease of at least 30% in our annual groundwater pumping volume. This project should be included in the GSP.
6. MVWC provided more than 30 years of data to the GSA consulting team for use in the GSP development, but we see no evidence in the plan that it was considered or utilized. Will there be an appendix or some acknowledgement that our data was used in the development of the plan?
7. The GSP utilizes estimates for much of the pumping data collection. The GSP should include a policy or at least a discussion of having all non-de minimis wells metered to ensure accuracy of the pumping data and for potential use to generate revenue to pay for recharge projects based on actual use.

Section 2: Comments on larger policy and management issues that do not directly affect the MVWC service area or operating conditions but may impact the implementation of the GSP for the MVWC and other agencies in the Madera Basin.

8. The GSP appears to depend on future purchases of surface water to account for much of the water budget deficit, but no details are given on these proposals. As the sub-basins are all interconnected, with no hard boundaries between them groundwater flows freely between sub-basins based on local gradients, pumping centers, etc. It seems that regional cooperation will be necessary to coordinate proposed recharge (and other) projects to optimize the impact of such projects. There is no discussion of such proposed regional cooperation outside of the Madera sub-basin in the plan. The GSP should include a policy or at least a discussion on how basin-wide or multi agency projects would be planned and developed to include all stake holders, including small agencies and DAC's, to ensure that recharge or other mitigation projects are effective and economically feasible.
9. Finally, the Implementation chapter of the GSP is the shortest chapter, and lacks the detail that would comprise a robust GSP. The MVWC recommends that the implementation chapter include more detail on how the GSP would be implemented and include policy statements regarding implementation such as those discussed in these comments.

Respectfully,

Gregory E. Rodgers
General Manager

CHOWCHILLA SUBBASIN
GROUNDWATER SUSTAINABILITY PLAN (GSP)
COMMENT FORM

Please complete the following information to provide comments on the draft Chowchilla Subbasin GSP. Type or print legibly for your comments to be considered.

Please return this form to (hand delivery, mail, or email accepted):

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637
Email: ChowchillaGSPComments@maderacounty.com

Date Submitted: Nov 2, 2019

Submitted By: MARK Hutson

Address: 13534 Ave 19 1/2 Chowchilla, CA 93610

Phone Number / Email: 559-217-6609

APNs: 023-040-014 + 022 023-110-009 + 008

Located in Groundwater Sustainability Agency (GSA):
☐ Madera County ☒ CWD ☐ Triangle TWD ☐ Merced County ☐ Other ____________

Affiliation: ☒ Irrigated Ag ☐ Non-Irrigated Ag ☐ Rural Residential
☐ Disadvantaged Community Member ☐ Agency/Government ☐ Other ____________

Chapter No. / Page No. of GSP: 5.5

Comments: I would remove the word 'All' in comply with All of the Requirements"

Chapter No. / Page No. of GSP: 5.6.1

Comments: Implementation of all projects. Remove "all"

In Short - Remove The words All, shall, will, etc. These words are strong assertions + can be left out. This would apply to all chapters

Chapter No. / Page No. of GSP: 4

Comments: I believe it is very important to strongly state in this chapter + others, that as knowledge, Technology + management practices adapt + change, that the methodology of projects will adapt. This area of operation is so new, what we think is right may be wrong, and visa-versa. Please leave

Chapter No. / Page No. of GSP:

Comments: A wide area to manuver within the GSP as GSA's become more knowledgable. They need to be nimble and not constrained by a plan that may become obsolete.

NORTH KINGS GROUNDWATER
SUSTAINABILITY AGENCY

Member Agencies
Bakman Water Company
Biola Community Services District
City of Clovis
City of Fresno
City of Kerman
County of Fresno
Fresno Irrigation District
Fresno Metropolitan Flood Control District
Garfield Water District
International Water District

Board of Directors
Chairman Jerry Prieto, Jr.
Fresno Irrigation District
Vice-Chairman Brian Pacheco
County of Fresno
Steve Pickens
Bakman Water Company
Jose Flores
City of Clovis
Lee Brand
City of Fresno
Rhonda Armstrong
City of Kerman
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Garfield Water District

Executive Officer
Gary Serrato

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Phone
559-233-7161

November 8, 2019

Via U.S. Mail and E-Mail (E-mail Address)

Ms. Stephanie Anagnoson, Director
Water and Natural Resources Department
Madera Subbasin GSA
C/O Madera County
200 W. 4th Street, Third Floor
Madera, CA 93637

RE: <u>Madera Subbasin Joint Groundwater Sustainability Draft Plan</u>

Dear Ms. Anagnoson:

The North Kings Groundwater Sustainability Agency (NKGSA) consists of member agencies including Fresno Irrigation District, the cities of Fresno, Clovis and Kerman, Fresno County, Bakman Water Company, Biola Community Services District, International Water District, Garfield Water District, and the Fresno Metropolitan Flood Control District. The NKGSA also consists of disadvantaged communities, private well owners, and other landowners. The Madera Subbasin borders the NKGSA boundary. The NKGSA submits this letter to the County of Madera (County) regarding the draft Joint Groundwater Sustainability Plan prepared for purposes of the Sustainability Groundwater Management Act (SGMA).

The NKGSA appreciates the opportunity to comment on the Madera Subbasin GSP. The NKGSA is concerned about the Madera Subbasin governing board adopting the draft GSP. Due to significant deficiencies as described below, NKGSA urges the Madera Subbasin to delay adoption of the GSP and address the issues described below, and summarized as follows:

- The Madera Subbasin draft GSP indicates there is approximately 69,400 AF of historical and current inflow and with no project actions, the amount of inflow increases to 108,200 AF in 2040, which the Madera Subbasin identifies as their sustainability goal. With projects implemented and completed, the inflow is reduced to approximately 21,400 AF between 2040 and 2090.

- The GSP demonstrates the Madera Subbasin will not achieve the sustainable yield or groundwater sustainability within SGMA's mandatory 20-year period, primarily due to the Madera Subbasin miscalculating the annual overdraft deficit when accounting for the inflow and failing to address how the Subbasin will mitigate the overdraft deficit including starting mitigation during the first year of GSP implementation. The Madera County GSA does indicate they will initiate their demand management program in year one but the details are being finalized. This could result in a reduction in demand of about 2%, which does not account for the total boundary flow of approximately 69,400 AF.

- The GSP infers the Madera Subbasin GSAs encroach on approximately 69,400 AF of water per year within the NKGSA's boundary which drains into the Madera Subbasin.

- NKGSA, including its member agencies and stakeholders, intends to capture and recapture water (as has been historically and currently occurring), whether surface water, groundwater, or recharge water, which the Madera Subbasin's draft GSP indicates is flowing into the Madera Subbasin and is a benefit to the Madera Subbasin through 2040. This practice is unlawful, inequitable and inappropriate by the Madera Subbasin.

- Time still remains to correct these deficiencies prior to the January 31, 2020, deadline for submitting the GSP to the California Department of Water Resources (DWR).

Ultimately, the Madera Subbasin GSP contains deficiencies arising to a definition of sustainability in the Madera Subbasin that is improperly reliant on boundary flows from the NKGSA, which may vary but more importantly, that are not abandoned by the NKGSA nor its member agencies or stakeholders. Accordingly, the Madera Subbasin GSAs must not make claim to that water.

The NKGSA looks forward to continuing to collaborate with the Madera Subbasin GSAs on the correction of the concerns contained in this letter. Please contact me at (559) 233-7161 should you have any questions.

Sincerely,

Gary R. Serrato

Gary R. Serrato
Executive Officer

CC: City of Madera GSA
Madera County GSA
Madera Irrigation District GSA
Madera Water District GSA
Root Creek Water District GSA
Gravelly Ford Water District GSA
Mr. Michael Carbajal – City of Fresno

MADERA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN (GSP) COMMENT FORM

Please complete the following information to provide comments on the draft Madera Subbasin GSP. Type or print legibly for your comments to be considered.

Please return this form to (hand delivery, mail, or email accepted):

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637
Email: MaderaGSPComments@maderacounty.com

Date Submitted: November 9, 2019

Submitted By: Phil Janzen, President, Madera Ag Water Association

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Phone Number / Email: (559) 674-8871 maderaagwater@gmail.com

APNs: ______

Located in Groundwater Sustainability Agency (GSA):
☑ Madera County ☐ MID ☐ City of Madera ☐ MWD ☐ Other ______

Affiliation: ☑ Irrigated Ag ☐ Non-Irrigated Ag ☐ Rural Residential
☐ Disadvantaged Community Member ☐ Agency/Government ☐ Other ______

Chapter No. / Page No. of GSP: ______

Comments: See attached letter.

MADERA AG
WATER ASSOCIATION

November 5, 2019

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637
Email: ChowchillaGSPComments@maderacounty.com
MaderaGSPComments@maderacounty.com

Re: Comments on the Madera and Chowchilla Draft GSPs

Dear Ms. Anagnoson:

The Madera Ag Water Association (MAWA) appreciates the extraordinary effort that has gone into developing the Draft Groundwater Sustainability Plans for the Madera and Chowchilla Subbasins (Draft GSPs). Throughout the development process, the Madera County Groundwater Sustainability Agency (Madera County GSA) has made every effort to be inclusive and transparent in the development of the Draft GSPs. We thank you for that approach and for the opportunity to provide comments on the Draft GSPs.

MAWA is a non-profit membership organization representing farmers operating in areas of Madera County managed by the Madera County GSA. We are committed to working with all stakeholders in our community and with the Madera County GSA to make our basins sustainable. While this difficult task means significant changes for the agricultural community, we recognize the importance of being successful. State intervention is simply not an option.

We also want to thank the team at Madera County for identifying funding to offset the costs of establishing the Madera County Groundwater Sustainability Agency and developing the Draft GSPs. This allowed our community to comply with the rigorous initial requirements of the Sustainable Groundwater Management Act (SGMA) without simultaneously being financially burdened from the outset. We believe this deliberate approach has provided best possible opportunity for our community to successfully implement SGMA.

Even with this sound start, implementing the GSP will be challenging, particularly for agriculture. While many will be impacted, the greatest burden will be borne by the agricultural community. Because of that circumstance, MAWA encourages the Madera County GSA to continue to ensure that farmers and ranchers have the appropriate opportunity to engage with the SGMA process.

Comments

Planning vs. Prescribing: One of the key challenges in drafting a GSP is balancing between establishing a workable long-term strategy and providing near-term certainty through specific prescriptions. The reality is that the first step in the journey to groundwater sustainability is establishing and refining critical measurement and monitoring systems. While this means that certainty about some parameters is delayed, this is a necessary foundation to ensuring a fair and workable system is ultimately implemented.

The Draft GSPs appropriately manage this balance by clearly identifying what is needed, how it will be obtained, and how it will be used to implement the management actions and projects that will achieve sustainability. The specific prescriptions and implementation of the tools is rightfully left to the implementation phase of the GSP. While this does leave some uncertainty at present, it is important that the tools and prescriptions be based on the needed information and not hurriedly placed on a flawed foundation.

ETAW vs. AW: In discussing the Draft GSPs with stakeholders there is some confusion about the difference between the Evapotranspiration of Applied Water (ETAW) and Applied Water (AW). Although the Draft GSPs are not deficient in their explanation of this distinction, additional clarification, perhaps in the Executive Summary, would help the reader understand the difference between these terms and how they are used in the Draft GSPs.

Projects and Management Actions – Section 4: The Draft GSPs identify recharge, conveyance, and (for the Chowchilla Subbasin) storage as projects, and demand management as a management action. These tools will be utilized to bring the basins into balance over the next twenty years.

While these projects and management actions may be implemented by the GSAs, it would be useful to clarify in the Draft GSPs how these projects and management actions may be also implemented by other entities or individuals. This would allow others, in coordination with the GSAs and consistent with the GSPs, to implement projects and management actions that move us toward sustainability. In some cases, these entities may be able to implement these projects or management actions more quickly and efficiently than the GSAs.

Recharge – Section 2.2.3.3 & Section 4 (Table 4-2): In discussing groundwater recharge, the Draft GSPs appropriately focus on Flood-MAR, recharge basins, and in lieu recharge. While these surface water diversion projects should remain the priority of the GSP, it may be useful for the GSP to anticipate inclusion of other types of projects and management actions that may not divert surface water but may contribute to the groundwater replenishment portfolio.

Increasing consideration and study is being given to forest management, tillage practices, stormwater management, and other management practices that may increase the amount of precipitation infiltrating into the groundwater system. While these management practices are not sufficiently developed to be included in the projected budget, it would be helpful if the GSP also referenced groundwater replenishment practices that do not rely on diverted surface water.

Measurement – Section 4.4.4.3/4.2.3.3: The Draft GSPs identify several methods for measuring groundwater use that may be used in the basins. While simply identifying these tools is appropriate for the GSP, it will be useful to for tools like remote-sensing measurement and analysis of ETAW to be implemented quickly so that bugs can be worked out and groundwater users can gain confidence in these systems as soon as possible.

Rampdown – Section 4.4.4.2/4.2.3.2: The Draft GSPs identify a target for ramping down groundwater use of 2% per year for the first five years and 6% per year thereafter. While this is an appropriate goal, there are two clarifications that would be useful to include.

First, it would be helpful to further explain that the annual rampdown targets apply to the Madera County GSA area as a whole and not to individual parcels or ownerships. Although the Draft GSP already indicates this is the case, highlighting this fact in the Executive Summary and in the relevant sections may help alleviate some confusion.

Second, during the first few years of implementation, information and tools may not be available to provide specificity about whether these targets are being met. This is an expected challenge as not all the information needed to demonstrate these conditions is available. However, it may be useful to indicate this fact so that an inability to conclusively demonstrate planned reductions in the first year of implementation does not suggest the plan is inadequate. While actions will be taken to reduce demand immediately upon implementation of the GSPs, whether certain targets are hit may not be demonstrable for some time.

Allocations – Section 4.4.4.2/4.2.3.2: Implementing a groundwater allocation program may not be the only way to achieve the required demand reduction goals. Another option may be carefully managing access, consistent with property rights, and limiting the total available water without individual user allocations. Amending the Draft GSP to refer to "Allocation/Access" may clarify that approaches other than allocation may also be used to meet demand reduction goals.

<u>Trading – Section 4.4.4.2/4.2.3.2</u>: The Draft GSPs refer to a "water trading program" as a means of trading water credits. While market systems can add important flexibility to a system where available supply is limited, the details of the market system may end up being something other than a water trading program. Consider describing a "market system" generally to ensure that other types of market systems are also anticipated in the GSP.

<u>Easements – Section 4.4.4.2/4.2.3.2</u>: Because the term "easements" can be understood in different ways, it would be helpful to use a more descriptive term to refer to voluntary programs to cease irrigating lands. Whether through easements or leases, irrigation abeyance agreements are a useful tool and should remain in the GSP. Find a good term to describe the range of such alternatives will help reduce confusion.

<u>Fallowing – Section 4.4.4.2/4.2.3.2</u>: The Draft GSPs appear to use the term fallowing to refer to ceasing to irrigate land that is currently irrigated. To the extent this term is used in the typical agronomic context, namely referring to land that has been plowed and left unseeded or is otherwise not in use, it is unnecessarily restrictive.

As the GSP is implemented and land come out of irrigated agricultural production, much of that land may find other uses that do not require irrigation. Such land, for example, may be dryland farmed, transitioned to rangeland, converted to habitat, or be used for a solar array. Each of these new uses would cease irrigation, but would not technically be fallowing. Consider amending the Draft GSPs to refer to "land transition" or a similar term that indicates cessation of irrigation but anticipates a future economic use.

<u>Conclusion</u>

The GSAs that worked together on the Draft GSP have done a remarkable job setting forth a plan to bring the Madera and Chowchilla Subbasins into a sustainable condition. MAWA appreciates this work and looks forward to working with these GSAs and with other stakeholders to ensure our community follows the best path forward.

Thank you for considering these comments.

Sincerely,

/s/ *Phil Janzen*

Phil Janzen, President
Madera Ag Water Association, Inc.

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October 21, 2019

VIA E-MAIL TO AND TO: MADERAGSPCOMMENTS@MADERACOUNTY.COM
STEPHANIE.ANAGNOSON@MADERACOUNTY.COM

Stephanie Anagnoson, Director
Water and Natural Resources Dept.
200 W. Fourth Street
Madera, CA 93637

Re: Gunner Ranch West

Dear Ms. Anagnoson:

This firm represents Gunner Ranch Inc., and Richard V. Gunner and Mimi S. Gunner, trustees of the Richard V. Gunner and Margaret S. Gunner Community Property Revocable Trust Agreement dated March 11, 2002 (collectively, the "Gunner Family"), with respect to the project known as Gunner Ranch West (the "Project").

This letter is being submitted concerning the Public Review Draft Joint Groundwater Sustainability Plan (the "GSP") prepared for the Madera Subbasin on behalf of the Madera Subbasin Coordination Committee, including the Madera County Groundwater Sustainability Agency. Please ensure that this letter, and the referenced materials, is included in the administrative record concerning the deliberations of the GSP by the Madera Subbasin Coordination Committee as well as the separate deliberations that may be conducted by the Madera County Groundwater Sustainability Agency.

I. The Gunner Ranch West Project and Its Adopted Water Balance Plan.

The Madera County Board of Supervisors (the "Board") approved the Gunner Ranch West Specific Plan (the "Specific Plan") by resolution adopted dated July 14, 2014. The Specific Plan is supported by a Development Agreement and Conditions of Approval 1-7 requiring, in part, development of a Groundwater Plan (the "GRW Groundwater Plan") accounting for a 1:1 water balance within the Project area.

Once completed, the Project will consist of a comprehensively planned mix of residential, regionally serving commercial, retail, hospital-related services, medical offices and governmental services, open spaces and parks, and land dedicated to other public uses. The plans are an important part of the development that support of the growth and operation of Valley Children's Hospital, which itself owns a significant amount of land within the County and is the County's largest private sector employer.

In conjunction with approval of the Specific Plan and the Development Agreement, the Board also approved the creation of a Zone of Benefit within the existing County Service Area No. 22, designated "Zone C" ("CSA 22C"), to provide water, sewer and park services to the Project, including the delivery of water. In accordance with Government Code Section 31010, a Municipal Advisory Committee (the "MAC") was subsequently formed to advise and provide recommendations the Board on all matters relating to the development of infrastructure and the provision of services within the geographic boundaries of CSA 22C. The MAC is empowered to provide recommendations to the Board regarding, in part, the development of water system improvements sufficient to support the Project.

Litigation concerning the Project's entitlements was initiated soon after the approval of those entitlements. Settlement of that litigation with Root Creek Water District (Settlement Agreement dated October 22, 2015, the "Settlement Agreement") resulted in the Board's adoption of an Enhanced Groundwater Balance Condition (the "Condition") applicable to the Project. That Condition required preparation and submission of the GRW Groundwater Plan to account for a 1:1 "Groundwater Balance" within the Project. The Condition defines Groundwater Balance as "the annual Water Extraction from the Local Aquifer for use within the [Project area] does not exceed [the Project's] annual Water Input to the Local Aquifer", as measured on a five-year rolling basis. The term "Water Input" is defined within the Condition to mean the direct and natural recharge of water to the aquifer, in addition to any off-site direct or "in lieu" water recharge (including conservation easements).

The Gunner Family submitted an initial draft of the GRW Groundwater Plan on March 9, 2018. Following a lengthy technical review and input by representatives from Madera Irrigation District, Chowchilla Water District, Root Creek Water District, Gravely Ford Water District and the Madera County Farm Bureau, and after further consideration by County staff, including the County Engineer, the revised and finalized GRW Groundwater Plan was approved by unanimous vote of the Board on May 7, 2019.[1]

The Board resolution adopting the GRW Groundwater Plan requires that the Gunner Family further revise the Plan within six (6) months of the adoption by the Board (sitting as the Madera County Groundwater Sustainability Agency) of a Groundwater Sustainability Plan ("GSP"), as required under California's Sustainable Groundwater Management Act ("SGMA"), and further "conform the [GRW Groundwater Plan] to the provisions of the adopted GSP."

In its present form, the GRW Groundwater Plan estimates a Project-specific average sustainable natural recharge per acre to the local aquifer of 1.05 acre feet of water per acre (the "Project Sustainable Yield"), as stipulated in the Settlement Agreement. The Project Sustainable Yield is based on the Hydrogeologic Investigation: Southeastern Madera County, October 2001, prepared for the Root Creek Water District by Provost & Prichard and Kenneth D. Schmidt and Associates, and calculated on a Project-specific basis by establishing demand, as offset by historic overdraft conditions, within the Project area itself. In essence, the Project Sustainable Yield is tied directly to the specific character of the Project and its underlying aquifer. Of utmost

[1] The GRW Groundwater Plan is available in the Board's May 7, 2019 Agenda meeting materials, item 7-F at http://maderacountyca.iqm2.com/Citizens/FileOpen.aspx?Type=1&ID=2561&Inline=True.

importance, the success of the Project is premised on the availability of a reasonable credit for the Project Sustainable Yield, any substantial reduction of which will significantly disrupt the functionality of the CSA 22C community water system.

To achieve a sustainable natural recharge, the GRW Groundwater Plan prohibits the pumping of groundwater in excess of annual groundwater recharge - either natural or engineered - such that there can never be a net negative in groundwater extracted. Although the Project is required to achieve groundwater balance within three years of the GRW Groundwater Plan's approval, the GRW Groundwater Plan demonstrates water balance at inception through Project build-out.

With respect to native groundwater recharge, in addition to rainfall and runoff, the GRW Groundwater Plan incorporates an analysis of returns to the aquifer resulting from the water applied to outdoor irrigation in excess of evapotranspiration demand that percolates to the groundwater basin. Deep percolation, as this processed is called, is an accepted element of groundwater accounting and is included in the Definitions section of the 2014 Madera Regional Groundwater Management Plan and the California Department of Water Resources' ("DWR") 2013 California Water Plan Update.

As for engineered recharge, the GRW Groundwater Plan contemplates the use of various enhancement recharge projects within the geographic boundaries of the Project, including ponds to be developed in conjunction with the Project's Waste Water Treatment Plant for recharge of effluent not applied for recycled water demand. The GRW Groundwater Plan further contemplates an extensive storm water drainage system, including substantial drainage basins, which is designed to provide significant enhanced recharge of storm water runoffs to the groundwater aquifer located beneath the Project.

In addition to implementing active recharge elements, the GRW Groundwater Plan requires ongoing, and real-time monitoring by the MAC, the County, and neighboring water districts to insure that the no net negative use requirement is fulfilled. To meet this requirement, the Gunner Family has placed a meter on each well located within the Project area in order to monitor water table elevation, and continues to provide monthly reports to the County Engineer to facilitate verification of the data collected from these meters.

The GRW Groundwater Plan also contains severe penalties for use of groundwater in excess of annual groundwater recharge, including the County's automatic refusal to process subdivision maps and building permits related to the Project, and the levy of a stiff per-acre foot penalty for any excess groundwater pumped.

In short, the GRW Groundwater Plan represents a comprehensive strategy for long-term groundwater sustainability within the portions of the County Subbasin that the Project overlies.

II. Summary of GSP's Key Findings about the Subbasin.

Since formation of the Madera County Groundwater Sustainability Agency ("MC GSA") on January 27, 2017, whose territories include the Project, the County has been engaged in the process of developing its GSP for application within the Madera Subbasin through various efforts of County staff, hired consultants, and the Madera County Subbasin Advisory Committee (the "Committee") in order to meet its regulatory burden under SGMA. The MC GSA is comprised of approximately 177,800 acres of primarily agricultural land.

The territory that comprises the MC GSA includes areas that resemble a patchwork quilt of territory, most of which are not contiguous to other portions of the territory.[2] Given the disparate and expansive geographic distribution of the MC GSA, the geology of the land varies significantly throughout, a perspective frequently echoed by members of the Committee during its monthly public meetings.

A significant portion of the MC GSA encompasses lands in the western portion of the County whose geology cause it have significant differences in its hydrogeology relative to other portions of the MC GSA territories. Specifically, significant deposits of Corcoran Clay impact the western reaches of the MC GSA.[3] These Corcoran Clay deposits result in such different hydrogeological circumstances. In fact, when the mapping groundwater elevations the impacted area is described in the GSP as an aquifer system separate from the remaining basin.[4] Changes in groundwater elevations within the basin are an important component of "undesirable results" identified in the MC GSA.[5]

Because of the disparate and disconnected nature of the MC GSA territory, even portions of the aquifer outside the reaches of the Corcoran Clay reflect substantial differences in historical and recent changes in groundwater elevations.[6] In comparison, the GSP identifies the area of the aquifer that the Project overlays as a more stable area of the subbasin.[7]

Despite this disparate nature of the MC GSA territory acquirer, the GSP, with respect to the MC GSA territory, makes no distinction regarding the range of potential undesirable results, and the triggers for such results, that may exist within the MC GSA territory. This single treatment of the entirety of the MC GSA territory is

[2] See GSP Figure 1-6.

[3] See GSP Section 2.2.1.1, pg. 2-26 and Figure 2-15.

[4] GSP Section 2.2.1.3, pg. 2-29 and Section 2.2.2.1, pg. 2-32.

[5] See GSP Section 3.3.1, pg. 3-18.

[6] GSP Section 2.2.2.1, pg. 2-35 and Figures 2-53, 2-56 and 2-57.

[7] GSP Section 2.2.2.1, pg. 2-35.

inconsistent with other aspects of the GSP, which establishes separate water budgets for each of the separate GSAs that constitute the Madera Subbasin Coordination Committee. Such separate water budgets effectively allow the GSP to identify more particularized minimum thresholds and measurable objectives for undesirable results for territories within those GSAs. The benefit of such arrangements is not made available to lands within the MCS GSA territory, despite its disparate geology.

III. <u>Lack of Reasoned Analysis Regarding Use of Management Areas within the MC GSA Territory.</u>

The disparate qualities of the geology underlying the MC GSA territory is compounded by the fact that the MC GSA did not make use of separately defined management areas within the GSP, which are expressly permitted under the regulations that govern the GSP development. Specifically, 23 California Code of Regulations Section 354.20 confirms that the MC GSA may define management areas within a basin if it determines their creation will facilitate implementation of the plan. The intention of these laws is that different minimum thresholds and different measurable objectives for undesirable results should be employed where there are disparate qualities within an aquifer, including differences in geology.

The desirable use of separate management areas is emphasized in the California Department of Water Resources publication of Best Management Practices for the Sustainable Management of Groundwater, issued November 2018 ("GSA BMP").[8] The GSA BMP specifically encourages the use of such management areas by GSAs. That publication confirms that "Management areas may have different minimum thresholds and measurable objectives than the basin at large and may be monitored at a different level."[9]

Despite the law's intended desired use of appropriate management areas, and despite the disconnected and disparate geology of the portions of the Madera Subbasin underlying the MC GSA, the GSP makes no reference to or use of management areas. Again, this failure is mitigated with respect to the lands of the other GSAs that comprise the Committee, because they are each provided separate Water Budgets that are a basis for important determinations of minimum thresholds and measurable objectives. Similar management approaches were not, however, adopted for any portion of the MC GSA. The treatment of the MC GSA lands is therefore

[8] The referenced document can be found at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-6-Sustainable-Management-Criteria-DRAFT.pdf

[9] GSA BMP, at pg. 6. See also GSA BMP at pg 33, which confirms that "Before setting sustainable management criteria, the GSA should understand the basin setting by establishing a hydrogeological conceptual model, engage stakeholders, and **define management areas as applicable.**" (emphasis added).

unreasonably and arbitrarily different than similarly situated lands within other GSAs within the Madera Basin.

The failure to incorporate appropriate management areas within the MC GSA to address these significant hydrogeologic differences will likely lead to regulatory impositions by the MC GSA upon landowners to address "undesirable results" in circumstances where the regulatory imposition on such landowner will be arbitrary because it has no relationship to avoidance of an actual circumstance of "undesirable result" intended for avoidance by SGMA.

Furthermore, the record of proceedings for the GSP adoption fails to reflect any reasoned consideration or evaluation of the potential benefits in using management areas within the MC GSA. The failure to incorporate management areas to GSP creates arbitrary treatment of the overlying lands that have dissimilar hydrogeology.

IV. Potential Arbitrary Allocations of Demand Reduction Targets.

Public deliberations of the draft GSP conducted by the Committee included substantial discussions of various options presented to it for potential allocation of "credits" concerning safe-yield extractions, native groundwater quantities, and activities that introduce new water to the Subbasin.[10] Similar allocations of such "credits" to specific properties are not an element of the implementation program of other GSAs whose arrangements are detailed in the GSP.

The GSP references California Water Code Section 10726.4(a)(2) as establishing the authority to control groundwater extractions through regulatory limitations.[11] However, the GSP does not specifically identify how it intends control such groundwater extractions. Nor does it specify establishment of any specific "credits" that it intends to be part of the regulatory regime it identifies. It simply confirms that any demand management strategies that incorporate trading programs will establish definitive limits on groundwater pumping through regulatory powers of the County.[12]

There are several concerns with the program that may be intended to be implemented by the MC GSA regarding its demand management criteria. The first relates to the failure to adopt management areas. By failing to do so, the demand management criteria will be imposing limitations on the groundwater rights of certain property owners in circumstances where such water usages (within the ambit of such water rights) does not contribute to an actual undesirable result in any portion of the basin. In that circumstance, the program would be imposing arbitrary and unreasonable

[10] GSP Section 4.4.4.2, pgs. 4-41 through 4-43.

[11] The GSP also states that its program for demand management would incorporate, among other principles, the maintenance of established water rights. (GSP at pg. 4-40). However, the manner in which existing groundwater rights of landowners is properly maintained, in a regulatory program of potentially unfettered regulation of groundwater extractions, is nowhere discussed in the GSP.

[12] GSP Section 4.4.4.2, pg. 4-43.

regulatory impositions on such groundwater rights. As previously noted, the arbitrary nature of this is compounded by the fact that other GSAs were provided separate water budgets that will not be impacted by the MC GSA's allocation arrangements.

The fact that the County has limited its evaluation to two classes of lands that seem primarily based upon alternative agricultural operations indicates that there has been limited consideration of these arrangements on the development entitled lands. It is possible that this is because the demand management programs proposed by the GSP for the MC GSA are to be applied only to agricultural uses and not to other land use activities. However, that is not readily apparent in the text of the GSP.

If the GSP intends to impose demand management programs on nonagricultural land users, then the failure to reasonably consider impacts on development entitled properties is significant omission in the GSP. The GSP specifically quantifies the economic impacts of the demand management strategies on the agricultural economy. However, no similar analysis or information is provided regarding the economic (and other policy impacts) of such strategies with respect to other businesses, employees, or residential development.[13]

The impact of the intended demand management strategies on the Project can lead to significant consequences for important goals of the County identified in its General Plan. Development of the new growth areas, including the Project, is intended by the County to assist in focusing development in designated growth areas, as a means of ameliorating development pressures on other locations where farmlands may be more substantially impacted (see Madera County General Plan Agricultural Land Use Policy 5.A.1).[14] Adding unnecessary and disproportionate regulatory constraints on the Project will arbitrarily frustrate such General Plan goals.

Continuation of large lot development patterns within the County is not a sustainable approach. A program that allocates existing large lots a right to 2 acre-feet of annual domestic water supply use per user, while imposing substantially more burdensome regulatory regimes on new growth areas (in instances where no actual "undesirable result" may be attributable to such development) has the potential to thwart the County's efforts at smart growth strategies.[15]

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[13] GSP Section 4.4.4, page. 4-45.

[14] The Madera County General Plan is available at https://www.maderacounty.com/Home/ShowDocument?id=2850.

[15] GSP Section 4.4.4, page. 4-40 references the fact that the SGMA establishes such 2-acre foot per annum use for domestic water supplies as de-minimis. The GRW Groundwater Plan indicates a projected population for the Project of 9,712. The total Project groundwater extractions (without regard to the substantial replenishment from natural recharge and engineered basins), is projected to total 1,887 acre-feet (inclusive of the Valley Children and commercial uses). Obviously, smart growth in

Long-term maintenance of a reasonably established Project Sustainable Yield is a critical component of the Project's ultimate success. Implementation of demand management strategies that do not take into account the effectiveness of the adopted GRW Groundwater Plan or its different geology, is an arbitrary regulatory approach.

V. **Conclusion.**

Based on the foregoing, the Gunner Family respectfully requests that the draft GSP be revised to incorporate management areas within the MC GSA territories to address the significant variation in geology and aquifer characteristics of lands within the MC GSP. As the GSP confirms, the geology and aquifer characteristics of the Project lands is significantly different from other portions of the MC GSA, and is in an area that is a more stable area of the subbasin.

Failure to have adequately documented a reasoned deliberation for the inclusion of such management areas is a violation of SGMA. It is particularly troublesome where the GSP intends (solely with respect to the MC GSA territories) to impose allocations of native groundwater credits as part of a potential demand management strategy. Management areas will help assure that a program of allocating credits for native groundwaters can be properly and rationally tailored to the unique geology of the underlying sub-aquifer of the management area. Without that aspect of the program, the program may be an arbitrary arrangement because it may not be rationally tied to properly structured thresholds required to avoid undesirable results.

The MC GSA should provide assurances that its demand management strategies will not encompass approaches that have arbitrary and unnecessary regulatory impositions on land owners. If the intention is to exempt non-agricultural users from such strategies (and instead rely on relevant land use entitlements conditions, such as the GRW Groundwater Plan) that should be made explicit. In all events such a program must assure that it establishes regulatory impositions that are reasonably and rationally tied to avoidance of "undesirable results".

We appreciate the opportunity to provide these comments to the Draft GSP.

Sincerely,
McCORMICK, BARSTOW, SHEPPARD,
WAYTE & CARRUTH LLP

Jeffrey M. Reid

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designated new growth areas is an important tool to preserve both farmland and groundwater resources.

NORTH KINGS GROUNDWATER
SUSTAINABILITY AGENCY

Member Agencies
Bakman Water Company
Biola Community Services District
City of Clovis
City of Fresno
City of Kerman
County of Fresno
Fresno Irrigation District
Fresno Metropolitan Flood Control District
Garfield Water District
International Water District

Board of Directors
Chairman Jerry Prieto, Jr.
Fresno Irrigation District
Vice-Chairman Brian Pacheco
County of Fresno
Steve Pickens
Bakman Water Company
Jose Flores
City of Clovis
Lee Brand
City of Fresno
Rhonda Armstrong
City of Kerman
Karl Kienow
Garfield Water District

Executive Officer
Gary Serrato

Internet
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Mail
North Kings GSA
c/o Fresno Irrigation District
2907 S. Maple Ave.
Fresno, CA 93725

Phone
559-233-7161

November 8, 2019

Via U.S. Mail and E-Mail (E-mail Address)

Ms. Stephanie Anagnoson, Director
Water and Natural Resources Department
Madera Subbasin GSA
C/O Madera County
200 W. 4th Street, Third Floor
Madera, CA 93637

RE: Madera Subbasin Joint Groundwater Sustainability Draft Plan

Dear Ms. Anagnoson:

The North Kings Groundwater Sustainability Agency (NKGSA) consists of member agencies including Fresno Irrigation District, the cities of Fresno, Clovis and Kerman, Fresno County, Bakman Water Company, Biola Community Services District, International Water District, Garfield Water District, and the Fresno Metropolitan Flood Control District. The NKGSA also consists of disadvantaged communities, private well owners, and other landowners. The Madera Subbasin borders the NKGSA boundary. The NKGSA submits this letter to the County of Madera (County) regarding the draft Joint Groundwater Sustainability Plan prepared for purposes of the Sustainability Groundwater Management Act (SGMA).

The NKGSA appreciates the opportunity to comment on the Madera Subbasin GSP. The NKGSA is concerned about the Madera Subbasin governing board adopting the draft GSP. Due to significant deficiencies as described below, NKGSA urges the Madera Subbasin to delay adoption of the GSP and address the issues described below, and summarized as follows:

- The Madera Subbasin draft GSP indicates there is approximately 69,400 AF of historical and current inflow and with no project actions, the amount of inflow increases to 108,200 AF in 2040, which the Madera Subbasin identifies as their sustainability goal. With projects implemented and completed, the inflow is reduced to approximately 21,400 AF between 2040 and 2090.

- The GSP demonstrates the Madera Subbasin will not achieve the sustainable yield or groundwater sustainability within SGMA's mandatory 20-year period, primarily due to the Madera Subbasin miscalculating the annual overdraft deficit when accounting for the inflow and failing to address how the Subbasin will mitigate the overdraft deficit including starting mitigation during the first year of GSP implementation. The Madera County GSA does indicate they will initiate their demand management program in year one but the details are being finalized. This could result in a reduction in demand of about 2%, which does not account for the total boundary flow of approximately 69,400 AF.

- The GSP infers the Madera Subbasin GSAs encroach on approximately 69,400 AF of water per year within the NKGSA's boundary which drains into the Madera Subbasin.

- NKGSA, including its member agencies and stakeholders, intends to capture and recapture water (as has been historically and currently occurring), whether surface water, groundwater, or recharge water, which the Madera Subbasin's draft GSP indicates is flowing into the Madera Subbasin and is a benefit to the Madera Subbasin through 2040. This practice is unlawful, inequitable and inappropriate by the Madera Subbasin.

- Time still remains to correct these deficiencies prior to the January 31, 2020, deadline for submitting the GSP to the California Department of Water Resources (DWR).

Ultimately, the Madera Subbasin GSP contains deficiencies arising to a definition of sustainability in the Madera Subbasin that is improperly reliant on boundary flows from the NKGSA, which may vary but more importantly, that are not abandoned by the NKGSA nor its member agencies or stakeholders. Accordingly, the Madera Subbasin GSAs must not make claim to that water.

The NKGSA looks forward to continuing to collaborate with the Madera Subbasin GSAs on the correction of the concerns contained in this letter. Please contact me at (559) 233-7161 should you have any questions.

Sincerely,

Gary R. Serrato
Executive Officer

CC: City of Madera GSA
Madera County GSA
Madera Irrigation District GSA
Madera Water District GSA
Root Creek Water District GSA
Gravelly Ford Water District GSA
Mr. Michael Carbajal – City of Fresno

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Memorandum

To:	Stephanie Anagnoson, Director of Water and Natural Resources, Madera County
CC:	Larkin Harman and Julia Berry, Clayton Water District
From:	Rick Iger (P&P) and Keasha Blew (former P&P)
Subject:	Dairy Water Budget Parameters
Date:	11/1/2019 Revised from 10/3/2018 Internal Draft

Introduction and Summary:

After attending the confined animal Ad Hoc Committee on October 3, 2019, I was concerned that the calculation of Dairy water use was not well developed in the Madera and Chowchilla Basin GSPs. Provost & Pritchard Consulting Group has been working on understanding Dairy use of groundwater for several years. We would like to share our methodology with the County to demonstrate how the consumptive use of dairies has been handled in the past and in other GSPs. Dairy water budgeting parameters, calculations, and data sources have been based on field calculations, canal turnout and water well measurements, annual dairy reports and milk production. Generally, about 9 gallons per cow each day is exported from the dairy as milk and another 7 to 10 is excreted as urine, sweat and solids; equating to 0.01 to 0.02 Acre Foot (AF) per cow each year. Wash water varies by operation and is reported in dairy reports as outflow to lagoons; generally, about 72 gallons/cow each day which equates to about 0.08 AF per cow each year. The total water used in the dairy facility ranges from 80 to 90 gallons per cow each day, or 0.09 to 0.1 AF/cow each year.

Methodology:

The following parameters are taken into consideration in determining groundwater use by dairy facilities:

Surface Water:
- Surface water from all sources should be monitored monthly and totaled annually
- Calculate all water flowing into and out of the Ranch and dairy facility

Groundwater
- If possible, collect all well construction reports and map shallow and deep wells
- Track pumping from deep and shallow wells separately in dairy facility and cropped land
- Monitor groundwater levels in both shallow and deep aquifers

Recycled Water
- Recycled water or lagoon water produced and applied is found in dairy reports

Precipitation
- Typically, about 50% of precipitation is used for crops. The remainder can become deep percolation or runoff depending on geographic location

Consumptive use

- For dairies consumptive use is from both fodder crops and cows so it is important to know:
  - Number of cows
  - Total lagoon water produced from dairy operations (dairy permit report)
  - Acreage of dairy facility (non-cropped area), of dairy lagoons/ponds and of crops by crop type
  - Location and quantity of irrigation for crops
- This information can be found in annual dairy reports as part of the State Dairy Permit requirements. A couple of studies were also referenced for use by another consulting firm (EKI) we are working with in Kern County using University of Nebraska-Lincoln resource: https://beef.unl.edu/water-requirements-for-beef-cattle, http://extensionpublications.unl.edu/assets/html/g2060/build/g2060.htm and https://beef.unl.edu/amountwatercowsdrink.
- Consumptive use for dairies also includes milk production. Milk is about 88% water and a cow can produce an average of 75 lbs of milk per day. This becomes approximately 9 gallons of water used for milk production per cow each day, adding cow consumption and dairy facility wash water the total becomes about 80 to 90 gallons of water per cow each day. This was verified with local dairymen and numbers calculated were within a small margin of error.

Other Losses

- Evaporation is the main source of losses that are not returned to the system. Publications have several different references for open water evaporation. Upon examination it was found that evaporation from small ponds surrounded by irrigated agriculture is about 0.8 or 80% of reference ET.

Groundwater Replenishment

- In order to know how surface water recharges back into the groundwater system it is important to know about soil types and recharge rates of the soil which can vary.
- It is assumed that any applied water not lost to evaporation or ET of crops is recharged into the system
- Ponding seepage or canal seepage can be determined many ways. The easiest being the difference between measurements at specific monitoring points and pond drops under no inflow and outflow conditions. Soil types can also be used to estimate seepage by comparing to known/measured recharge areas on various soil types. In the case of dairy lagoons, the State Permit requires lining to prevent seepage, so the majority of losses from the lagoons are due to evaporation, not seepage.

Example Calculation:

In the case of one particular dairy studied in Merced County with 2,900 cows, about 0.009 AF/cow each year was exported as milk and 0.08 AF/cow each year was effluent sent to lagoon (per Dairy Annual Report). The total being 0.089 AF/cow each year, say 0.09 AF/cow each year.

In this case the dairy facility footprint was about 105 acres resulting in an average annual unit rate of 2.5 AF/Ac (2,900 cows x 0.09 = 261 AF; 261 AF/105 Ac = 2.5 AF/Ac). Keep in mind that the effluent component (0.08 x 2,900 cows = 232 AF) of the water generated in the Dairy facility minus that part lost to evaporation, is sent to the cropped grounds for effluent disposal/irrigation, which does reduce the crop water needs as would be estimated on the cropped field using ET methods. In this case there is about 2,000 acres of cropped land, so about 0.12 AF/Ac (232 AF/2000 Ac) is provided for irrigation coming from the Dairy facility lands. If the ET method was used to calculate groundwater pumping from the cropped field, the pumping would be overestimated from the cropped acreage which could be inappropriately subject to reduction if demand reduction is implemented.

From: Madera County Water [mailto:website@maderacountywater.com]
Sent: Wednesday, September 4, 2019 8:10 AM
To: MCwater
Subject: New submission from Contact Us

Name

Paul Provenzano

Email

provenzanopc@aol.com

Phone

(559) 232-9249

Message

Hello Stephanie
Looking at Appendix 3 page 5. Just wondering how they calculated an annual domestic well mitigation program cost of $277,000. The annual administrative cost is purported to be $150,000 plus $5,000 per well. This would leave only $127,000 for wells ($277,000 less $150,000). At $30,000 per well ($25,000 plus $5,000 admin fee) this would leave enough for only enough reimbursement for about 4 wells yet there is supposed to be enough to reimburse for 12 wells per year. (240 impacted wells divided by a 20 year implementation period) Do I have my math right? This does not look right! I think 12 wells per year is a little light! Talked to my well driller Horner and Sons and he drills 2 wells per week for 100 per year. Thanks!

Meta

205.157.153.167 Mozilla/5.0 (Windows NT 6.1; Win64; x64; rv:68.0) Gecko/20100101 Firefox/68.0

November 9, 2019

Stephanie Anagnoson
Water and Natural Resources Department
Madera County
200 W. Fourth Street
Madera, CA 93736

RE: Root Creek Water District Comments on Madera Subbasin Joint GSP

Dear Stephanie:

The Madera Subbasin Joint Groundwater Sustainability Plan (GSP) covers a significant majority of the Madera Basin. It is recognized that the Madera Irrigation District GSA and Madera County GSA cover over 89% of the basin and these two entities and the resultant programs implemented by these agencies will have the most significant ability to achieve sustainability. The Root Creek Water District (RCWD) GSP covers a small portion of the basin – almost 10,000 acres or about 4% of the total. To this end, the RCWD GSA has participated with the other GSA's in the basin to develop the data and information to develop a better understanding of the groundwater conditions of the basin and develop specific projects that will benefit our local agency. Because the land area is smaller, the RCWD GSP has the advantage of more specific data in the area that it encompasses and encourages the other GSAs to develop similar data sets in the areas that each GSA borders, so that there is more definition as to documenting the actions and results of each GSA.

Our comments can be grouped into three different categories. The first being conceptual or big picture issues on which the GSP is based. The second being water budget and model-based comments. The third being specific comments regarding specific language, statements, maps, boundaries and factual statements and/or differences in this GSP and numbers identified in the RCWD GSP.

Conceptual:
The Hydrological Conceptual Model for the Madera Subbasin Joint GSP depicts the aquifer as being semiconfined below about 200 feet, the Corcoran Clay extending midway through the

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basin and water levels that historically trended from Northeast to the Southwest and now, due primarily to pumping, trend from the Southeast to the Northwest. Wells are also identified as being deeper east of State Highway 99. From all the charts, graphs and data that has been developed, there is very little data and information in the approximately 72,000-acre area defined southeast of State Highway 99 and 145. This area accounts for about 33% of the total basin area and more than 50% of the County GSA and relies almost exclusively on groundwater. This is also an area that has significant rural residential properties and it is recommended that this be an area of keen interest going forward. In Figure 3-6, there are four wells that are identified as lower aquifer well monitoring sites. Two of these, MCE RMS-4 and, 5, are of unknown construction. Similarly, on Figure 3-7, MCE RMS-2, and 3 are also of unknown construction. It is concerning that there are not more monitor sites for water levels in this area and data from these wells may not be comparable.

Water Budget:
Per Section 354.18 a water budget is required for the basin. The Madera Subbasin Joint GSP provides a very detailed subbasin water budget given the information that is available at this time. The data and methodologies used to develop both the budget, estimate overdraft and determine sustainable yield are thought to be within the range of the estimates given the confidence in the basic data. It is expected that the numbers will change over time and as better information becomes available. It is also recognized partitioning these basin wide values to smaller areas is difficult and given that these smaller areas have more and perhaps better-defined numbers that the accuracy of more localized data and information will be more acceptable than the regional generalizations.

As documented in the Madera Subbasin Joint GSP, the goal of the GSP is to stabilize groundwater levels, allow for annual but stable storage change over the long term while maintaining quality without the realization of subsidence and limiting negative impacts to interconnected surface waters. Even though a model was used to develop some predictions of what may happen, it will be imperative to monitor levels and quality of groundwater supplies to measure success of the program.

The following are specific comments detailing page number, comment and discussion regarding the comment:

page	Issue or statement	Discussion
ES-3	Figure ES-1 shows RCWD GSA boundaries incorrectly	This map and all other maps in the GSP should reflect the current RCWD GSP boundary.
ES-7	The sustainable yield of 441,800 af doesn't match Figure ES-4	
ES-10	Table ES-3 Lowering of groundwater levels	The MO and MT are set via the model. The model is based upon data from wells. The RCWD GSP are based upon observed water levels

		and extending the trends into the future recognizing the implementation of projects.
ES-10	The GSA's intend to mitigate for potential impacts to domestic wells caused by further decline in groundwater levels	The RCWD GSA has implemented and is operating projects and does not intend to participate in mitigating impacts to wells in adjacent GSAs.
ES-13	Figure ES-5 – there are limited monitor wells in Southeast Madera basin bounded by State Highways 99 and 145	The RWCD GSA encourages installation of additional monitor wells at the border of the GSA's as well as in the Madera Ranchos as well as between the Madera Ranchos and State Highway 41 North of RCWD GSA.
ES-13	Figure ES-5 – The monitor system proposed in Southeast Madera County does not propose discrete sampling by zone.	The proposed monitoring program is spatially and temporally inadequate. One area of considerable interest is the level change within the Madera Ranchos. No proposed monitor well is proposed and many of the wells proposed are composite or are of unknown construction.
ES-14	Table ES-4 RCWD tabulation of surface supplies	See the attached information taken from the RCWD GSA proposed GSP for more information. See Attachment 1 to this communication.
ES-15	Table ES-5 RCWD tabulation of total surface water supplies	Same as above comment
1-4	Figure 1-1 Map incorrect – RCWD GSA boundaries	
	Figure 2-47 Spring 1988 Contour Map	It is noted that this Figure documents a northwesterly groundwater flow direction similar to the groundwater flow direction found on Figure 3-22 in the RCWD GSP.
	Figure 2-48 Spring 2014 Contour Map	This map appears to have more data points than the 1988 map but much fewer

		than in an area of the Madera Ranchos. Compared to Figure 3-23 in the RCWD GSP, it appears that the location of the depression in the Southeast is located more to the west under the Madera Ranchos.
	Figure 2-49 Spring 2016 Contour Map	It appears that there is even less data when compared to other maps to prepare this map in the Southeast portion of Madera County.
	Figure 2-53 Hydrograph shows level data from 2000 to present	The hydrograph for well id 11S20E31P001M is in the same proximate area as RCWD well 130 as shown on Figure 3-21 in the RCWD GSP which indicates a depth to water of approximately 275 feet in 1998 and continuing this trend to a depth of about 295 feet presently. The recovery shown in well P1M would be expected to be in a shallower well.
	Figure 2-56 Change shows ground water level rise in southeast Madera basin	As suggested in the document the groundwater elevation rise shown in the Southeast area south of State Highway 145 is from a lack of data and interpolations on data.
2-33	Paragraph 1 – identifies local depression in southeast	When looking at more specific data in the Southeast region it appears that the groundwater depressions are further east than noted on the maps.
3-5	Sustainable Management Criteria	As stated in the paragraph on measurable objectives (MO) the MO were developed based upon a model with average hydrology with implementation of projects. Since this is a layered model it is important to note that at

		varying depth or layers in the model that vary different water elevations can be realized. In the Southeastern Madera area as well, there were fewer wells to calibrate the model. Using historical data over a long period of time will provide significant insight into the realization of sustainability.
3-55	Data Gaps – elevations – lower aquifer and extreme eastern portions of basin	The data gaps mentioned earlier are identified. No plan to fill this data gap is offered.
4-3	Table 4-1	RCWD is currently purchasing water from partners outside the basin and should be added in this category.
4-4	Table 4-2	See Attachment 1 to this communication.
4-51	Section 4.7.1 Distribution of Purchased Water for In-Lieu Storage	Since completion over 16,000 af has been delivered through the system. The Madera SB GSP indicates only 8,000AF.
	Figure 3A-1 Elevation of Minimum Thresholds	Comparison with RCWD GSP shows in general range but RCWD GSP shows slightly lower levels
	Figure 3A-3 Elevation of Measurable Objectives	Comparison with RCWD GSP shows in general range but RCWD GSP shows lower levels
	Appendix 3 – Hydrograph MC-RMS-5	It should be noted that this well is shallow adjacent to the SJR and should be used discretely and may not be reflective of shallow groundwater levels.

Root Creek Water District GSA will add to its draft GSP documentation of the recent Riverstone municipal development and the resultant conversion of agricultural demand to urban demands. This project affects water use in the RCWDGSA and should be incorporated in summary in the Madera Subbasin Joint GSP. Attachment 1 illustrates the project.

Thank you for the opportunity to comment. We look forward to a successful relationship as we work toward the common goal of groundwater sustainability in the Madera Subbasin.

Sincerely,

Julia D. Berry

JULIA BERRY
General Manager
Root Creek Water District

ATTACHMENT 1

Root Creek Water District GSA GSP
Chapter 6

Project – RIVERSTONE DEVELOPMENT

6.3 Agricultural Land Conversion

6.3.1 Project Description

The Village of Gateway was initially conceived by Castle and Cooke and initiated discussions with the County of Madera in the early 1990's. Groundwater levels and the more recent dropping groundwater level trends was a problem and with the Madera Ranchos located in the vicinity and to the northwest of the lands proposed for development, the County of Madera established requirements for the development of land for municipal uses to balance the water supply. To this end, in 1996, the Root Creek Water District was formed with the purpose to balance the newly formed district's contribution to overdraft. The District contacted with various agencies for surface water supplies and have constructed a conveyance and distribution system to allow for the importation and delivery of surface supplies. This has allowed groundwater pumping to be lessened on the lands served by the surface water system. More recently, (in 2017) the construction and development of Riverstone (formerly the Village of Gateway) to commence. As of this date approximately 600 acres have been taken out of agricultural production and about 125 acres are occupied by residential properties. It is expected that about 100 acres will be converted annually until the 2,000 acres planned for development are built out.

6.3.2 Project Benefits

While it is understood that agriculture drives the economy of the county, urban development of agricultural lands can have a positive benefit on the water balance of an area and the county. The data for 2018 suggest that the reduction in agricultural pumping has been about 1,800 af with an associated municipal pumping demand of 186 af. The wastewater generated from the development is treated to tertiary levels and at present is recharged to offset pumping. The total recharge from treated effluent is 22 af resulting in a net demand of 164 af. The net result of these actions are a reduction in groundwater pumping of 1,636 af.

Similar results are projected to occur yearly as the development builds out and when fully completed the estimate is that the annual savings will approximate about 2,000 af/yr in reduced groundwater pumping for supply and a reclaimed water supply benefit of approximately 1,000 af/ yr for a total reduction in supply of about 3,000 af/yr or about 1.5 af/ac.

6.3.3 Measurable Objectives

The District will monitor water use of the development by use of meters both on water production as well as the wastewater flow and evaluate the efficiency of the system and means for water efficiency. When the wastewater flow is of an amount to justify the construction and use of this supply, the system will be constructed to either existing farm acreage and/or to parkway uses.

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6.3.4 Circumstance for Implementation
The process has been ongoing for over 20 years and as of two years ago the development has been in the early stages of construction and development.

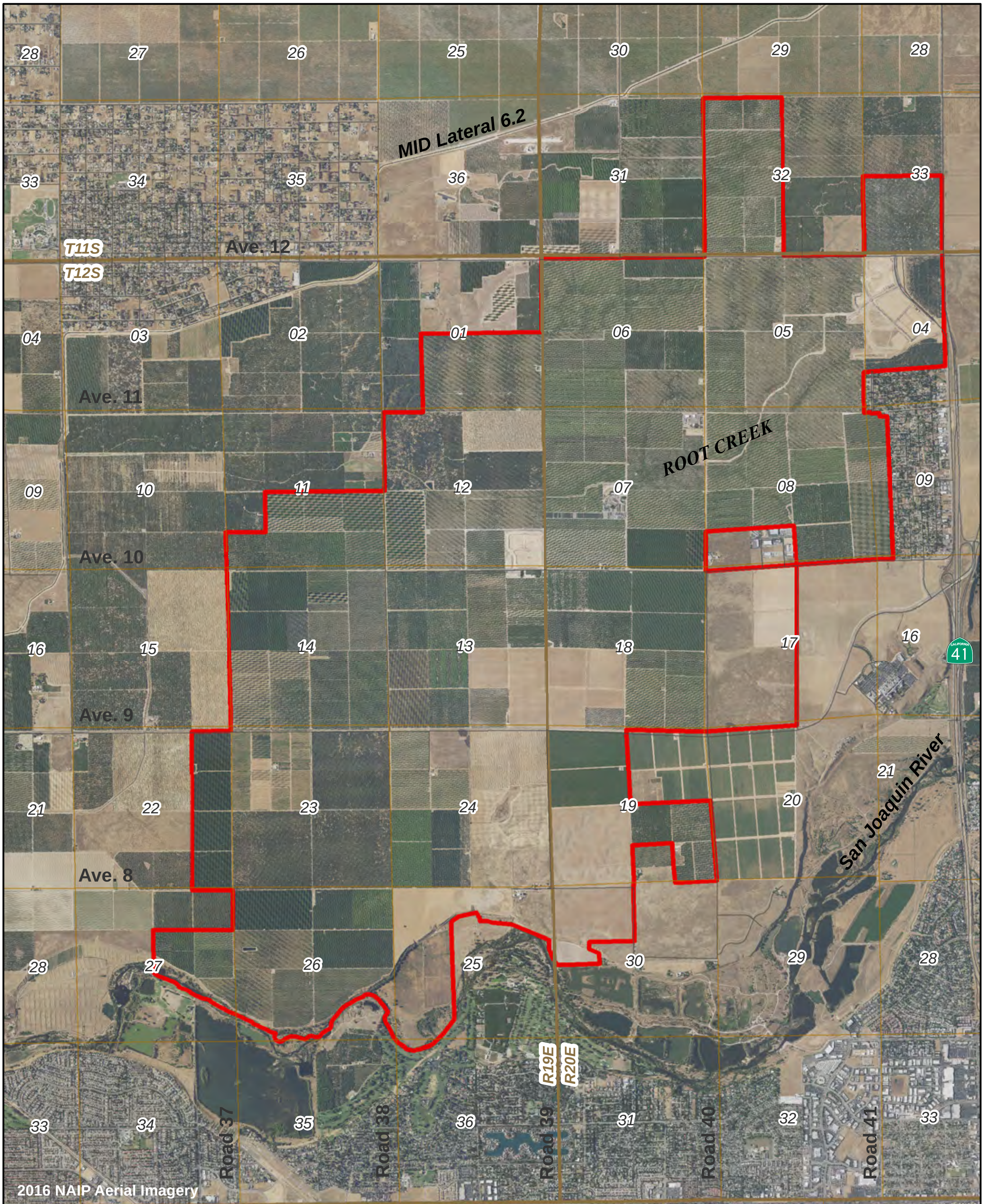
6.3.5 Permitting and Regulatory Process
As stated previously the permitting and regulatory process started over 25 years ago with the County of Madera with numerous studies investigations, permits by multiple agencies and ultimate approval in 2007.

6.3.6 Project Schedule
In progress

6.3.7 Legal Authority
Madera County Board of Supervisors in September 2007 adopted Ordinance 627 for the Gateway Village. An Infrastructure Master Plan was approved, and a groundwater recharge program was to be initiated to replace 3,400 AF of water on a 5-year rolling average basis within Root Creek Water District (District, RCWD or Root Creek WD). The recharge program included a combination of direct recharge via land application and in-lieu recharge.
6.3.8 Cost Estimate
Not applicable

6.3.9 Management of Groundwater Extractions and Recharge
As stated previously the groundwater extractions and wastewater flows will be monitored and compared to projections. Groundwater levels will also be monitored to understand the response to the activities and actions of the District.

ATTACHMENT 2



0 0.25 0.5
Miles

Legend

- Root Creek WD
- Township/Range
- Section

Root Creek WD

District Boundary

2/28/2018: G:\Root Creek WD-1249\GIS\Map\Basemaps\RCWD.mxd

MADERA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN (GSP) COMMENT FORM

Please complete the following information to provide comments on the draft Madera Subbasin GSP. Type or print legibly for your comments to be considered.

Please return this form to (hand delivery, mail, or email accepted):

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637
Email: MaderaGSPComments@maderacounty.com

Date Submitted: 10/22/19

Submitted By: SARB JOHAL

Address: 12903 ROAD 34 3/4, MADERA, CA 93636

Phone Number / Email: (559) 917-8101

APNs:

Located in Groundwater Sustainability Agency (GSA):
☐ Madera County ☐ MID ☐ City of Madera ☐ MWD ☐ Other

Affiliation: ☐ Irrigated Ag ☐ Non-Irrigated Ag ☑ Rural Residential
☐ Disadvantaged Community Member ☐ Agency/Government ☐ Other

Chapter No. / Page No. of GSP:

Comments: HOW DO YOU PROPOSE TO CHANGE TYPES OF CROPS GROWN BY MARKET MECHANISMS?

Self-Help Enterprises

A Nonprofit Housing and Community Development Organization

November 8, 2019

Madera Subbasin Groundwater Sustainability Agencies
Public Review Draft Joint Groundwater Sustainability Plan

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637

Submitted electronically to: MaderaGSPComments@maderacounty.com

Re: Comments/Recommendations on the Madera Draft Joint Groundwater Sustainability Plan

Dear City of Madera Groundwater Sustainability Agency, Madera County Groundwater Sustainability Agency, Madera Irrigation District Groundwater Sustainability Agency, and Madera Water District Groundwater Sustainability Agency, hereinafter referred to as Madera Groundwater Sustainability Agencies (Madera GSAs):

Self-Help Enterprises (SHE) would like to offer several comments and recommendations in response to the Madera Joint Groundwater Sustainability Plan (GSP) that was released for a 90-day public comment period on August 7, 2019. SHE is a nationally recognized community development organization whose mission is to work together with low-income families to build and sustain healthy homes and communities. To date, SHE has been assisting several communities to participate in Sustainable Groundwater Management Act (SGMA) related workshops, trainings and Groundwater Sustainability Agency (GSA) meetings. Within the Madera Subbasin, SHE has partnered with GSA staff to hold various regional SGMA workshops and conducted outreach in disadvantaged communities (DACs) in order to encourage and facilitate their participation in the development of their GSP. Additionally, SHE staff have served on the County's Advisory Committee and Domestic Well Ad Hoc committee.

The submitted comments are intended to assist Madera GSAs in developing a groundwater sustainability plan that accomplishes the following objectives:

1. Understands DACs' unique vulnerabilities and adequately addresses their drinking water needs;
2. Avoids developing groundwater management actions that cause negative impacts to drinking water supplies or cause a disparate impact on low-income communities of color; and
3. Achieves the objectives required by the GSP regulations and California's Human Right to Drinking Water (AB 685) in order to ensure the GSP adequately addresses the requirements necessary for GSP approval by the Department of Water Resources (DWR).

In 2012, California became the first state in the nation to legislatively recognize the Human Right to Water. AB 685 declares it is the policy of the state that "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes." With this passage of AB 685, relevant state agencies, including the State Water Resources Control Board (SWRCB) and DWR are now required to consider this state policy when revising, adopting, or establishing policies, regulations, and grant

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criteria that may impact the uses of water for domestic purposes. These agencies must consider how state actions may impact the Human Right to Water. As such and according to 23 CCR §350.4, DWR will be considering AB 685 when reviewing and approving GSPs. Moreover, as stated in the Water Quality Frequently Asked Questions document developed by the SWRCB, which provides guidance to GSAs about the role of water quality in SGMA and the requirements of GSP regulations, a GSA "should particularly consider whether any groundwater quality constituents in the basin may impact the state's policy of protecting the right of every human being to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes (Water Code Section 106.3)." Therefore, GSPs that do not properly consider groundwater reliance and drinking water uses by DACs and households served by private domestic wells, or that do not effectively avoid significant and unreasonable impacts, may not be deemed adequate and may result in costly and time-consuming revisions in order to obtain approval from DWR which we all hope to avoid.

To review the Madera Joint GSP, SHE partnered with Leadership Counsel for Justice and Accountability to conduct a focused technical review of the sustainable management criteria for water levels and water quality, the proposed monitoring network, and the local water budget (hereinafter referred to as Focused Technical Review). For the remaining sections of the draft GSP, SHE conducted an independent review that focused on the description of the plan area, the current and historical groundwater conditions for water levels and water quality, the projects and management actions, and the framework for the potential domestic well mitigation program (hereinafter referred to as SHE Review). Both reviews can be found in **Attachment A**. The reviews provide detailed explanations of the draft GSP's main gaps and serve as the base of our key findings and recommendations included below.

Our key findings and recommendations also reflect concerns and suggestions provided by groundwater users who attended the Parksdale and Parkwood community GSP review workshop on November 5, 2019. Participants were asked to share their vision for sustainability and provide comments and recommendations on keys sections of the draft GSP, including the sustainable management criteria for groundwater levels and groundwater quality and potential projects and management actions.

Upon conducting these reviews, it appears that the draft GSP did not properly identify DACs and households served by domestic wells. In addition, the proposed sustainable management criteria and monitoring networks for groundwater levels and water quality appear to be inadequate to properly monitor and prevent adverse effects to these users if the subbasin is managed to these MOs/MTs. Lastly, it is unclear how the GSAs plan to inform the public about progress implementing the Plan.

For these reasons, we request that you consider the following comments and recommendations as well as direct GSA staff to work with the consulting team to thoroughly review and address our comments as a revision of the GSP.

Insufficient Identification of DACs and Households Served by Private Domestic Wells

Per SGMA, GSAs are required to develop and implement a GSP that considers the interests of all beneficial uses and users of groundwater within the subbasin, including DACs and domestic well users. Laying the foundation to properly consider the interests of all beneficial uses and users of groundwater happens by first identifying who are the users and describing their dependency on groundwater. The draft GSP section Description of Plan Area, however, does not incorporate a thorough description identifying the region's broad and diverse groundwater users and DACs' dependence on groundwater for drinking water purposes, nor does the plan include a map that captures the general distribution and characterization of domestic water supply wells and public water systems serving DACs. The draft GSP section Basin Setting also lacks important information about groundwater issues that is currently or has historically affected groundwater sources of DACs and households relying on domestic wells.

Without this information, the GSAs lack insight on the exact locations of drinking water wells that are more vulnerable to groundwater changes and potentially underestimates the effects of changes in groundwater levels and quality that may be exacerbated in specific areas by pumping volume or location, conjunctive management, or other forms of active management as part of GSP implementation. As a result, the public and DWR is not able to fully evaluate whether the interests of these beneficial uses and users have been considered per 23 CCR § 355.4; how the GSP may affect their drinking water sources per 23 CCR § 354.28; nor how the GSP may affect their Human Right to Water as required by 23 CCR §350.4. Please refer to the focused technical review (Attachment A) for more information about our analysis and for detailed recommendations by GSP section. Overall, we believe the following need to be included:

- A thorough description of DACs' and rural households dependence on groundwater for drinking water purposes, including the historical and current issues affecting drinking water sources caused by changes in water levels, plume migration, and increase of water quality degradation.
- Maps that capture the distribution and characterization of domestic water supply wells and public water systems serving DACs. Maps overlaying the location of these communities must be included in all sections of the GSP, including but not limited to maps describing the plan area, groundwater conditions, monitoring network, or potential recharge locations.
- A thorough description within Section 2.2.2.3 of all constituents of concern and most importantly those that have concentrations above the Maximum Contaminant Level (DBCP, EDB, 1,2,3-TCP, perchlorate, PCE, BTEX, uranium, and manganese) and that are shown in Appendix 2E.

Inadequate Sustainable Management Criteria (SMC) for Groundwater Levels and Water Quality

Groundwater Levels

According to the analysis contained in the Focused Technical Review, if water levels reach the proposed minimum threshold (MTs), then approximately 1,600 wells within a 1.5 mile radius of representative monitoring wells (RMWs) would be expected to be fully dewatered and an additional 330 wells would be expected to be partially dewatered. We acknowledge that this was a quick assessment of domestic well impacts; however, the results of this assessment are significantly different from the results of the domestic well impact assessment presented in the draft GSP Appendix 3D, which estimates that only 130 domestic wells[1] will be impacted by the implementation of the draft GSP. Additionally, the analysis included in the draft GSP did not fully describe or present information in a clear and transparent manner that allows the reader to understand the scope assumptions or results of the analysis and therefore appears to significantly underrepresent the potential impacts of the proposed SMCs on domestic well users.

Further, the GSP does not define the occurrence of an undesirable result (UR) until "greater than 30% of the representative monitoring sites each exceed the groundwater level minimum thresholds for the same two consecutive Fall readings" (draft GSP Section 3.4.1). Therefore, the GSP allows water levels to drop significantly across the subbasin, and allows large areas of the subbasin to fall below MTs for multiple years before the GSAs are required to take significant actions to stabilize water levels. Given that the subbasin is in critical overdraft, the proposed SMCs may be overlooking and neglecting the risks imposed on drinking water users and could create a disproportionate impact on already vulnerable communities, particularly those that rely on domestic wells and have limited financial resources.

Water Quality

The draft GSP identifies nitrate, total dissolved solids, and arsenic as contaminants of concern (COCs) and established SMCs for these constituents. However, Appendix 2E includes maps of other constituents that have concentrations above the MCLs (DBCP, EDB, 1,2,3-TCP, perchlorate, PCE, BTEX, uranium, and manganese).

[1] Appendix 3 D identifies the count of impacted domestic wells as 120 in one location and 130 in another location.

Because these constituents are present above MCLs and because they present a clear risk to drinking water beneficial users of the subbasin and thus do not represent sustainable conditions, the GSAs should include these constituents in its monitoring program and establish MOs and MTs for these constituents.

While we appreciate that a temporary domestic well mitigation program is under consideration to address water level declines that are expected to occur during the GSP implementation period, the draft GSP does not, however, provide sufficient information about the impact assessment and the domestic well mitigation program. Without this information, the public cannot assess the adequacy of the mitigation program to address the needs of the communities or provide productive and meaningful comments on such a plan. Moreover, the proposed domestic well mitigation program does not include any consideration to address water quality degradation.

Lastly, participants at the Parksdale community GSP review workshop expressed that, even though rural domestic and small water system demand do not contribute substantially to the overdraft conditions, the risks imposed on these groundwater users are significant and unreasonable, creating a disproportionate impact on already vulnerable communities. Participants stressed the importance of preserving drinking water supplies for shallow domestic well users, small farmers, and for future generations. In regards to groundwater quality, residents explained that some water providers are already having ongoing water quality challenges and that the GSA should, therefore, prioritize protecting water quality to further prevent public health impacts. In terms of recommendations, participants would like more protective thresholds for groundwater levels near vulnerable groundwater users. They also recommended that the SMCs for groundwater quality cover all contaminants of concern for public health and that the Madera GSAs work together to avoid any further degradation of the water quality. Lastly, residents appreciated Madera GSAs considering a well mitigation program, as this addresses interim solutions for drinking water users in need of dry well remediation. Additionally, residents were concerned with how the program might be funded and encourage the GSA to avoid offering loans to support low-income families with replacing their dry, or contaminated wells. They would like the GSAs to seek public funding and exempt residents from paying into the fund. The need for the availability of a water quality monitoring program to monitor COCs was also voiced.

For these reasons and given our involvement at several Madera Subbasin GSA meetings, SHE is proposing various recommendations on the SMC for water levels and water quality and their respective monitoring network in order to protect the human right to safe and affordable water. Please refer to the focused technical review (Attachment A) for more information about our analysis and for detailed recommendations by GSP section. Overall, our key recommendations include the following:

- Reconsider the approach to set SMCs (minimum thresholds, measurable objectives, and undesirable results). The revision of the SMCs should be based off a robust drinking water well impact assessment that provides information about: 1) what communities are most affected (including DACs) by water levels decline, water quality degradation, and plume movement, 2) where the likely impacted wells are located, 3) an estimate of the size of the population that relies on these domestic wells, 4) if the creation of a new or expanded community water system could address some or all of the population affected by the loss of domestic wells, and 5) potential impacts to groundwater gradients at the proposed MOs and MTs and how that could affect water quality for drinking water users. Ensure that the analysis is described and presented in a clear and transparent manner sufficient for the reader to understand the scope assumptions and result of the assessment.
- Include and set SMCs for all constituents of concern and most importantly those that have concentrations above the Maximum Contaminate Level (DBCP, EDB, 1,2,3-TCP, perchlorate, PCE, BTEX, uranium, and manganese) and that are shown in Appendix 2E.
- Provide more specific and clearer details about the domestic well mitigation plan. Key considerations for establishing such a program are provided in Attachment A, under SHE review.

Limited Monitoring Network Coverage for drinking water users.

As required by 23 CCR § 354.34, DWR will evaluate the ability to properly monitor impacts to the beneficial uses or users of groundwater. However, based on the information presented in the draft GSP, it is not clear how representative the monitoring network is for domestic well users and DACs. The focused technical review indicates that that current monitoring network for water levels lacks adequate coverage for roughly 2,700 domestic wells, including those in the communities of Fairmead and Chowchilla (both DACs), Storey, Lake Madera Country Estates, and the area north of Madera. It also appears that limited monitoring of water quality will be conducted in areas with high densities of domestic well users. The GSP should therefore explain how the proposed monitoring network is adequate to monitor conditions for sensitive beneficial users, in particular for Fairmead, Chowchilla, Storey, Lake Madera Country Estates, and the area north of Madera, including areas with high densities of domestic well users. When assessing the monitoring network data gaps, the GSP should consider the locations of beneficial users, including DACs, small water systems, and domestic wells. For detailed comments and recommendations, please refer to the focused technical review.

Inadvertent Risks on Water Quality from Projects and Management Actions

Even though it is acknowledged in the draft GSP that additional percolation of water on agricultural lands can affect movement of nitrates or other constituents into groundwater, it is unclear if these proposed projects will include precautions of groundwater quality degradation such as water quality monitoring and mitigation strategies. Given that even relatively unpolluted water used for recharge, such as most purchased water or streamflow, may contain constituents of concern, GSAs must consider potential impacts to water quality when planning groundwater recharge projects[2]. The draft GSP should provide more information regarding how the risks of inadvertent drinking water impacts associated with management actions and projects, in particular on-farm recharge projects, will be evaluated and monitored as a part of each identified project and management action. For detailed comments and recommendations for specific projects and management actions, please refer to the SHE review.

Effective Public Engagement

Effective public engagement is extremely important during plan development and implementation. Based on the information presented in section 2.1.5 and Appendix 2 of the draft GSP, it is unclear how the GSAs plan to inform the public about progress implementing the Plan. Per 23 CCR § 354.10, the GSP should include and describe the methods the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions. When developing such a strategy, Madera GSAs should develop recommendations to improve public participation during GSP implementation based on an evaluation of the success and constraints encountered during the GSP development phase. Key considerations for establishing effective outreach and engagement strategies for DACs are provided in Appendix A, under SHE review.

Moreover, given the significant non-English-speaking population, Madera GSAs should consider developing a more formalized translation policy to fund appropriate and effective outreach strategies to engage DAC residents, private domestic wells users and others. At a minimum, Madera GSAs should account for DAC outreach, engagement and translation services when establishing and approving operating budgets, enacting groundwater fees and applying for state funding.

Lastly, the draft GSP should include the outreach and engagement recommendations provided by participants at the Parksdale GSP Review workshop. Participants provided recommendations that include: shifting GSA and Advisory Committee meeting times to the evening (i.e. 6:00 P.M.) with consideration of residents' travel. It would also be helpful to share more information about their local GSAs and appropriately include residents in discussions about proposed rate increases.

[2] State Water Boards, Water Quality Frequently Asked Questions document: https://www.waterboards.ca.gov/water_issues/programs/gmp/docs/sgma/sgma_water_quality_faq.pdf

In closing, we would like to reiterate our commitment to working with you, GSA staff, and the consulting team to ensure that the Madera Joint GSP properly protects the drinking water sources of the most vulnerable, and often underrepresented, groundwater users within the subbasin.

Please let us know if you have any questions or wish to discuss our comments and recommendations further.

Sincerely,

Tom Collishaw
President/CEO

Attachments

MADERA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN (GSP) COMMENT FORM

Please complete the following information to provide comments on the draft Madera Subbasin GSP. Type or print legibly for your comments to be considered.

Please return this form to (hand delivery, mail, or email accepted):

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637
Email: MaderaGSPComments@maderacounty.com

Date Submitted: November 8, 2019

Submitted By: San Joaquin River Exchange Contractors GSA

Address: 541 H Street, P.O. Box 2115, Los Banos, CA 93635

Phone Number / Email: 209-827-8616/cwhite@sjrecwa.net

APNs: ______________________________

Located in Groundwater Sustainability Agency (GSA):
□ Madera County □ MID □ City of Madera □ MWD [x] Other SJREC GSA

Affiliation: □ Irrigated Ag □ Non-Irrigated Ag □ Rural Residential
□ Disadvantaged Community Member [x] Agency/Government □ Other ______

Chapter No. / Page No. of GSP:

Comments:

The SJREC GSA, representing two public water agencies, two mutual water companies, six disadvantaged communities and county white areas, include our comments in the attached letter.

Chapter No. / Page No. of GSP:

Comments:

Chapter No. / Page No. of GSP:

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Chapter No. / Page No. of GSP:

Comments:

SAN JOAQUIN RIVER EXCHANGE CONTRACTORS
GROUNDWATER SUSTAINABILITY AGENCY
Post Office Box 2115
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November 8, 2019

Stephanie Anagnoson
Madera Subbasin GSP
Madera County
200 W. Fourth Street
Madera, CA 93637

RE: ***Comments on the Draft Madera Subbasin Groundwater Sustainability Plan***

Dear Stephanie:

The San Joaquin River Exchange Contractors Groundwater Sustainability Agency (SJREC GSA) has reviewed the draft GSP for the Madera Subbasin. Additionally, the SJREC GSA participated in workshops between the Delta-Mendota Subbasin and the Madera Subbasin. The purpose of these workshops was to review groundwater conditions along our shared basin boundary and evaluate the draft proposed Sustainable Management Criteria and potential impacts to our adjacent subbasin. Included herein are comments from the SJREC GSA.

1. The GSP relies too heavily on a numerical groundwater model that has not been calibrated and therefore does not accurately reflect current and future boundary conditions with the Delta-Mendota Subbasin.

2. For the storage change calculations in the unconfined or upper aquifer, instead of over reliance on the water budget, a better method is evaluating unconfined water-level changes and specific yields. For the confined or lower aquifer, compaction of fine-grained layers, as reflected by the amount of land subsidence, is a better approach.

3. The groundwater flow estimates were developed from the groundwater model, which is not the preferred approach. This approach relies on values for a multitude of parameters, some of which are poorly known. The preferred approach is to use suitable water-level elevation maps and transmissivity values from pump tests for both the upper and lower aquifer.

4. Subsidence - The plan asserts in Sections 3.2.3 and 3.3.3.1 that "No significant impacts to infrastructure has been noted in the Plan area…" and therefore the Land Subsidence analysis and proposed actions were minimized. However, there was no discussion of the subsidence along the Eastside Bypass which the California Department of Water Resources has determined the flood carrying capacity has been significantly decreased by about 50% in the area near the Fresno River, nor the collapsed wells due to subsidence in the vicinity due to subsidence.

5. The Madera GSP should be updated to mitigate land subsidence in the areas closest to the Delta-Mendota Subbasin. A successful mitigation program is being implemented by the Triangle T Water District in cooperation with the member agencies of the SJREC GSA. Other areas in the western Madera County should be held to a similar standard and immediately reduce extractions from the lower aquifer at or below the sustainable yield.

6. The "net groundwater flow" (one value) should be divided into flow at each of the three sub-basin boundaries, also between the upper and lower aquifers in each case. As presented, one cannot readily check the groundwater flow value. There is also downward groundwater flow throughout most of the subbasin (from the upper aquifer to the lower aquifer). This also needs to be determined but wasn't discussed in the plan.

7. The GSP for the Exchange Contractor GSA calls for keeping water levels in the future from declining below 2015 levels. In contrast, the GSP for the Madera Subbasin allows continuing water level declines through almost 2040. This will result in more groundwater outflow from the Delta Mendota Subbasin into the Madera Subbasin which will negatively impact our subbasin.

8. Your plan sets the minimum thresholds for Chronic Lowering of Groundwater Levels, and provides for the continued lowering of groundwater levels through almost 2040. As defined, this poses an immediate risk to the SJREC GSA and the Delta-Mendota Subbasin. Intentional decline in water levels in the Madera Subbasin will directly impact the Delta-Mendota Subbasins infrastructure, water supply, and the following sustainability indicators: a) chronic lowering of groundwater levels, b) reduction of groundwater storage, c) land subsidence, and d) degraded water quality.
    a. Chronic lowering of groundwater levels: the SJREC GSP is managing groundwater levels to maintain historic levels. If the Madera Subbasin intends to lower the water levels across the subbasin boundary, inherently more groundwater

will flow out of the Delta-Mendota Subbasin inducing a groundwater imbalance and overdraft in the Delta-Mendota Basin.

b. Reduction of groundwater storage: As described above lowering water levels will increase the lateral groundwater outflow from the Delta-Mendota Subbasin. The results of increased outflow will result in a reduction in groundwater storage in the Delta-Mendota Subbasin.
c. Land subsidence: this GSP fails to identify and address the subsidence occurring along the East Side Bypass and near the Delta-Mendota Subbasin.
d. Degraded water quality: Lowering water levels in the Madera Subbasin will exacerbate the problem of migrating high TDS water into the SJREC GSA. This problem is not discussed in the GSP and should be evaluated to ensure regional sustainability.

9. This GSP did not include a regional water quality concern of the northeasterly flow of high TDS groundwater associated with overdraft in the Madera Subbasin. Declining water levels in the upper aquifer of the Madera Subbasin has increased the migration of high TDS groundwater into the Delta-Mendota Subbasin.

10. There has consistently been groundwater flows in both the upper and lower aquifers from the Delta-Mendota Subbasin to the Madera Subbasin. Based on natural (pre-pumping) conditions, all of these flows have been induced by pumping in the Madera Subbasin.

This letter serves as a continuation of the regional coordination the SJREC GSA has pursued with neighboring subbasins and GSP's adjacent to the Delta-Mendota Subbasin. Please feel free to contact us with any questions or concerns you have so we can collectively and collaboratively manage our groundwater sustainability in the future.

Sincerely yours,

Chris White,
Executive Director

MADERA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN (GSP)
COMMENT FORM

Please complete the following information to provide comments on the draft Madera Subbasin GSP. Type or print legibly for your comments to be considered.

Please return this form to (hand delivery, mail, or email accepted):

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637
Email: MaderaGSPComments@maderacounty.com

Date Submitted: 11/8/2019

Submitted By: Ruthie Redmond, The Nature Conservancy

Address: 555 Capitol Mall, Ste. 1290 Sacramento, CA 95814

Phone Number / Email: Ruthie.Redmond@tnc.org

APNs: __________

Located in Groundwater Sustainability Agency (GSA):
☐ Madera County ☐ MID ☐ City of Madera ☐ MWD ☒ Other __________

Affiliation: ☐ Irrigated Ag ☐ Non-Irrigated Ag ☐ Rural Residential
☐ Disadvantaged Community Member ☐ Agency/Government ☒ Other The Nature Conservancy

Chapter No. / Page No. of GSP: Please see attached comments.

Comments: __________

The Nature Conservancy
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nature.org
GroundwaterResourceHub.org

8 November 2019

Stephanie Anagnoson, Director
Water and Natural Resources Department
Madera County
200 W. Fourth Street
Madera, CA 93637

Submitted via email: MaderaGSPComments@maderacounty.com

Re: Madera Subbasin Groundwater Sustainability Plan (GSP)

Dear Ms. Anagnoson,

The Nature Conservancy (TNC) appreciates the opportunity to comment the Joint GSP for the Madera Subbasin, being prepared under the Sustainable Groundwater Management Act (SGMA).

TNC as a Stakeholder Representative for the Environment

TNC is a global, nonprofit organization dedicated to conserving the lands and waters on which all life depends. We seek to achieve our mission through science-based planning and implementation of conservation strategies. For decades, we have dedicated resources to establishing diverse partnerships and developing foundational science products for achieving positive outcomes for people and nature in California. TNC was part of a stakeholder group formed by the Water Foundation in early 2014 to develop recommendations for groundwater reform and actively worked to shape and pass SGMA.

Our reason for engaging is simple: California's freshwater biodiversity is highly imperiled. We have lost more than 90 percent of our native wetland and river habitats, leading to precipitous declines in native plants and the populations of animals that call these places home. These natural resources are intricately connected to California's economy providing direct benefits through industries such as fisheries, timber and hunting, as well as indirect benefits such as clean water supplies. SGMA must be successful for us to achieve a sustainable future, in which people and nature can thrive within the Madera County Groundwater Sustainability region and California.

We believe that the success of SGMA depends on bringing the best available science to the table, engaging all stakeholders in robust dialog, providing strong incentives for beneficial outcomes and rigorous enforcement by the State of California.

Given our mission, we are particularly concerned about the inclusion of nature, as required, in GSPs. The Nature Conservancy has developed a suite of tools based on best available science to help GSAs, consultants, and stakeholders efficiently incorporate nature into GSPs. These tools and resources are available online at GroundwaterResourceHub.org. Some of these tools have been used in the preparation of the present draft plan. Additional resources are available and referred to in the comments that follow, and are considered pertinent to the development of this plan.

Addressing Nature's Water Needs *in GSPs*

SGMA requires that all beneficial uses and users, including environmental users of groundwater, be considered in the development and implementation of GSPs (Water Code § 10723.2).

The GSP Regulations include specific requirements to identify and consider groundwater dependent ecosystems (23 CCR §354.16(g)) when determining whether groundwater conditions are having potential effects on beneficial uses and users. GSAs must also assess whether sustainable management criteria may cause adverse impacts to beneficial uses, which include environmental uses, such as plants and animals. In addition, monitoring networks should be designed to detect potential adverse impacts to beneficial uses due to groundwater. Adaptive management is embedded within SGMA and provides a process to work toward sustainability over time by beginning with the best available information to make initial decisions, monitoring the results of those decision, and using data collected through monitoring to revise decisions in the future. Over time, GSPs should improve as data gaps are reduced and uncertainties addressed.

To help ensure that GSPs adequately address nature as required under SGMA, The Nature Conservancy has prepared a checklist (Attachment A) for GSAs and their consultants to use. The Nature Conservancy believes the following elements are foundational for 2020 GSP submittals. For detailed guidance on how to address the checklist items, please also see our publication, *GDEs under SGMA: Guidance for Preparing GSPs*[1].

1. Environmental Representation

SGMA requires that groundwater sustainability agencies (GSAs) consider the interests of all beneficial uses and users of groundwater. To meet this requirement, we recommend actively engaging environmental stakeholders by including environmental representation on the GSA board, technical advisory group, and/or working groups. This could include local staff from state and federal resource agencies, nonprofit organizations and other environmental interests. By engaging these stakeholders, GSAs will benefit from access to additional data and resources, as well as a more robust and inclusive GSP.

2. Basin GDE and ISW Maps

SGMA requires that groundwater dependent ecosystems (GDEs) and interconnected surface waters (ISWs) be identified in the GSP. We recommend using the Natural Communities Commonly Associated with Groundwater Dataset (NC Dataset) provided online[2] by the Department of Water Resources (DWR) as a starting point for the GDE map. The NC Dataset was developed through a collaboration between DWR, the Department of Fish and Wildlife and TNC.

3. Potential Effects on Environmental Beneficial Users

SGMA requires that potential effects on GDEs and environmental surface water users be described when defining undesirable results. In addition to identifying GDEs in the basin, The Nature Conservancy recommends identifying beneficial users of surface water, which include environmental users. This is a critical step, as it is impossible to define "significant and unreasonable adverse impacts" without knowing *what* is being impacted. For your

[1]GDEs under SGMA: Guidance for Preparing GSPs is available at: https://groundwaterresourcehub.org/public/uploads/pdfs/GWR_Hub_GDE_Guidance_Doc_2-1-18.pdf

[2] The Department of Water Resources' Natural Communities Commonly Associated with Groundwater dataset is available at: https://gis.water.ca.gov/app/NCDatasetViewer/

convenience, we've provided a list of freshwater species within the boundary of the Madera Subbasin in Attachment C. Our hope is that this information will help your GSA better evaluate the impacts of groundwater management on environmental beneficial users of surface water. We recommend that after identifying which freshwater species exist in your basin, especially federal and state listed species, that you contact staff at the Department of Fish and Wildlife (DFW), United States Fish and Wildlife Service (USFWS) and/or National Marine Fisheries Services (NMFS) to obtain their input on the groundwater and surface water needs of the organisms on the GSA's freshwater species list. We also refer you to the Critical Species Lookbook[3] prepared by The Nature Conservancy and partner organizations for additional background information on the water needs and groundwater reliance of critical species. Because effects to plants and animals are difficult and sometimes impossible to reverse, we recommend erring on the side of caution to preserve sufficient groundwater conditions to sustain GDEs and ISWs.

4. Biological and Hydrological Monitoring
If sufficient hydrological and biological data in and around GDEs is not available in time for the 2020/2022 plan, data gaps should be identified along with actions to reconcile the gaps in the monitoring network.

The Nature Conservancy has thoroughly reviewed the Madera Draft GSP and appreciates the work that has gone into the preparation of this plan. Specifically, we recognize the use of the NC dataset, GDE Pulse, and other TNC guidance for initial identification and evaluation of GDE areas in the basin. However, we believe that additional work is needed for further identification and analysis of GDEs and ISWs. Hence, we consider the current GSP draft to be incomplete under SGMA.

Our specific comments related to the Madera Subbasin Groundwater Sustainability Plan are provided in detail in Attachment B and are in reference to the numbered items in Attachment A. Attachment C provides a list of the freshwater species located in the Madera Subbasin. Attachment D describes six best practices that GSAs and their consultants can apply when using local groundwater data to confirm a connection to groundwater for DWR's Natural Communities Commonly Associated with Groundwater Dataset[2].

Thank you for fully considering our comments as you develop your GSP.

Best Regards,

Sandi Matsumoto
Associate Director, California Water Program
The Nature Conservancy

[3] Available online at: https://groundwaterresourcehub.org/sgma-tools/the-critical-species-lookbook/

Attachment A

Considering Nature under SGMA: A Checklist

The Nature Conservancy is neither dispensing legal advice nor warranting any outcome that could result from the use of this checklist. Following this checklist does not guarantee approval of a GSP or compliance with SGMA, both of which will be determined by DWR and the State Water Resources Control Board.

GSP Plan Element*		GDE Inclusion in GSPs: Identification and Consideration Elements	Check Box
Admin Info	2.1.5 Notice & Communication *23 CCR §354.10*	Description of the types of environmental beneficial uses of groundwater that exist within GDEs and a description of how environmental stakeholders were engaged throughout the development of the GSP.	1
Planning Framework	2.1.2 to 2.1.4 Description of Plan Area *23 CCR §354.8*	Description of jurisdictional boundaries, existing land use designations, water use management and monitoring programs; general plans and other land use plans relevant to GDEs and their relationship to the GSP.	2
		Description of instream flow requirements, threatened and endangered species habitat, critical habitat, and protected areas.	3
		Summary of process for permitting new or replacement wells for the basin, and how the process incorporates any protection of GDEs	4
Basin Setting	2.2.1 Hydrogeologic Conceptual Model *23 CCR §354.14*	Basin Bottom Boundary: Is the bottom of the basin defined as at least as deep as the deepest groundwater extractions?	5
		Principal aquifers and aquitards: Are shallow aquifers adequately described, so that interconnections with surface water and vertical groundwater gradients with other aquifers can be characterized?	6
		Basin cross sections: Do cross-sections illustrate the relationships between GDEs, surface waters and principal aquifers?	7
	2.2.2 Current & Historical Groundwater Conditions *23 CCR §354.16*	Interconnected surface waters:	8
		Interconnected surface water maps for the basin with gaining and losing reaches defined (included as a figure in GSP & submitted as a shapefile on SGMA portal).	9
		Estimates of current and historical surface water depletions for interconnected surface waters quantified and described by reach, season, and water year type.	10
		Basin GDE map included (as figure in text & submitted as a shapefile on SGMA Portal).	11

		If NC Dataset *was* used:	Basin GDE map denotes which polygons were kept, removed, and added from NC Dataset (Worksheet 1, can be attached in GSP section 6.0).	12
			The basin's GDE shapefile, which is submitted via the SGMA Portal, includes two new fields in its attribute table denoting: 1) which polygons were kept/removed/added, and 2) the change reason (e.g., why polygons were removed).	13
			GDEs polygons are consolidated into larger units and named for easier identification throughout GSP.	14
		If NC Dataset *was not* used:	Description of why NC dataset was not used, and how an alternative dataset and/or mapping approach used is best available information.	15
		Description of GDEs included:		16
		Historical and current groundwater conditions and variability are described in each GDE unit.		17
		Historical and current ecological conditions and variability are described in each GDE unit.		18
		Each GDE unit has been characterized as having high, moderate, or low ecological value.		19
		Inventory of species, habitats, and protected lands for each GDE unit with ecological importance (Worksheet 2, can be attached in GSP section 6.0).		20
	2.2.3 Water Budget *23 CCR §354.18*	Groundwater inputs and outputs (e.g., evapotranspiration) of native vegetation and managed wetlands are included in the basin's historical and current water budget.		21
		Potential impacts to groundwater conditions due to land use changes, climate change, and population growth to GDEs and aquatic ecosystems are considered in the projected water budget.		22
Sustainable Management Criteria	3.1 Sustainability Goal *23 CCR §354.24*	Environmental stakeholders/representatives were consulted.		23
		Sustainability goal mentions GDEs or species and habitats that are of particular concern or interest.		24
		Sustainability goal mentions whether the intention is to address pre-SGMA impacts, maintain or improve conditions within GDEs or species and habitats that are of particular concern or interest.		25
	3.2 Measurable Objectives *23 CCR §354.30*	Description of how GDEs were considered and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.		26
	3.3 Minimum Thresholds *23 CCR §354.28*	Description of how GDEs and environmental uses of surface water were considered when setting minimum thresholds for relevant sustainability indicators:		27
		Will adverse impacts to GDEs and/or aquatic ecosystems dependent on interconnected surface waters (beneficial user of surface water) be avoided with the selected minimum thresholds?		28
		Are there any differences between the selected minimum threshold and state, federal, or local standards relevant to the species or habitats residing in GDEs or aquatic ecosystems dependent on interconnected surface waters?		29
	3.4 Undesirable Results *23 CCR §354.26*	For GDEs, hydrological data are compiled and synthesized for each GDE unit:		30
		If hydrological data *are available* within/nearby the GDE	Hydrological datasets are plotted and provided for each GDE unit (Worksheet 3, can be attached in GSP Section 6.0).	31
			Baseline period in the hydrologic data is defined.	32

			GDE unit is classified as having high, moderate, or low susceptibility to changes in groundwater.	33
			Cause-and-effect relationships between groundwater changes and GDEs are explored.	34
		If hydrological data *are not available* within/nearby the GDE	Data gaps/insufficiencies are described.	35
			Plans to reconcile data gaps in the monitoring network are stated.	36
		For GDEs, biological data are compiled and synthesized for each GDE unit:		37
		Biological datasets are plotted and provided for each GDE unit, and when possible provide baseline conditions for assessment of trends and variability.		38
		Data gaps/insufficiencies are described.		39
		Plans to reconcile data gaps in the monitoring network are stated.		40
		Description of potential effects on GDEs, land uses and property interests:		41
		Cause-and-effect relationships between GDE and groundwater conditions are described.		42
		Impacts to GDEs that are considered to be "significant and unreasonable" are described.		43
		Known hydrological thresholds or triggers (e.g., instream flow criteria, groundwater depths, water quality parameters) for significant impacts to relevant species or ecological communities are reported.		44
		Land uses include and consider recreational uses (e.g., fishing/hunting, hiking, boating).		45
		Property interests include and consider privately and publicly protected conservation lands and opens spaces, including wildlife refuges, parks, and natural preserves.		46
Sustainable Management Criteria	3.5 Monitoring Network *23 CCR §354.34*	Description of whether hydrological data are spatially and temporally sufficient to monitor groundwater conditions for each GDE unit.		47
		Description of how hydrological data gaps and insufficiencies will be reconciled in the monitoring network.		48
		Description of how impacts to GDEs and environmental surface water users, as detected by biological responses, will be monitored and which GDE monitoring methods will be used in conjunction with hydrologic data to evaluate cause-and-effect relationships with groundwater conditions.		49
Projects & Mgmt Actions	4.0. Projects & Mgmt Actions to Achieve Sustainability Goal *23 CCR §354.44*	Description of how GDEs will benefit from relevant project or management actions.		50
		Description of how projects and management actions will be evaluated to assess whether adverse impacts to the GDE will be mitigated or prevented.		51

* In reference to DWR's GSP annotated outline guidance document, available at: https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/GD_GSP_Outline_Final_2016-12-23.pdf

Attachment B

TNC Evaluation of the
Madera Subbasin Groundwater Sustainability Plan

This attachment summarizes our comments on the complete public draft GSP for the Madera Subbasin. TNC previously submitted comments on early drafts of Chapters 1 and 2 of the GSP in a letter dated 1 July 2019. Where these comments have not yet been addressed, they are repeated here. Comments are provided in the order of the checklist items included as Attachment A.

Checklist Item 1 - Notice & Communication (23 CCR §354.10)

[Section 2.1.5.2 Description of Beneficial Uses and Users (p. 2-20)]

- In Table 2-5 (p. 2-21), please expand the stakeholder list associated with the Environmental and Ecosystem Uses category to include the appropriate agencies and list of environmental groups. Although environmental agencies and environmental groups are listed as one of the beneficial users of groundwater in the Subbasin, no specific uses are given.
- The types and locations of environmental uses, species and habitats supported, and the designated beneficial environmental uses of surface waters that may be affected by groundwater extraction in the Subbasin should be specified. To identify environmental users, please refer to the following:
    - Natural Communities Commonly Associated with Groundwater dataset (NC Dataset) - https://gis.water.ca.gov/app/NCDatasetViewer/
    - The list of freshwater species located in the Madera Subbasin in Attachment C of this letter. Please take particular note of the species with protected status.
    - Lands that are protected as open space preserves, habitat reserves, wildlife refuges, etc. or other lands protected in perpetuity and supported by groundwater or interconnected surface waters should be identified and acknowledged.

Checklist Items 2 to 4 - Description of general plans and other land use plans relevant to GDEs and their relationship to the GSP (23 CCR §354.8)

[Section 2.1.1 Summary of Jurisdictional Areas and Other Features (p. 2-1)]

- The GSP states "The Madera Subbasin … contains no considerable state land or federal land" and provides a brief description of these lands as a footnote. Other than State preserves and parks, protected lands that could contain aquatic, riparian, and other potentially groundwater-dependent habitat are not identified. Please identify all state park land, wildlife preserves, wetlands, open space, mitigation areas, and local parks with potentially groundwater-connected aquatic resources and habitat.

[Section 2.1.2 Water Resources Monitoring and Management Programs (p. 2-8)]

- Per the GSP Regulations (23 CCR §354.34), monitoring must address trends in groundwater *and related surface conditions*. For this section to provide the appropriate context and help assure integration of GSP implementation with other ongoing regulatory programs, please describe jurisdictions related to aquatic resources, interconnected surface waters (ISWs), instream flow requirements, and groundwater-dependent ecosystems (GDEs) that could be affected by groundwater withdrawals.

[Section 2.1.2.2 Surface Water Monitoring and Management Programs (p. 2-9 to 2-11]

- The GSP states (p. 2-10): "Limitations on surface water deliveries will limit operational flexibility by reducing surface water supplies available for conjunctive use programs." The limitations are not defined and warrant further description, either in this section or in Section 2.1.2.4, to more specifically identify potential effects on the flows of interconnected surface waters and potential stress to the groundwater system. Please ensure that description of the surface water monitoring system clarifies the limitations and please specify whether these limitations could affect the surface water conditions of any GDEs or instream habitat in ISWs that may be present in the area.
- This section describes the types of monitoring performed by federal, state and local entities of surface water inflows and outflows. The monitoring stations for flows are listed in Table 2-3 and other recording stations for flow or irrigation releases are listed in Table 2-4. Please explain the relationship of existing stream flow monitoring to the protection of ISWs and GDEs.

[Section 2.1.3.1 Madera County General Plan (p. 2-14 to 2-15)]

- The Madera County General Plan includes restrictions on development in "areas with sensitive environmental resources" (Policy 1.A.5). This section should include a discussion of General Plan goals and policies related to the protection and management of GDEs and aquatic resources that could be affected by groundwater withdrawals. Please include a discussion of how implementation of the GSP may affect and be coordinated with General Plan policies and procedures regarding the protection of wetlands, aquatic resources and other GDEs and ISWs.
- This section should identify Habitat Conservation Plans (HCPs) or Natural Community Conservation Plans (NCCPs) within the Subbasin and if they are associated with critical, GDE or ISW habitats. Please identify all relevant HCPs and NCCPs within the Subbasin and address how GSP implementation will coordinate with the goals of these HCPs or NCCPs.
- Please refer to the Critical Species Lookbook[4] to review and discuss the potential groundwater reliance of critical species in the basin. Please include a discussion

[4] Available online at: https://groundwaterresourcehub.org/sgma-tools/the-critical-species-lookbook/

regarding the management of critical habitat for these aquatic species and its relationship to the GSP.

[Section 2.1.3.3 Permitting Process for Wells in Madera Subbasin (p. 2-16)]

- Madera County has an online well permitting system that includes agricultural wells, observation/monitoring wells, community water supply wells, and individual domestic water supply wells. Please include a discussion of how future well permitting will be coordinated with the GSP to assure achievement of the sustainability goals.
- The State Third Appellate District recently found that Counties have a responsibility to consider the potential impacts of groundwater withdrawals on public trust resources when permitting new wells near streams with public trust uses (ELF vs. SWRCB and Siskiyou County, No. C083239). Compliance of well permitting programs with this requirement should be stated in the GSP.

Checklist Items 5, 6, and 7 – Hydrogeologic Conceptual Model (23 CCR §354.14)

[Section 2.2.1.2 Lateral and Vertical Subbasin Boundaries (p. 2-27)]

- In the Madera Subbasin, the base of the usable aquifer corresponds with the base of fresh water, defined as having "total dissolved solids of less than 1,000 milligrams/liter (mg/L) or conductivity of less than 1,600 umhos/cm." The text states, "In general, the aquifer base is controlled mostly by the base of freshwater provided in Figure 2-18 except in the far eastern portions of the subbasin" where the depth of the basement complex is shallower. As noted on page 9 of DWR's Hydrogeologic Conceptual Model BMP (https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_HCM_Final_2016-12-23.pdf) "the definable bottom of the basin should be at least as deep as the deepest groundwater extractions." Thus, groundwater extraction well depth data should also be included in the determination of the basin bottom. Properly defining the bottom of the basin will prevent the possibility of extractors with wells deeper than the basin boundary from claiming exemption from SGMA due to their well residing outside the vertical extent of the basin boundary.

[Section 2.2.1.3 Major Aquifers/Aquitards (p. 2-27)]

- The cross sections in Chapter 2 (Figures 2-24 through 2-34) show the base of freshwater and the top of the basement rocks. However, they do not include a graphical representation of the manner in which shallow groundwater may interact with ISWs or GDEs that would allow the reader to understand this topic. Please include an example near-surface cross section that depicts the conceptual understanding of shallow or perched stream, riparian and other GDE interactions at different locations.

- The extent and depth of the Corcoran Clay layer is shown in Figure 2-15. "Where the Corcoran Clay aquitard exists, the aquifer system is subdivided into an upper unconfined aquifer above the Corcoran Clay and a lower confined aquifer below the Corcoran Clay. In the central and eastern portions of the subbasin where the Corcoran Clay does not exist, the aquifer system is generally considered to be semi-confined with discontinuous clay layers interspersed with more permeable coarse-grained units" (p. 2-29). Please confirm that only wells with screened intervals in the unconfined aquifer are being used to compare with surface water and to identify and confirm potential GDEs.

Checklist Items 8, 9, and 10 – Interconnected Surface Waters (ISW) (23 CCR §354.16)

[Section 2.2.2.5 Groundwater - Surface Water Interaction (p. 2-40)]

- Figures 2-71 and 2-72 present depth to shallow groundwater for 2014 and 2016. Please further describe how these figures were developed, specifically noting the following best practices for developing depth to groundwater contours presented in Attachment D. Ensure that the first step is contouring groundwater elevations, and the subtracting this layer from land surface elevations from a DEM to estimate depth to groundwater contours across the landscape. This will provide much more accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found. Depth to groundwater contours developed from depth to groundwater measurements at wells assumes that the land surface is constant, which is a poor assumption to make.
- The text states (p. 2-40): "A review of historical regional aquifer groundwater levels compared to stream thalweg (deepest portion of stream channel) elevations conducted for this study indicate that surface water – groundwater interactions are not a significant issue (i.e., regional groundwater levels are relatively far below creek thalweg elevations) along Berenda Creek, Dry Creek, the Fresno River, and Cottonwood Creek in Madera Subbasin." Please note that ISWs are best estimated by first determining which reaches are completely disconnected from groundwater. This approach would involve comparing groundwater elevations with a land surface Digital Elevation Model that could identify which surface waters have groundwater consistently below surface water features, such that an unsaturated zone would separate surface water from groundwater. Groundwater elevations that are always deeper than 50 feet below the land surface can be used to identify the above ground reaches as disconnected surface waters. As shown in Figures 2-71 and 2-72, depth to groundwater is greater than 100 feet in 2014 and 2016 across much of the Subbasin. However, areas in upstream reaches of the Fresno River and San Joaquin River show depths to groundwater within 20-30 feet in 2014. Please provide further evidence, such as cross-sections or corresponding hydrographs, to show the relationship between the river channel and the depth to groundwater at wells near the Fresno River and San Joaquin river to improve ISW mapping. Where data gaps exist regarding the existence of ISWs, make plans to reconcile them in the Monitoring section.

- The regulations [23 CCR §351(o)] define interconnected surface waters as "surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted". "At any point" has both a spatial and temporal component. Even short durations of interconnections of groundwater and surface water can be crucial for surface water flow and supporting environmental users of groundwater and surface water. ISWs can be either gaining or losing. The defining feature of disconnected surface waters is that groundwater is consistently below surface water features such that an unsaturated zone always separates surface water from groundwater, not whether the reach is gaining or losing. To improve ISW mapping, please reconcile data gaps (shallow monitoring wells, stream gauges, and nested/clustered wells) along surface water features in the Monitoring Network section of the GSP.
- The GSP states (p. 2-41): "It is likely that seepage from the San Joaquin River is the source of water combined with the presence of shallow clay layers, which serves to maintain shallow groundwater levels at these locations." Please provide estimates of current and historical surface water depletions for the San Joaquin River, quantified and described by reach, season, and water year type. Provide a discussion of the expected effect of the SJRRP on flows, GDEs and ISWs along the San Joaquin River.

<u>Checklist Items 11 to 15, Identifying and Mapping GDEs (23 CCR §354.16)</u>

[Section 2.2.2.6 Groundwater Dependent Ecosystems (p. 2-42 to 2-48)]
[Appendix 2.B (Assessment of Groundwater Dependent Ecosystems)]

- The GSP states (p. 2-42): "GDEs may also occur in areas where regional groundwater levels are deeper than 30 feet but shallower perched groundwater exists atop bedrock or another type of aquitard; however, these types of GDEs would generally not be impacted by pumping of groundwater supply wells." The GSP discounts the perched water zones as derived from surface water, and therefore they were not considered in evaluation of GDEs. The GSP should provide clear evidence of hydraulic disconnection where shallow groundwater is considered perched or identify hydraulic connection as a data gap. In addition, the GSP should consider perched water as a shallow aquifer, because even though it may not be pumped at present, it could be in the future. Groundwater in the perched water zones may provide water supply to GDEs and ISWs. Please explicitly enumerate the principal aquifer(s) and intervening aquitards, their relationship to each other, and their role in supplying groundwater to all beneficial uses and users of groundwater (including environmental).
- The GSP states (p. 2-42): "A DTW cutoff of 30 feet was used in the initial screening of potential GDEs. The use of a 30-foot DTW criterion to identify potential GDEs is based on reported maximum rooting depths of California phreatophytes and is consistent with guidance provided by The Nature Conservancy (Rohde et al. 2018) for identifying potential GDEs." We have the following comments regarding this

sentence and on the methodology for identifying GDEs in the Subbasin as further described in Appendix 2.B.

- *30-ft criteria from TNC Guidance:* In TNC's GDE Guidance, the depth criterion of 30 feet is presented as a criterion for inclusion, not a standalone criterion for exclusion. In other words, if groundwater is within 30 feet of the ground surface, then a GDE can be identified. If it is not, then further analysis must be conducted (see Appendix III of the GDE Guidance, Worksheet 1, for other indicators of GDEs).
- *30-ft as maximum rooting depths of California phreatophytes:* Please use care when considering rooting depths of vegetation. While Valley Oak (*Quercus lobata*) have been observed to have a max rooting depth of ~24 feet (https://groundwaterresourcehub.org/gde-tools/gde-rooting-depths-database-for-gdes/), rooting depths are likely to spatially vary based on the local hydrologic conditions available to the plant. Also, max rooting depths do not take capillary action into consideration, which will vary with soil type and is an important consideration since woody phreatophytes generally do not prefer to have their roots submerged in groundwater for extended periods of time, and hence can access groundwater at deeper depths. In addition, while it is likely to be true that shallow water availability is necessary to support the recruitment of saplings, hydraulic lift of groundwater to shallow depths has been observed in *Quercus* spp.
- *Use of depth to water maps from 2014 and 2016:*
  - 2016 is <u>after</u> the SGMA benchmark date of January 1, 2015. Please rely on groundwater condition data prior to the SGMA benchmark date.
  - We highly recommend using depth to groundwater data from multiple seasons and water year types (e.g., wet, dry, average, drought) to determine the range of depth to groundwater around NC dataset polygons. Please refer to Attachment D of this letter for best practices for using local groundwater data to verify whether polygons in the NC Dataset are supported by groundwater in an aquifer. If insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons in the GSP <u>until</u> data gaps are reconciled in the monitoring network. While depth to groundwater levels within 30 feet are generally accepted as being a proxy for confirming that polygons in the NC dataset are connected to groundwater, it is highly advised that seasonal and interannual groundwater fluctuations in the groundwater regime are taken into consideration. Utilizing groundwater data from one or two points in time can misrepresent groundwater levels required by GDEs, and inadvertently result in adverse impacts to the GDEs. Based on a study we recently submitted to Frontiers in Environmental Science Journal, we've observed riparian forests along the Cosumnes River to experience a range in groundwater levels between 1.5 and 75 feet over seasonal and interannual timescales. Seasonal fluctuations in the

regional water table can support perched groundwater near an intermittent river that seasonally runs dry due to large seasonal fluctuations in the regional water table. While perched groundwater itself cannot directly be managed due to its position in the vadose zone, the water table position within the regional aquifer (via pumping rate restrictions, restricted pumping at certain depths, restricted pumping around GDEs, well density rules) and its interactions with surface water (e.g., timing and duration) can be managed to prevent adverse impacts to ecosystems due to changes in groundwater quality and quantity under SGMA.

- Please provide more details on how depth to groundwater contour maps were developed (Figures 2-71 and 2-72):
  - Are the wells used for interpolating depth to groundwater sufficiently close (<5km) to NC Dataset polygons to reflect local conditions relevant to ecosystems?
  - Are the wells used for interpolating depth to groundwater screened within the surficial unconfined aquifer and capable of measuring the true water table?
  - Is depth to groundwater contoured using groundwater elevations at monitoring wells to get groundwater elevation contours across the landscape? This layer can then be subtracted from land surface elevations from a Digital Elevation Model (DEM)[5] to estimate depth-to-groundwater contours across the landscape. This will provide much more accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found. Depth to groundwater contours developed from depth to groundwater measurements at wells assumes that the land surface is constant, which is a poor assumption to make. It is better to assume that water surface elevations are constant in between wells, and then calculate depth to groundwater using a DEM of the land surface to contour depth to groundwater.

- Please further explain how NC Dataset polygons adjacent to the San Joaquin River were retained or removed as potential GDEs. On Appendix 2.B, Figure 1 polygons are shown as removed based on depth to groundwater greater than 30 feet, but the groundwater depth contours (Figures 2-71 and 2-72) do not show enough detail to make this distinction and subsequent determination. Please refer to specific well hydrographs that were used to analyze particular reaches of the San Joaquin River.
- The GSP states (p. 2-45): "The adjacent San Joaquin River contains Essential Fish Habitat (EFH) for the endangered Chinook salmon which is partially dependent on riparian inputs to provide important salmon habitat elements including shade, overhead cover, nutrients, and woody material for instream cover and habitat complexity," and further states (p. 25 of Appendix 2.B): "the riparian vegetation community of the San Joaquin River Riparian Potential GDE Unit fulfills several

[5] USGS Digital Elevation Model data products are described at: https://www.usgs.gov/core-science-systems/ngp/3dep/about-3dep-products-services and can be downloaded at: https://iewer.nationalmap.gov/basic/

essential ecosystem functions or provides important habitat elements, such as large wood and riparian shade, on which both semiaquatic species of the GDE unit and aquatic species of the San Joaquin River depend for completing essential life behaviors". Please consider retaining all NC Dataset polygons adjacent to the San Joaquin River due to the essential ecosystem function that the riparian vegetation community performs for the critical habitat of the Chinook salmon in the San Joaquin River.
- As shown on Appendix 2.B, Figure 1, it appears that there is one potential GDE unit in light green on the far western border of the Subbasin. Please describe further and clarify if this is indeed a polygon from the NC Dataset that was kept as a potential GDE.

Checklist Items 16 to 20, Describing GDEs (23 CCR §354.16)

[Section 2.2.2.6 Groundwater Dependent Ecosystems (p. 2-42 to 2-48)]
[Appendix 2.B (Assessment of Groundwater Dependent Ecosystems)]

- TNC acknowledges and appreciates the comprehensive evaluation of the four GDE Units identified in the GSP following our guidance, including analyzing hydrologic conditions, ecological conditions, providing an inventory of species and ecological value, along with concurrent field **studies and reconnaissance. We also appreciate the use of TNC's GDE Pulse** to examine NDVI and NDMI trend data for the GDE polygons within the GDE Units.
- The Sumner Hill GDE Unit is located on an unnamed tributary of the San Joaquin River and includes riparian vegetation and a freshwater wetland. The source of water to the wetland is unknown and may be an intermittent tributary to the San Joaquin River. This potential GDE was considered to have a high ecological value because it supports special status species and habitat. The GSP states (p. 2-48): "Reconnaissance level biological assessments, aerial photograph analysis, and NDVI/NDMI data indicate adverse impacts are not likely occurring in the Sumner Hill Potential GDE Unit (Appendix 2.B)." Please obtain groundwater data before concluding that there are no adverse impacts to the GDE Unit and make plans to address this data gap in the Monitoring section of the GSP.

Checklist Items 21 and 22 – Water Budget (23 CCR §354.18)

[Section 2.2.3.1 Water Budget Conceptual Model (p. 2-49 to 2-56)]

- In the Land Surface System component of the water budget, ET is split into ET of applied water and ET of precipitation (Table 2-11, p. 2-54). ET of groundwater (ETg) is not included. Please include ETg in the water budget, or explain where it is included.

[Section 2.2.3.3 Water Budget Components and Uncertainties (p. 2-61 to 2-64)]

- Please clarify how the Integrated Water Flow Model Demand Calculator (IDC) model of the root zone budget was used to differentiate ET among the agricultural, urban, and native vegetation land uses. Please explain how any native vegetation present in GDEs was handled in the water budget process.

[Section 2.2.3.4 Historical Water Budget Analysis (p. 2-77)]

- The GSP states (p. 2-84): "…for native lands, groundwater extraction by riparian vegetation was considered to be negligible because of the depth to groundwater in the subbasin." Because there are GDEs in the Madera Subbasin, please quantify the evapotranspiration from groundwater by riparian vegetation. Please revise the text and budget as necessary.

<u>Checklist Items 23 to 25 – Sustainability Goal (23 CCR §354.24)</u>

[Section 3.1 Sustainability Goal (p. 3-3)]

- The sustainability goal does not specifically mention beneficial uses or users of groundwater, including environmental users. It states "the six sustainability indicators, established measurable objectives, and minimum thresholds will ensure no undesirable results of significant and unreasonable economic, social, or environmental impacts occur…" Please rephrase the Sustainability Goal to specifically call out beneficial uses and users of groundwater, including environmental users. Please state how the sustainability of environmental uses will be protected. In addition, a statement about any intention to address pre-SGMA impacts should be included.
- Because potential GDEs have been identified along the Fresno and San Joaquin Rivers, please include these surface waters in the Sustainability Goal.

<u>Checklist Item 26 – Measurable Objectives (23 CCR §354.30</u>)

[Sections 3.2.1.1 Measurable Objectives for Chronic Lowering of Groundwater Levels (p. 3-5)]

- The description of Measurable Objectives (in this section of the text, or Appendix 2.B) does not explain how GDEs were considered. Please include GDEs in this section and explain how the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.
- The Sumner Hill and Friant Riparian GDE Units do not have nearby monitoring wells that monitor hydrologic conditions. Please specifically address the data gap with respect to these GDE Units, or refer to a later section of the GSP.

[Sections 3.2.4.1 Measurable Objectives for Water Quality (p. 3-12)]

- The description of Measurable Objectives does not consider how water quality needs of GDEs were considered. Please include a discussion about GDEs and water quality and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.

[Sections 3.2.5 Depletion of Surface Water (p. 3-15)]

- The GSP fails to establish measurable objectives or minimum thresholds for this sustainability indicator. The GSP states (p. 3-15): "Thus, the connection between regional groundwater and streams was broken prior to 2015, and the surface water depletion sustainability criteria is not applicable to the Plan area." However, the existence of riparian GDEs along the streams in the basin has been identified in Appendix 2.B, and their connection to groundwater is assumed. Their occurrence in the riparian zone means that these GDEs should be considered a beneficial user of groundwater that could be affected by chronic groundwater level decline as discussed above, as well as beneficial users of surface water that could be depleted by groundwater extraction. A more detailed discussion of the known facts regarding these surface-groundwater interactions in the riparian zone should be provided. In addition, a more detailed discussion regarding specific data gaps should also be included.
- There is a need to evaluate and discuss potential effects on beneficial uses of surface and groundwater. This is necessary, at a minimum, so that the nature of the data gaps can be understood. In addition, the applicable state, federal and local standards for the protection of aquatic, riparian and other protected habitats should be discussed. Please refer to Attachment C for a list of freshwater species in Madera Subbasin that may exist within ISWs. We recommend that after identifying which freshwater species exist in your basin, especially federal and state listed species, that you contact staff at the Department of Fish and Wildlife (DFW), United States Fish and Wildlife Service (USFWS) and/or National Marine Fisheries Services (NMFS) to obtain their input on the groundwater and surface water needs of the organisms on the freshwater species list. Because effects to plants and animals are difficult and sometimes impossible to reverse, we recommend erring on the side of caution to preserve sufficient groundwater conditions to sustain GDEs and ISWs. Please refer to the Critical Species Lookbook[6] to review and discuss the potential groundwater reliance of critical species in the basin.
- The SJRRP identifies instream flow needs for salmon in multiple reaches which form the southern border of the Subbasin (http://www.restoresjr.net/about/overview-map/). Please include instream flow requirements in this section and set measurable objectives and interim milestones that will help achieve the sustainability goal as it pertains to the environment.

Checklist Item 27-29 – Minimum Thresholds (23 CCR §354.28)

[6] Available online at: https://groundwaterresourcehub.org/sgma-tools/the-critical-species-lookbook/

[Sections 3.3.1 Minimum Thresholds for Chronic Lowering of Groundwater Levels (p. 3-18 to 3-26)]

- For the discussion of GDE susceptibility to changes in groundwater conditions (p. 3-25 to 3-26), please present or refer to specific hydrologic data or figures to back up claims of low susceptibility to impacts related to groundwater management and to allow the reader to more readily follow the discussion.
- The Friant Riparian and the Sumner Hill GDE Units do not have wells nearby. While the likelihood of impacts due to pumping is considered low in these areas, the groundwater levels should be monitored; thus, new wells are recommended for installation in these areas. Please include proposed monitoring wells for the Friant Riparian and the Sumner Hill GDE Units as representative monitoring sites (RMS) for minimum thresholds.
- Until monitoring wells are available in GDE Units Friant Riparian and Sumner Hill, consideration should be given to establishing minimum thresholds based on species or ecosystem response as measured by biological monitoring or remote sensing.

[Sections 3.3.4 Degraded Water Quality (p. 3-30 to 3-33)]

- The Minimum Thresholds do not consider water quality needs of GDEs. The GSP states (p. 3-33): "Protection of municipal and domestic beneficial uses is also protective of all other groundwater beneficial uses." Please provide evidence or basis for the statement that protection of municipal and domestic beneficial uses is also protective of all other groundwater beneficial uses including environmental uses. Include a discussion about GDEs and water quality and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.

[Sections 3.3.5 Depletion of Surface Water (p. 3-34)]

- Minimum Thresholds for depletion of surface water were not developed for the Subbasin because the GSP determined that surface water was no longer connected to groundwater. GDEs are often adjacent to streams or associated with riparian corridors where ISWs exist, even if only seasonally or are discontinuous along a longitudinal profile. GDEs have been identified along parts of Fresno and San Joaquin Rivers. The San Joaquin River "contains Essential Fish Habitat (EFH) for Chinook salmon which is partially dependent on riparian inputs to provide important salmon habitat elements including shade, overhead cover, nutrients, and woody material for instream cover and habitat complexity" (p. 2-45). Following the discussion presented above for Checklist Item 26 (Measurable Objectives), please include a discussion of Sustainable Management Criteria for ISWs, including Minimum Thresholds, in the GSP. Cite data gaps regarding ISWs and make plans to reconcile them in the Monitoring Section of the GSP.

<u>Checklist Items 30-46 – Undesirable Results (23 CCR §354.26)</u>

[Section 3.4 Undesirable Results (p. 3-34 to 3-35)]

- This section only describes undesirable results relating to human beneficial uses of groundwater and neglects environmental beneficial uses that could be adversely affected by chronic groundwater level decline. **Please add "potential adverse** impacts to GDE**s" to the list of potential undesirable results presented in** Table 3-8 (p. 3-35).

[Section 3.4.1 Undesirable Results for Chronic Lowering of Groundwater Levels (p. 3-35)]

- The GSP states (p. 3-36): "The undesirable result for groundwater levels is defined as more than 30 percent of RMS exceeding their minimum thresholds for the same two consecutive Fall readings. The 30 percent criterion was selected to balance the interest of beneficial use with the practical aspect of groundwater management uncertainty. Given a total of 37 RMS sites, a total of 12 or more of the initial RMS would need to exceed MTs as defined above to constitute an undesirable result for chronic lowering of groundwater levels." The use of 30 percent to define an undesirable result does not allow for the occurrence of low water levels in one area, such as near a GDE, to be an Undesirable Result, which may impact an environmental beneficial use. Please consider the use of separate management areas for the GDE Units, so that Sustainable Management Criteria protective of GDEs can be established for the GDE Units. Please elaborate on how the exceedance criteria would be applied in a way that is protective of significant and unreasonable harm to GDEs.

[Section 3.4.4 Description of Undesirable Results for Degraded Water Quality (p. 3-38)]

- This section describes undesirable results in terms of meeting drinking water standards, including arsenic, but does not discuss degradation of water quality that may impact GDEs. Any potential undesirable results from degradation of water quality that may impact GDEs and freshwater species in the area should be discussed in this section.

[Section 3.4.5 Undesirable Results for Depletion of Surface Water (p. 3-39)]

- The Fresno and San Joaquin Rivers were connected historically, but are not considered connected under current conditions. The GSP states (p. 3-39): "The Fresno River and the San Joaquin River are adjacent to, but not a part of, the Fresno River Riparian potential GDE Unit and the Friant Riparian and San Joaquin River Riparian potential GDE units, respectively. Both rivers are in a net-losing condition, with surface flow likely contributing directly to the shallow groundwater systems that support the vegetation in these GDE units." The analysis for potential depletion of ISWs in Section 3.4.5 should include all beneficial users of surface water that could be affected by groundwater withdrawals, including environmental users.
- The GSP states (p. 2-47) that for the San Joaquin River Riparian Potential GDE Unit, "the adjacent San Joaquin River contains Essential Fish Habitat (EFH) for Chinook

salmon which is partially dependent on riparian inputs to provide important salmon habitat elements including shade, overhead cover, nutrients, and woody material for instream cover and habitat complexity (PFMC 2014)." Further, the GSP states (p. 3-39): "However, the shallow groundwater system underlying the portion of the San Joaquin River that supports the San Joaquin River Riparian Potential GDE Unit does have at least the potential (albeit quite muted) to be affected by regional groundwater pumping." These statements illustrate the need to develop Sustainable Management Criteria for ISWs. Following the discussion presented above for Checklist Item 26 (Measurable Objectives), please include a discussion of Sustainable Management Criteria for ISWs, including Undesirable Results, in the GSP. Please cite data gaps regarding ISWs and make plans to reconcile them in the Monitoring Section of the GSP.

<u>Checklist Items 47, 48 and 49 – Monitoring Network (23 CCR §354.34)</u>

[Section 3.5 Monitoring Network (p. 3-39)]

- Per the GSP Regulations (23 CCR §354.34 (a) and (b)), monitoring must address trends in groundwater *<u>and related surface conditions</u>* (emphasis added). Groundwater level monitoring alone may be insufficient to establish a linkage between groundwater extraction and potentially resulting impacts to environmental resources associated with GDEs and ISWs. The cause-effect relationship between groundwater levels and the biological responses that could result in significant and unreasonable impacts to ISWs and GDEs depends on a number of complicated factors, and this relationship is not characterized or discussed. The Monitoring Network section currently does not address future needs for ISW monitoring. In this section, please describe monitoring for ISWs as described below:
    - In addition to the need for additional shallow monitoring wells in the upper aquifer to map GDEs, there is also a need to enhance monitoring of stream flow and vertical groundwater gradients by installing more stream gauges and clustered/nested wells near streams, rivers or wetlands. Ideally, co-locating stream gauges with wells that can monitor groundwater levels in both the upper and lower aquifers would enhance understanding about where ISWs exist in the basin and whether pumping is causing depletions of surface water or impacts on beneficial users of surface water and groundwater. Please provide sufficient detail for the investigation and monitoring program including stream gauges, screened intervals and frequency of monitoring, in order to describe monitoring of both the extent of ISWs and the quantity of surface water depletions from ISWs.

[Section 3.5.1.1 Groundwater Level Monitoring Program (p. 3-41 to 3-45)]

- The proposed wells to be used for monitoring groundwater levels are shown in Figure 3-1 and include 11 wells in the Upper Aquifer and 22 wells in the Lower Aquifer. At present the Upper Aquifer wells are located in the southwestern part of the Madera GSA. Several of the monitoring wells are missing well construction information. Four composite wells are listed in Table 3-11 (p. 3-44). Please describe how the missing well construction information will be obtained, or how data from the wells will be used if it cannot be obtained. Please indicate how the composite wells will be used and whether the proposed nested wells will replace them.

[Section 3.5.2.5 GDE Monitoring Program (p. 3-53)]
[Appendix 2.B, Section 5 GDE Monitoring]

- The GSP states (p. 3-53): "Biological data will be analyzed in conjunction with hydrological data, where available, to assess potential ecological effects related to changes in groundwater levels and the relative degree of influence on GDE conditions exerted by streamflows and groundwater levels associated with each potential GDE." Appendix 2.B refers to an adaptive management framework to facilitate improvements in the monitoring program. Please further describe how adaptive management will facilitate improvements in the monitoring program and refine projects and management actions.

[Section 3.5.4.2 Identification and Description of Data Gaps (p. 3-55)]

- The Friant Riparian Potential GDE Unit does not have any wells or monitoring points nearby and the true depth to groundwater is unknown. "Part of the GSP Implementation Plan will be to further investigate existing wells in this area for verifying presence of shallow groundwater (i.e., less than or equal to 30 feet bgs) and possible inclusion of a well as a representative monitoring station (RMS), if necessary (p. 19 of Appendix 2.B). If there are no appropriate existing wells to obtain current groundwater depth data for this GDE Unit, it is recommended to install one or more shallow wells to verify the presence of shallow groundwater.
- The Sumner Hill Potential GDE Unit is located on an unnamed tributary of the San Joaquin River and includes riparian vegetation and a freshwater wetland. This potential GDE has a shallow depth to bedrock and is close to the Madera Canal, but no groundwater data are available. If there are no appropriate existing wells to obtain current groundwater depth data for this GDE Unit, it is recommended to install one or more shallow wells to verify the presence of shallow groundwater.

<u>Checklist Items 50 and 51 – Projects and Management Actions to Achieve Sustainability Goal (23 CCR §354.44)</u>

[Section 4 Subbasin Project and Management Actions (p. 4-1 to 4-52)]

- The Madera Subbasin includes GDEs and ISWs that are beneficial uses and users of groundwater, and may include potentially sensitive resources and protected lands. Environmental beneficial users and uses of groundwater should be considered in establishing project priorities. In addition, consideration should be given to multi-benefit projects that can address water quantity as well as providing environmental benefits or benefits to disadvantaged communities. Please include environmental benefits and multiple benefits as criteria for assessing project priorities.

- This section identifies many important projects; however, the descriptions of benefits for these projects only identifies benefits to water level and storage. Because maintenance or recovery of groundwater levels, or construction of recharge facilities, may have potential environmental benefits in many cases it would be advantageous to demonstrate multiple benefits from a funding and prioritization perspective.
    - For the projects already identified, please consider stating how ISWs and GDEs will benefit or be protected, or what other environmental benefits will accrue.
    - If ISWs will not be adequately protected by those listed, please include and describe additional management actions and projects targeted for protecting ISWs.
    - Recharge ponds, reservoirs and facilities for managed stormwater recharge can be designed as multiple-benefit projects that include elements that act functionally as wetlands and provide a benefit for wildlife and aquatic species. In some cases, such facilities have been incorporated into local Habitat Conservation Plans (HCPs) and Natural Community Conservation Plans (NCCPs), more fully recognizing the value of the habitat that they provide and the species they support. For projects that construct recharge ponds, please consider identifying if there is habitat value incorporated into the design and how the recharge ponds will be managed for multiple-benefits including environmental users.
    - For examples of case studies on how to incorporate environmental benefits into groundwater projects, please visit our website: https://groundwaterresourcehub.org/case-studies/recharge-case-studies/

[Section 4.4.5.1 Arundo Removal (p. 4-45)]

- The GSP states (p. 4-45): "Based on preliminary estimates, approximately 500 acres of Arundo exists in concentrated stretches of Berenda, Cottonwood, and Dry Creeks. Details on acreage of infestation, water use, the potential for reduction, and the cost would be developed before a removal/control plan is prepared." We appreciate the citing of **TNC's** literature review of Arundo evapotranspiration studies and recognizing Arundo removal as a potential project for the Subbasin.

Attachment C

Freshwater Species Located in the Madera Subbasin

To assist in identifying the beneficial users of surface water necessary to assess the undesirable result "depletion of interconnected surface waters", Attachment C provides a list of freshwater species located in the Madera Subbasin. To produce the freshwater species list, we used ArcGIS to select features within the California Freshwater Species Database version 2.0.9 within the GSA's boundary. This database contains information on ~4,000 vertebrates, macroinvertebrates and vascular plants that depend on fresh water for at least one stage of their life cycle. The methods used to compile the California Freshwater Species Database can be found in Howard et al. 2015[7]. The spatial database contains locality observations and/or distribution information from ~400 data sources. The database is housed in the California Department of Fish and Wildlife's BIOS[8] as well as on The Nature Conservancy's science website[9].

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
BIRDS				
Actitis macularius	Spotted Sandpiper			
Aechmophorus occidentalis	Western Grebe			
Agelaius tricolor	Tricolored Blackbird	Bird of Conservation Concern	Special Concern	BSSC - First priority
Aix sponsa	Wood Duck			
Anas acuta	Northern Pintail			
Anas americana	American Wigeon			
Anas clypeata	Northern Shoveler			
Anas crecca	Green-winged Teal			
Anas cyanoptera	Cinnamon Teal			
Anas discors	Blue-winged Teal			
Anas platyrhynchos	Mallard			
Anas strepera	Gadwall			
Anser albifrons	Greater White-fronted Goose			
Ardea alba	Great Egret			
Ardea herodias	Great Blue Heron			
Aythya affinis	Lesser Scaup			
Aythya americana	Redhead		Special Concern	BSSC - Third priority
Aythya collaris	Ring-necked Duck			
Aythya marila	Greater Scaup			
Aythya valisineria	Canvasback		Special	
Botaurus lentiginosus	American Bittern			
Bucephala albeola	Bufflehead			
Bucephala clangula	Common Goldeneye			
Butorides virescens	Green Heron			
Calidris alpina	Dunlin			
Calidris mauri	Western Sandpiper			
Calidris minutilla	Least Sandpiper			
Chen caerulescens	Snow Goose			
Chen rossii	Ross's Goose			
Chlidonias niger	Black Tern		Special Concern	BSSC - Second priority

[7] Howard, J.K. et al. 2015. Patterns of Freshwater Species Richness, Endemism, and Vulnerability in California. PLoSONE, 11(7). Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0130710
[8] California Department of Fish and Wildlife BIOS: https://www.wildlife.ca.gov/data/BIOS
[9] Science for Conservation: https://www.scienceforconservation.org/products/california-freshwater-species-database

Chroicocephalus philadelphia	Bonaparte's Gull			
Cistothorus palustris palustris	Marsh Wren			
Egretta thula	Snowy Egret			
Empidonax traillii	Willow Flycatcher	Bird of Conservation Concern	Endangered	
Fulica americana	American Coot			
Gallinago delicata	Wilson's Snipe			
Geothlypis trichas trichas	Common Yellowthroat			
Grus canadensis	Sandhill Crane			
Haliaeetus leucocephalus	Bald Eagle	Bird of Conservation Concern	Endangered	
Himantopus mexicanus	Black-necked Stilt			
Limnodromus scolopaceus	Long-billed Dowitcher			
Lophodytes cucullatus	Hooded Merganser			
Megaceryle alcyon	Belted Kingfisher			
Mergus merganser	Common Merganser			
Mergus serrator	Red-breasted Merganser			
Numenius americanus	Long-billed Curlew			
Numenius phaeopus	Whimbrel			
Nycticorax nycticorax	Black-crowned Night-Heron			
Oxyura jamaicensis	Ruddy Duck			
Pelecanus erythrorhynchos	American White Pelican		Special Concern	BSSC - First priority
Phalacrocorax auritus	Double-crested Cormorant			
Phalaropus tricolor	Wilson's Phalarope			
Plegadis chihi	White-faced Ibis		Watch list	
Pluvialis squatarola	Black-bellied Plover			
Podiceps nigricollis	Eared Grebe			
Podilymbus podiceps	Pied-billed Grebe			
Porzana carolina	Sora			
Rallus limicola	Virginia Rail			
Recurvirostra americana	American Avocet			
Riparia riparia	Bank Swallow		Threatened	
Setophaga petechia	Yellow Warbler			BSSC - Second priority
Tachycineta bicolor	Tree Swallow			
Tringa melanoleuca	Greater Yellowlegs			
Tringa semipalmata	Willet			
Tringa solitaria	Solitary Sandpiper			
Xanthocephalus xanthocephalus	Yellow-headed Blackbird		Special Concern	BSSC - Third priority
CRUSTACEANS				
Branchinecta lynchi	Vernal Pool Fairy Shrimp	Threatened	Special	IUCN - Vulnerable
Lepidurus packardi	Vernal Pool Tadpole Shrimp	Endangered	Special	IUCN - Endangered
Linderiella occidentalis	California Fairy Shrimp		Special	IUCN - Near Threatened
FISH				
Catostomus occidentalis occidentalis	Sacramento sucker			Least Concern - Moyle 2013
Cottus asper ssp. 1	Prickly sculpin			Least Concern - Moyle 2013
Cottus gulosus	Riffle sculpin		Special	Near-Threatened - Moyle 2013
Gasterosteus aculeatus microcephalus	Inland threespine stickleback		Special	Least Concern - Moyle 2013

Lampetra hubbsi	Kern brook lamprey		Special Concern	Vulnerable - Moyle 2013
Lavinia exilicauda exilicauda	Sacramento hitch		Special	Near-Threatened - Moyle 2013
Lavinia symmetricus symmetricus	Central California roach		Special Concern	Near-Threatened - Moyle 2013
Mylopharodon conocephalus	Hardhead		Special Concern	Near-Threatened - Moyle 2013
Mylopharodon conocephalus	Hardhead		Special Concern	Near-Threatened - Moyle 2013
Oncorhynchus mykiss irideus	Coastal rainbow trout			Least Concern - Moyle 2013
Oncorhynchus tshawytscha - CV fall	Central Valley fall Chinook salmon	Species of Special Concern	Special Concern	Vulnerable - Moyle 2013
Oncorhynchus tshawytscha - CV late fall	Central Valley late fall Chinook salmon	Species of Special Concern		Endangered - Moyle 2013
Orthodon microlepidotus	Sacramento blackfish			Least Concern - Moyle 2013
Ptychocheilus grandis	Sacramento pikeminnow			Least Concern - Moyle 2013
HERPS				
Actinemys marmorata marmorata	Western Pond Turtle		Special Concern	ARSSC
Ambystoma californiense californiense	California Tiger Salamander	Threatened	Threatened	ARSSC
Anaxyrus boreas boreas	Boreal Toad			
Pseudacris regilla	Northern Pacific Chorus Frog			
Rana draytonii	California Red-legged Frog	Threatened	Special Concern	ARSSC
Spea hammondii	Western Spadefoot	Under Review in the Candidate or Petition Process	Special Concern	ARSSC
Taricha torosa	Coast Range Newt		Special Concern	ARSSC
Thamnophis couchii	Sierra Gartersnake			
Thamnophis gigas	Giant Gartersnake	Threatened	Threatened	
Thamnophis sirtalis sirtalis	Common Gartersnake			
INSECTS & OTHER INVERTEBRATES				
Ablabesmyia spp.	Ablabesmyia spp.			
Agapetus malleatus	A Caddisfly			
Baetidae fam.	Baetidae fam.			
Baetis spp.	Baetis spp.			
Baetis tricaudatus	A Mayfly			
Callibaetis spp.	Callibaetis spp.			
Centroptilum spp.	Centroptilum spp.			
Chironomidae fam.	Chironomidae fam.			
Chironomus spp.	Chironomus spp.			
Corixidae fam.	Corixidae fam.			
Cricotopus spp.	Cricotopus spp.			
Cryptotendipes spp.	Cryptotendipes spp.			
Dicrotendipes spp.	Dicrotendipes spp.			
Eubrianax edwardsii				Not on any status lists
Eukiefferiella spp.	Eukiefferiella spp.			
Fallceon spp.	Fallceon spp.			
Heptageniidae fam.	Heptageniidae fam.			
Hetaerina americana	American Rubyspot			

Hydropsyche spp.	Hydropsyche spp.			
Laccobius spp.	Laccobius spp.			
Laccophilus spp.	Laccophilus spp.			
Leptoceridae fam.	Leptoceridae fam.			
Libellula luctuosa	Widow Skimmer			
Limnophyes spp.	Limnophyes spp.			
Mideopsis spp.	Mideopsis spp.			
Nanocladius spp.	Nanocladius spp.			
Nectopsyche spp.	Nectopsyche spp.			
Parakiefferiella spp.	Parakiefferiella spp.			
Paratendipes spp.	Paratendipes spp.			
Phaenopsectra spp.	Phaenopsectra spp.			
Polypedilum spp.	Polypedilum spp.			
Procladius spp.	Procladius spp.			
Pseudochironomus spp.	Pseudochironomus spp.			
Pseudosmittia spp.	Pseudosmittia spp.			
Rheotanytarsus spp.	Rheotanytarsus spp.			
Robackia spp.	Robackia spp.			
Serratella micheneri	A Mayfly			
Sigara spp.	Sigara spp.			
Simulium spp.	Simulium spp.			
Stenochironomus spp.	Stenochironomus spp.			
Tanytarsus spp.	Tanytarsus spp.			
Tipulidae fam.	Tipulidae fam.			
Tramea lacerata	Black Saddlebags			
Tricoryhyphes spp.	Tricoryhyphes spp.			
Tropisternus spp.	Tropisternus spp.			
MAMMALS				
Castor canadensis	American Beaver			Not on any status lists
Lontra canadensis canadensis	North American River Otter			Not on any status lists
Neovison vison	American Mink			Not on any status lists
Ondatra zibethicus	Common Muskrat			Not on any status lists
MOLLUSKS				
Anodonta californiensis	California Floater		Special	
Lymnaea spp.	Lymnaea spp.			
Margaritifera falcata	Western Pearlshell		Special	
Menetus spp.	Menetus spp.			
Physa spp.	Physa spp.			
Sphaeriidae fam.	Sphaeriidae fam.			
PLANTS				
Alnus rhombifolia	White Alder			
Alopecurus carolinianus	Tufted Foxtail			
Alopecurus saccatus	Pacific Foxtail			
Anemopsis californica	Yerba Mansa			
Azolla filiculoides	NA			
Bergia texana	Texas Bergia			
Brodiaea nana				Not on any status lists
Callitriche fassettii	NA			Not on any status lists
Callitriche heterophylla bolanderi	Large Water-starwort			
Callitriche longipedunculata	Longstock Water-starwort			
Callitriche marginata	Winged Water-starwort			
Callitriche trochlearis	Waste-water Water-starwort			
Carex alma	Sturdy Sedge			

Carex amplifolia	Bigleaf Sedge			
Carex densa	Dense Sedge			
Carex diandra	Lesser Panicled Sedge			
Carex feta	Green-sheath Sedge			
Carex hirtissima	Fuzzy Sedge			
Carex integra	Smooth-beak Sedge			
Carex lemmonii	Lemmon's Sedge	Endangered		
Carex senta	Western Rough Sedge			
Carex simulata	Copycat Sedge			
Carex utriculata	Beaked Sedge			
Castilleja campestris succulenta	Fleshy Owl's-clover	Threatened	Endangered	CRPR - 1B.2
Castilleja miniata miniata	Greater Red Indian-paintbrush			
Cephalanthus occidentalis	Common Buttonbush			
Chloropyron palmatum	NA	Endangered	Special	CRPR - 1B.1
Cicendia quadrangularis	Oregon Microcala			
Crassula aquatica	Water Pygmyweed			
Crypsis vaginiflora	NA			
Cyperus acuminatus	Short-point Flatsedge			
Cyperus erythrorhizos	Red-root Flatsedge			
Darmera peltata	Umbrella Plant			
Downingia bella	Hoover's Downingia			
Downingia cuspidata	Toothed Calicoflower			
Downingia ornatissima	NA			
Downingia pusilla	Dwarf Downingia		Special	CRPR - 2B.2
Echinodorus berteroi	Upright Burhead			
Elatine brachysperma	Shortseed Waterwort			
Elatine californica	California Waterwort			
Eleocharis acicularis acicularis	Least Spikerush			
Eleocharis atropurpurea	Purple Spikerush			
Eleocharis macrostachya	Creeping Spikerush			
Elodea canadensis	Broad Waterweed			
Epilobium campestre	NA			Not on any status lists
Epilobium cleistogamum	Cleistogamous Spike-primrose			
Eriophorum crinigerum	Fringed Cotton-grass			
Eryngium spinosepalum	Spiny Sepaled Coyote-thistle		Special	CRPR - 1B.2
Eryngium vaseyi vaseyi	Vasey's Coyote-thistle			Not on any status lists
Euthamia occidentalis	Western Fragrant Goldenrod			
Gratiola ebracteata	Bractless Hedge-hyssop			
Gratiola heterosepala	Boggs Lake Hedge-hyssop		Endangered	CRPR - 1B.2
Helenium bigelovii	Bigelow's Sneezeweed			
Hydrocotyle verticillata verticillata	Whorled Marsh-pennywort			
Hypericum anagalloides	Tinker's-penny			
Isoetes howellii	NA			
Isoetes nuttallii	NA			
Isoetes orcuttii	NA			
Juncus acuminatus	Sharp-fruit Rush			
Juncus dubius	Mariposa Rush			
Juncus effusus pacificus				
Juncus exiguus				Not on any status lists
Juncus uncialis	Inch-high Rush			
Juncus usitatus	NA			Not on any status lists

Juncus xiphioides	Iris-leaf Rush			
Lasthenia fremontii	Fremont's Goldfields			
Leersia oryzoides	Rice Cutgrass			
Lemna aequinoctialis	Lesser Duckweed			
Lemna minuta	Least Duckweed			
Leucothoe davisiae	Western Doghobble			
Limnanthes douglasii douglasii	Douglas' Meadowfoam			
Limnanthes douglasii nivea	Douglas' Meadowfoam			
Limnanthes douglasii rosea	Douglas' Meadowfoam			
Limnanthes montana	Mountain Meadowfoam			
Limosella acaulis	Southern Mudwort			
Lipocarpha micrantha	Dwarf Bulrush			
Ludwigia palustris	Marsh Seedbox			
Ludwigia peploides peploides	NA			Not on any status lists
Lythrum californicum	California Loosestrife			
Marsilea vestita vestita	NA			Not on any status lists
Mimulus guttatus	Common Large Monkeyflower			
Mimulus latidens	Broad-tooth Monkeyflower			
Mimulus tricolor	Tricolor Monkeyflower			
Myosurus minimus	NA			
Najas guadalupensis guadalupensis	Southern Naiad			
Navarretia intertexta	Needleleaf Navarretia			
Navarretia leucocephala bakeri	Baker's Navarretia		Special	CRPR - 1B.1
Navarretia leucocephala leucocephala	White-flower Navarretia			
Navarretia leucocephala minima	Least Navarretia			
Neostapfia colusana	Colusa Grass	Threatened	Endangered	CRPR - 1B.1
Oenanthe sarmentosa	Water-parsley			
Orcuttia inaequalis	San Joaquin Valley Orcutt Grass	Threatened	Endangered	CRPR - 1B.1
Orcuttia pilosa	Hairy Orcutt Grass	Endangered	Endangered	CRPR - 1B.1
Panicum acuminatum acuminatum				Not on any status lists
Panicum dichotomiflorum	NA			
Paspalum distichum	Joint Paspalum			
Perideridia bacigalupii	Bacigalupi's Perideridia		Special	CRPR - 4.2
Perideridia howellii	Howell's False Caraway			
Perideridia lemmonii	Lemmon's Yampah			
Perideridia parishii latifolia	Parish's Yampah			
Persicaria hydropiper	NA			Not on any status lists
Persicaria hydropiperoides				Not on any status lists
Persicaria lapathifolia				Not on any status lists
Persicaria maculosa	NA			Not on any status lists
Phacelia distans	NA			
Phalacroseris bolanderi	NA			
Phalaris arundinacea	Reed Canarygrass			
Phyla nodiflora	Common Frog-fruit			
Pilularia americana	NA			
Plagiobothrys acanthocarpus	Adobe Popcorn-flower			
Plagiobothrys austiniae	Austin's Popcorn-flower			

Plagiobothrys distantiflorus	California Popcorn-flower			
Plagiobothrys greenei	Greene's Popcorn-flower			
Plagiobothrys humistratus	Dwarf Popcorn-flower			
Plagiobothrys leptocladus	Alkali Popcorn-flower			
Plagiobothrys undulatus	NA			Not on any status lists
Plantago elongata elongata	Slender Plantain			
Platanus racemosa	California Sycamore			
Pogogyne douglasii	NA			
Potamogeton diversifolius	Water-thread Pondweed			
Potamogeton foliosus foliosus	Leafy Pondweed			
Potamogeton nodosus	Longleaf Pondweed			
Potamogeton pusillus pusillus	Slender Pondweed			
Psilocarphus brevissimus brevissimus	Dwarf Woolly-heads			
Psilocarphus oregonus	Oregon Woolly-heads			
Psilocarphus tenellus	NA			
Puccinellia simplex	Little Alkali Grass			
Ranunculus bonariensis	NA			
Rhododendron occidentale occidentale	Western Azalea			
Rorippa palustris palustris	Bog Yellowcress			
Rotala ramosior	Toothcup			
Sagittaria latifolia latifolia	Broadleaf Arrowhead			
Sagittaria longiloba	Longbarb Arrowhead			
Sagittaria sanfordii	Sanford's Arrowhead		Special	CRPR - 1B.2
Salix exigua exigua	Narrowleaf Willow			
Salix exigua hindsiana				Not on any status lists
Salix gooddingii	Goodding's Willow			
Salix laevigata	Polished Willow			
Salix lasiolepis lasiolepis	Arroyo Willow			
Salix melanopsis	Dusky Willow			
Schoenoplectus acutus occidentalis	Hardstem Bulrush			
Scirpus congdonii	Congdon's Bulrush			
Scirpus microcarpus	Small-fruit Bulrush			
Senecio triangularis	Arrow-leaf Groundsel			
Sidalcea calycosa calycosa	Annual Checker-mallow			
Sidalcea hirsuta	Hairy Checker-mallow			
Sidalcea reptans	Creeping Checker-mallow			
Solidago elongata				Not on any status lists
Stachys ajugoides	Bugle Hedge-nettle			
Stachys albens	White-stem Hedge-nettle			
Stachys stricta	Sonoma Hedge-nettle			
Tuctoria greenei	Green's Awnless Orcutt Grass	Endangered	Rare	CRPR - 1B.1
Typha domingensis	Southern Cattail			
Typha latifolia	Broadleaf Cattail			
Veronica americana	American Speedwell			
Veronica anagallis-aquatica	NA			
Viola macloskeyi	NA			
Wolffia columbiana	Columbian Watermeal			
Wolffia globosa	Asian Watermeal			

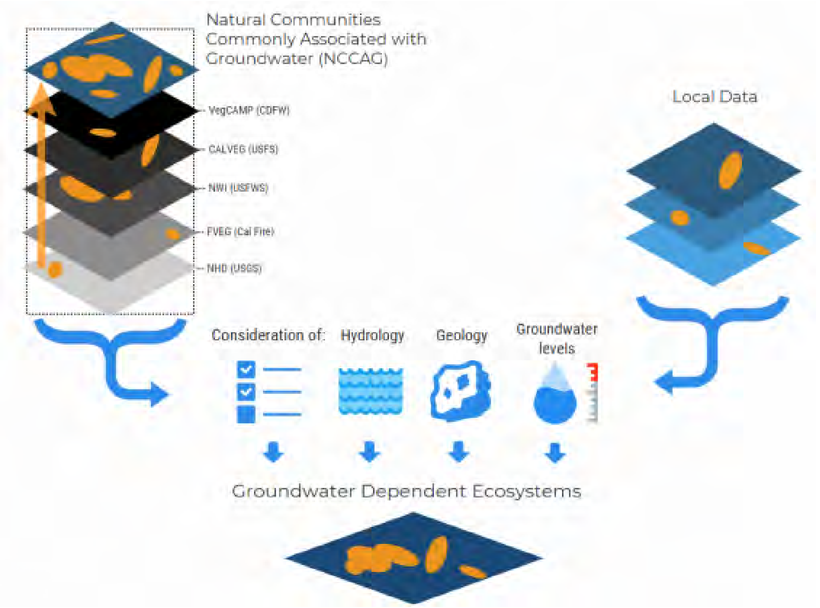
Attachment D

The Nature Conservancy

July 2019

IDENTIFYING GDEs UNDER SGMA
Best Practices for using the NC Dataset

The Sustainable Groundwater Management Act (SGMA) requires that groundwater dependent ecosystems (GDEs) be identified in Groundwater Sustainability Plans (GSPs). As a starting point, the Department of Water Resources (DWR) is providing the Natural Communities Commonly Associated with Groundwater Dataset (NC Dataset) online[10] to help Groundwater Sustainability Agencies (GSAs), consultants, and stakeholders identify GDEs within individual groundwater basins. To apply information from the NC Dataset to local areas, GSAs should combine it with the best available science on local hydrology, geology, and groundwater levels to verify whether polygons in the NC dataset are likely supported by groundwater in an aquifer (Figure 1)[11]. This document highlights six best practices for using local groundwater data to confirm whether mapped features in the NC dataset are supported by groundwater.



[10] *NC Dataset Online Viewer: https://gis.water.ca.gov/app/NCDatasetViewer/*

[11] California Department of Water Resources (DWR). 2018. Summary of the "Natural Communities Commonly Associated with Groundwater" Dataset and Online Web Viewer. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Data-and-Tools/Files/Statewide-Reports/Natural-Communities-Dataset-Summary-Document.pdf

The NC Dataset identifies vegetation and wetland features that are good indicators of a GDE. The dataset is comprised of 48 publicly available state and federal datasets that map vegetation, wetlands, springs, and seeps commonly associated with groundwater in California[12]. It was developed through a collaboration between DWR, the Department of Fish and Wildlife, and The Nature Conservancy (TNC). TNC has also provided detailed guidance on identifying GDEs from the NC dataset[13] on the Groundwater Resource Hub[14], a website dedicated to GDEs.

BEST PRACTICE #1. Establishing a Connection to Groundwater

Groundwater basins can be comprised of one continuous aquifer (Figure 2a) or multiple aquifers stacked on top of each other (Figure 2b). In unconfined aquifers (Figure 2a), using the depth-to-groundwater and the rooting depth of the vegetation is a reasonable method to infer groundwater dependence for GDEs. If groundwater is well below the rooting (and capillary) zone of the plants and any wetland features, the ecosystem is considered disconnected and groundwater management is not likely to affect the ecosystem (Figure 2d). However, it is important to consider local conditions (e.g., soil type, groundwater flow gradients, and aquifer parameters) and to review groundwater depth data from multiple seasons and water year types (wet and dry) because intermittent periods of high groundwater levels can replenish perched clay lenses that serve as the water source for GDEs (Figure 2c). Maintaining these natural groundwater fluctuations are important to sustaining GDE health.

Basins with a stacked series of aquifers (Figure 2b) may have varying levels of pumping across aquifers in the basin, depending on the production capacity or water quality associated with each aquifer. If pumping is concentrated in deeper aquifers, SGMA still requires GSAs to sustainably manage groundwater resources in shallow aquifers, such as perched aquifers, that support springs, surface water, domestic wells, and GDEs (Figure 2). This is because vertical groundwater gradients across aquifers may result in pumping from deeper aquifers to cause adverse impacts onto beneficial users reliant on shallow aquifers or interconnected surface water. The goal of SGMA is to sustainably manage groundwater resources for current and future social, economic, and environmental benefits. While groundwater pumping may not be currently occurring in a shallower aquifer, use of this water may become more appealing and economically viable in future years as pumping restrictions are placed on the deeper production aquifers in the basin to meet the sustainable yield and criteria. Thus, identifying GDEs in the basin should done irrespective to the amount of current pumping occurring in a particular aquifer, so that future impacts on GDEs due to new production can be avoided. A good rule of thumb to follow is: *if groundwater can be pumped from a well - it's an aquifer*.

[12] *For more details on the mapping methods, refer to: Klausmeyer, K., J. Howard, T. Keeler-Wolf, K. Davis-Fadtke, R. Hull, A. Lyons. 2018. Mapping Indicators of Groundwater Dependent Ecosystems in California: Methods Report. San Francisco, California. Available at: https://groundwaterresourcehub.org/public/uploads/pdfs/iGDE_data_paper_20180423.pdf*
[13] "Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act: Guidance for Preparing Groundwater Sustainability Plans" is available at: https://groundwaterresourcehub.org/gde-tools/gsp-guidance-document/
[14] *The Groundwater Resource Hub: www.GroundwaterResourceHub.org*

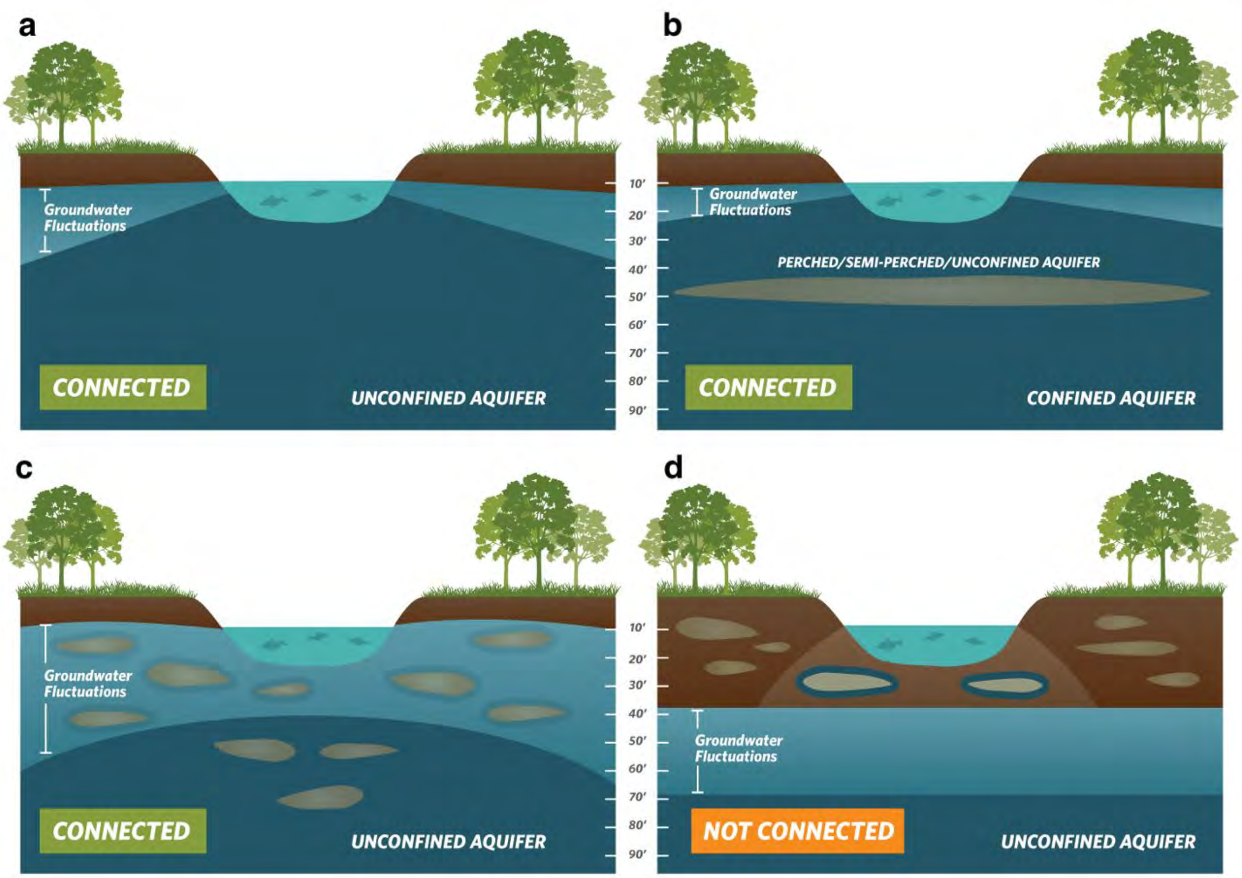


Figure 2. Confirming whether an ecosystem is connected to groundwater. Top: (a) Under the ecosystem is an unconfined aquifer with depth-to-groundwater fluctuating seasonally and interannually within 30 feet from land surface. (b) Depth-to-groundwater in the shallow aquifer is connected to overlying ecosystem. Pumping predominately occurs in the confined aquifer, but pumping is possible in the shallow aquifer. Bottom: (c) Depth-to-groundwater fluctuations are seasonally and interannually large, however, clay layers in the near surface prolong the ecosystem's connection to groundwater. (d) Groundwater is disconnected from surface water, and any water in the vadose (unsaturated) zone is due to direct recharge from precipitation and indirect recharge under the surface water feature. These areas are not connected to groundwater and typically support species that do not require access to groundwater to survive.

BEST PRACTICE #2. Characterize Seasonal and Interannual Groundwater Conditions

SGMA requires GSAs to describe current and historical groundwater conditions when identifying GDEs [23 CCR §354.16(g)]. Relying solely on the SGMA benchmark date (January 1, 2015) or any other single point in time to characterize groundwater conditions (e.g., depth-to-groundwater) is inadequate because managing groundwater conditions with data from one time point fails to capture the seasonal and interannual variability typical of California's climate. DWR's Best Management Practices document on water budgets[15] recommends using 10 years of water supply and water budget information to describe how historical conditions have impacted the operation of the basin within sustainable yield, implying that a baseline[16] could be determined based on data between 2005 and 2015. Using this or a similar time period, depending on data availability, is recommended for determining the depth-to-groundwater.

GDEs depend on groundwater levels being close enough to the land surface to interconnect with surface water systems or plant rooting networks. The most practical approach[17] for a GSA to assess whether polygons in the NC dataset are connected to groundwater is to rely on groundwater elevation data. As detailed in TNC's GDE guidance document[4], one of the key factors to consider when mapping GDEs is to contour depth-to-groundwater in the aquifer that is supporting the ecosystem (see Best Practice #5).

Groundwater levels fluctuate over time and space due to California's Mediterranean climate (dry summers and wet winters), climate change (flood and drought years), and subsurface heterogeneity in the subsurface (Figure 3). Many of California's GDEs have adapted to dealing with intermittent periods of water stress, however if these groundwater conditions are prolonged, adverse impacts to GDEs can result. While depth-to-groundwater levels within 30 feet[4] of the land surface are generally accepted as being a proxy for confirming that polygons in the NC dataset are supported by groundwater, it is highly advised that fluctuations in the groundwater regime be characterized to understand the seasonal and interannual groundwater variability in GDEs. Utilizing groundwater data from one point in time can misrepresent groundwater levels required by GDEs, and inadvertently result in adverse impacts to the GDEs. Time series data on groundwater elevations and depths are available on the SGMA Data Viewer[18]. However, if insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons in the GSP until data gaps are reconciled in the monitoring network (see Best Practice #6).

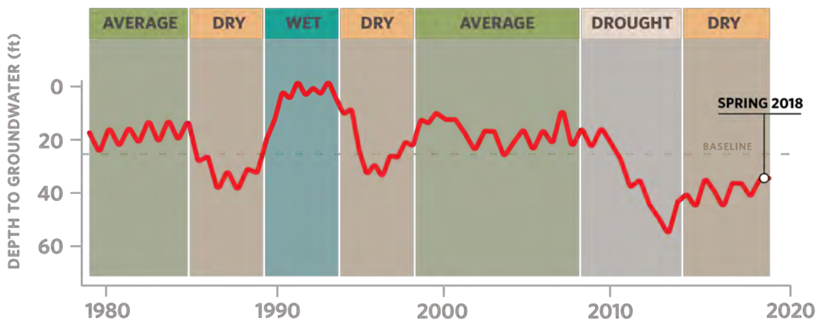


Figure 3. Example seasonality and interannual variability in depth-to-groundwater over time. Selecting one point in time, such as Spring 2018, to characterize groundwater conditions in GDEs fails to capture what groundwater conditions are necessary to maintain the ecosystem status into the future so adverse impacts are avoided.

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[15] DWR. 2016. Water Budget Best Management Practice. Available at: https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_Water_Budget_Final_2016-12-23.pdf

[16] *Baseline is defined under the GSP regulations as "historic information used to project future conditions for hydrology, water demand, and availability of surface water and to evaluate potential sustainable management practices of a basin." [23 CCR §351(e)]*

[17] Groundwater reliance can also be confirmed via stable isotope analysis and geophysical surveys. For more information see The GDE Assessment Toolbox (Appendix IV, GDE Guidance Document for GSPs[4]).

[18] *SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer*

BEST PRACTICE #3. Ecosystems Often Rely on Both Groundwater and Surface Water

GDEs are plants and animals that rely on groundwater for all or some of its water needs, and thus can be supported by multiple water sources. The presence of non-groundwater sources (e.g., surface water, soil moisture in the vadose zone, applied water, treated wastewater effluent, urban stormwater, irrigated return flow) within and around a GDE does not preclude the possibility that it is supported by groundwater, too. SGMA defines GDEs as "ecological communities and species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" [23 CCR §351(m)]. Hence, depth-to-groundwater data should be used to identify whether NC polygons are supported by groundwater and should be considered GDEs. In addition, SGMA requires that significant and undesirable adverse impacts to beneficial users of surface water be avoided. Beneficial users of surface water include environmental users such as plants or animals[19], which therefore must be considered when developing minimum thresholds for depletions of interconnected surface water.

GSAs are only responsible for impacts to GDEs resulting from groundwater conditions in the basin, so if adverse impacts to GDEs result from the diversion of applied water, treated wastewater, or irrigation return flow away from the GDE, then those impacts will be evaluated by other permitting requirements (e.g., CEQA) and may not be the responsibility of the GSA. However, if adverse impacts occur to the GDE due to changing groundwater conditions resulting from pumping or groundwater management activities, then the GSA would be responsible (Figure 4).

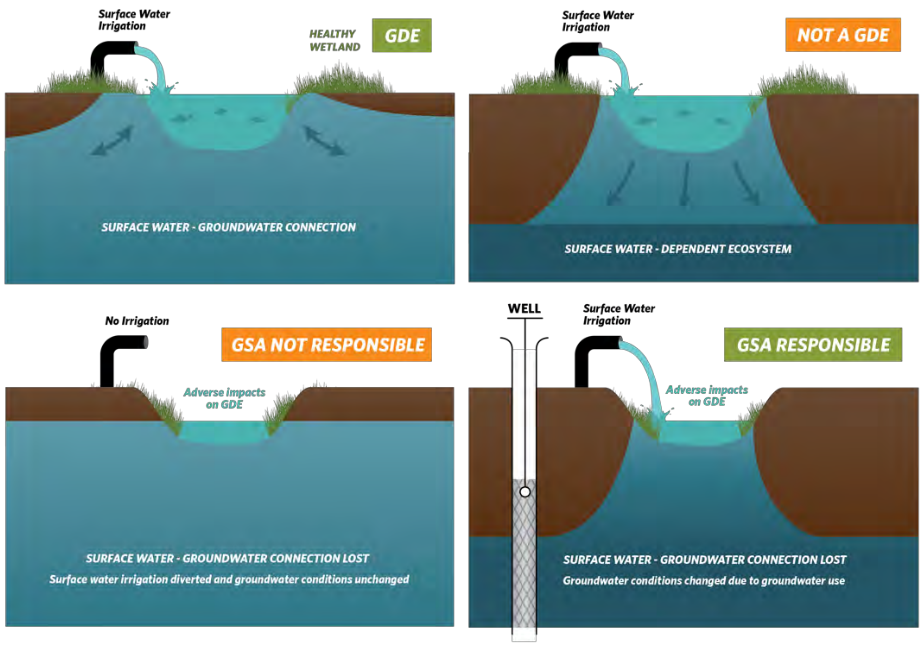

Figure 4. Ecosystems often depend on multiple sources of water. Top: (Left) Surface water and groundwater are interconnected, meaning that the GDE is supported by both groundwater and surface water. (Right) Ecosystems that are only reliant on non-groundwater sources are not groundwater-dependent. Bottom: (Left) An ecosystem that was once dependent on an interconnected surface water, but loses access to groundwater solely due to surface water diversions may not be the GSA's responsibility. (Right) Groundwater dependent ecosystems once dependent on an interconnected surface water system, but loses that access due to groundwater pumping is the GSA's responsibility.

[19] *For a list of environmental beneficial users of surface water by basin, visit: https://groundwaterresourcehub.org/gde-tools/environmental-surface-water-beneficiaries/*

BEST PRACTICE #4. Select Representative Groundwater Wells

Identifying GDEs in a basin requires that groundwater conditions are characterized to confirm whether polygons in the NC dataset are supported by the underlying aquifer. To do this, proximate groundwater wells should be identified to characterize groundwater conditions (Figure 5). When selecting representative wells, it is particularly important to consider the subsurface heterogeneity around NC polygons, especially near surface water features where groundwater and surface water interactions occur around heterogeneous stratigraphic units or aquitards formed by fluvial deposits. The following selection criteria can help ensure groundwater levels are representative of conditions within the GDE area:

- Choose wells that are within 5 kilometers (3.1 miles) of each NC Dataset polygons because they are more likely to reflect the local conditions relevant to the ecosystem. If there are no wells within 5km of the center of a NC dataset polygon, then there is insufficient information to remove the polygon based on groundwater depth. Instead, it should be retained as a potential GDE until there are sufficient data to determine whether or not the NC Dataset polygon is supported by groundwater.

- Choose wells that are screened within the surficial unconfined aquifer and capable of measuring the true water table.

- Avoid relying on wells that have insufficient information on the screened well depth interval for excluding GDEs because they could be providing data on the wrong aquifer. This type of well data should not be used to remove any NC polygons.

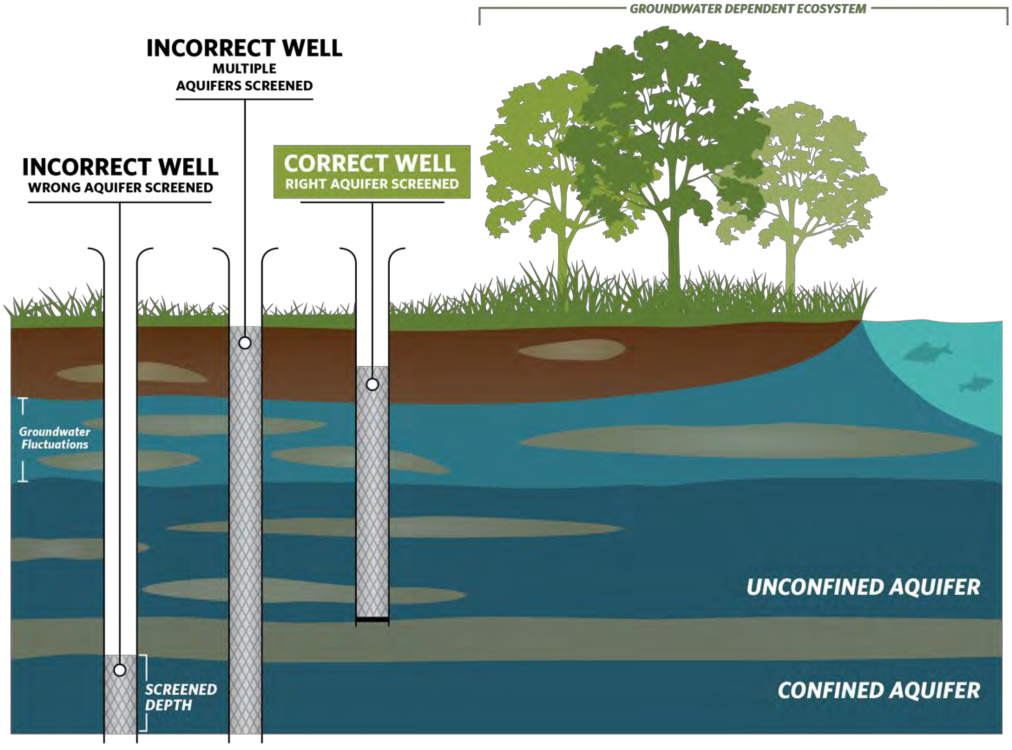

Figure 5. Selecting representative wells to characterize groundwater conditions near GDEs.

BEST PRACTICE #5. Contouring Groundwater Elevations

The common practice to contour depth-to-groundwater over a large area by interpolating measurements at monitoring wells is unsuitable for assessing whether an ecosystem is supported by groundwater. This practice causes errors when the land surface contains features like stream and wetland depressions because it assumes the land surface is constant across the landscape and depth-to-groundwater is constant below these low-lying areas (Figure 6a). A more accurate approach is to interpolate groundwater elevations at monitoring wells to get groundwater elevation contours across the landscape. This layer can then be subtracted from land surface elevations from a Digital Elevation Model (DEM)[20] to estimate depth-to-groundwater contours across the landscape (Figure b; Figure 7). This will provide a much more accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found.

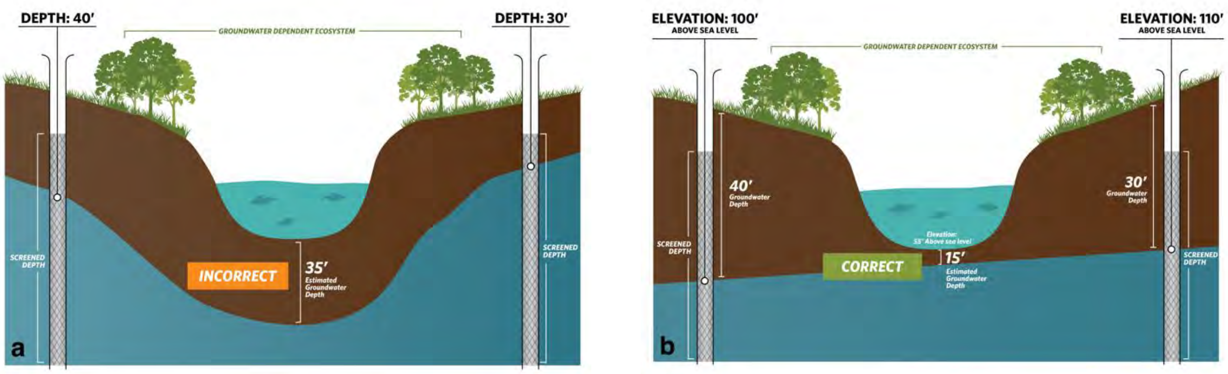

Figure 6. Contouring depth-to-groundwater around surface water features and GDEs. (a) Groundwater level interpolation using depth-to-groundwater data from monitoring wells. (b) Groundwater level interpolation using groundwater elevation data from monitoring wells and DEM data.

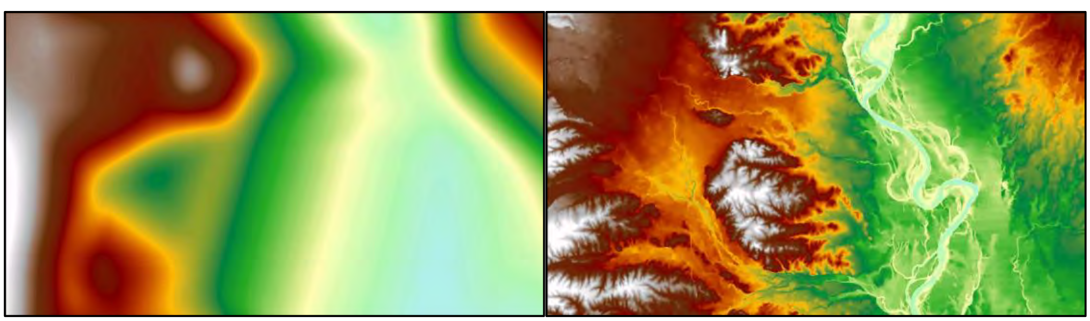

Figure 7. Depth-to-groundwater contours in Northern California. (Left) Contours were interpolated using depth-to-groundwater measurements determined at each well. (Right) Contours were determined by interpolating groundwater elevation measurements at each well and superimposing ground surface elevation from DEM spatial data to generate depth-to-groundwater contours. The image on the right shows a more accurate depth-to-groundwater estimate because it takes the local topography and elevation changes into account.

[20] USGS Digital Elevation Model data products are described at: https://www.usgs.gov/core-science-systems/ngp/3dep/about-3dep-products-services and can be downloaded at: https://iewer.nationalmap.gov/basic/

BEST PRACTICE #6. Best Available Science

Adaptive management is embedded within SGMA and provides a process to work toward sustainability over time by beginning with the best available information to make initial decisions, monitoring the results of those decisions, and using the data collected through monitoring programs to revise decisions in the future. In many situations, the hydrologic connection of NC dataset polygons will not initially be clearly understood if site-specific groundwater monitoring data are not available. If sufficient data are not available in time for the 2020/2022 plan, The Nature Conservancy strongly advises that questionable polygons from the NC dataset be included in the GSP until data gaps are reconciled in the monitoring network. Erring on the side of caution will help minimize inadvertent impacts to GDEs as a result of groundwater use and management actions during SGMA implementation.

KEY DEFINITIONS

Groundwater basin is an aquifer or stacked series of aquifers with reasonably well-defined boundaries in a lateral direction, based on features that significantly impede groundwater flow, and a definable bottom. *23 CCR §341(g)(1)*

Groundwater dependent ecosystem (GDE) are ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface. *23 CCR §351(m)*

Interconnected surface water (ISW) surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. *23 CCR §351(o)*

Principal aquifers are aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems. *23 CCR §351(aa)*

ABOUT US

The Nature Conservancy is a science-based nonprofit organization whose mission is *to conserve the lands and waters on which all life depends*. To support successful SGMA implementation that meets the future needs of people, the economy, and the environment, TNC has developed tools and resources (www.groundwaterresourcehub.org) intended to reduce costs, shorten timelines, and increase benefits for both people and nature.

The Nature Conservancy
Protecting nature. Preserving life.

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1 July 2019

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637

Submitted via email: MaderaGSPComments@maderacounty.com

Re: Chapters 1 and 2 of the Madera Subbasin Groundwater Sustainability Plan (GSP)

Dear Stephanie Anagnoson,

The Nature Conservancy (TNC) appreciates the opportunity to comment on Chapters 1 and 2 of the Madera Subbasin Groundwater Sustainability Plan, being prepared under the Sustainable Groundwater Management Act (SGMA).

TNC as a Stakeholder Representative for the Environment

TNC is a global, nonprofit organization dedicated to conserving the lands and waters on which all life depends. We seek to achieve our mission through science-based planning and implementation of conservation strategies. For decades, we have dedicated resources to establishing diverse partnerships and developing foundational science products for achieving positive outcomes for people and nature in California. TNC was part of a stakeholder group formed by the Water Foundation in early 2014 to develop recommendations for groundwater reform and actively worked to shape and pass SGMA.

Our reason for engaging is simple: California's freshwater biodiversity is highly imperiled. We have lost more than 90 percent of our native wetland and river habitats, leading to precipitous declines in native plants and the populations of animals that call these places home. These natural resources are intricately connected to California's economy providing direct benefits through industries such as fisheries, timber and hunting, as well as indirect benefits such as clean water supplies. SGMA must be successful for us to achieve a sustainable future, in which people and nature can thrive within the Madera County Groundwater Sustainability region and California.

We believe that the success of SGMA depends on bringing the best available science to the table, engaging all stakeholders in robust dialog, providing strong incentives for beneficial outcomes and rigorous enforcement by the State of California.

Given our mission, we are particularly concerned about the inclusion of nature, as required, in GSPs. The Nature Conservancy has developed a suite of tools based on best available science to help GSAs, consultants, and stakeholders efficiently incorporate nature into GSPs. These tools and resources are available online at GroundwaterResourceHub.org. The Nature

Conservancy's tools and resources are intended to reduce costs, shorten timelines, and increase benefits for both people and nature.

Addressing Nature's Water Needs in GSPs

SGMA requires that all beneficial uses and users, including environmental users of groundwater, be considered in the development and implementation of GSPs (Water Code § 10723.2).

The GSP Regulations include specific requirements to identify and consider groundwater dependent ecosystems (23 CCR §354.16(g)) when determining whether groundwater conditions are having potential effects on beneficial uses and users. GSAs must also assess whether sustainable management criteria may cause adverse impacts to beneficial uses, which include environmental uses, such as plants and animals. In addition, monitoring networks should be designed to detect potential adverse impacts to beneficial uses due to groundwater. Adaptive management is embedded within SGMA and provides a process to work toward sustainability over time by beginning with the best available information to make initial decisions, monitoring the results of those decision, and using data collected through monitoring to revise decisions in the future. Over time, GSPs should improve as data gaps are reduced and uncertainties addressed.

To help ensure that GSPs adequately address nature as required under SGMA, The Nature Conservancy has prepared a checklist (**Attachment A**) for GSAs and their consultants to use. The Nature Conservancy believes the following elements are foundational for 2020 GSP submittals. For detailed guidance on how to address the checklist items, please also see our publication, *GDEs under SGMA: Guidance for Preparing GSPs*[1].

1. Environmental Representation

SGMA requires that groundwater sustainability agencies (GSAs) consider the interests of all beneficial uses and users of groundwater. To meet this requirement, we recommend actively engaging environmental stakeholders by including environmental representation on the GSA board, technical advisory group, and/or working groups. This could include local staff from state and federal resource agencies, nonprofit organizations and other environmental interests. By engaging these stakeholders, GSAs will benefit from access to additional data and resources, as well as a more robust and inclusive GSP.

2. Basin GDE and ISW Maps

SGMA requires that groundwater dependent ecosystems (GDEs) and interconnected surface waters (ISWs) be identified in the GSP. We recommend using the Natural Communities Commonly Associated with Groundwater Dataset (NC Dataset) provided online[2] by the Department of Water Resources (DWR) as a starting point for the GDE map. The NC Dataset was developed through a collaboration between DWR, the Department of Fish and Wildlife and TNC.

3. Potential Effects on Environmental Beneficial Users

SGMA requires that potential effects on GDEs and environmental surface water users be described when defining undesirable results. In addition to identifying GDEs in the basin, The Nature Conservancy recommends identifying beneficial users of surface water, which include

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[1]GDEs under SGMA: Guidance for Preparing GSPs is available at: https://groundwaterresourcehub.org/public/uploads/pdfs/GWR_Hub_GDE_Guidance_Doc_2-1-18.pdf

[2] The Department of Water Resoruces' Natural Communities Commonly Associated with Groundwater dataset is available at: *https://gis.water.ca.gov/app/NCDatasetViewer/*

environmental users. This is a critical step, as it is impossible to define "significant and unreasonable adverse impacts" without knowing *what* is being impacted. For your convenience, we've provided a list of freshwater species within the boundary of the Madera Subbasin in **Attachment C**. Our hope is that this information will help your GSA better evaluate the impacts of groundwater management on environmental beneficial users of surface water. We recommend that after identifying which freshwater species exist in your basin, especially federal and state listed species, that you contact staff at the Department of Fish and Wildlife (DFW), United States Fish and Wildlife Service (USFWS) and/or National Marine Fisheries Services (NMFS) to obtain their input on the groundwater and surface water needs of the organisms on the GSA's freshwater species list. Because effects to plants and animals are difficult and sometimes impossible to reverse, we recommend erring on the side of caution to preserve sufficient groundwater conditions to sustain GDEs and ISWs.

4. Biological and Hydrological Monitoring
If sufficient hydrological and biological data in and around GDEs is not available in time for the 2020/2022 plan, data gaps should be identified along with actions to reconcile the gaps in the monitoring network.

Our specific comments related to the Madera Subbasin Groundwater Sustainability Plan Chapters 1 and 2 are provided in detail in **Attachment B** and are in reference to the numbered items in **Attachment A.** Please note that because critical sections of Chapter 2 were not provided in the downloaded file, we will provide further comments on Chapter 2 when the full chapter is available. **Attachment C** provides a list of the freshwater species located in the Madera Subbasin. **Attachment D** describes six best practices that GSAs and their consultants can apply when using local groundwater data to confirm a connection to groundwater for DWR's Natural Communities Commonly Associated with Groundwater Dataset[2]. **Attachment E** provides an overview of a new, free online tool that allows GSAs to assess changes in groundwater-dependent ecosystem (GDE) health using satellite, rainfall, and groundwater data.

Thank you for fully considering our comments as you develop your GSP.

Best Regards,

Sandi Matsumoto
Associate Director, California Water Program
The Nature Conservancy

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C

Attachment A
Considering Nature under SGMA: A Checklist

The Nature Conservancy is neither dispensing legal advice nor warranting any outcome that could result from the use of this
does not guarantee approval of a GSP or compliance with SGMA, both of which will be determined by DWR and the State Wa

GSP Plan Element*		GDE Inclusion in GSPs: Identification and Consideration Elements	
Admin Info	**2.1.5 Notice & Communication** *23 CCR §354.10*	**Description of the types of environmental beneficial uses of groundwater that exist within GDEs how environmental stakeholders were engaged throughout the development of the GSP.**	
Planning Framework	**2.1.2 to 2.1.4 Description of Plan Area** *23 CCR §354.8*	**Description of jurisdictional boundaries, existing land use designations, water use management a programs; general plans and other land use plans relevant to GDEs and their relationship to the G**	
		Description of instream flow requirements, threatened and endangered species habitat, critical ha areas.	
		Summary of process for permitting new or replacement wells for the basin, and how the p protection of GDEs	
Basin Setting	**2.2.1 Hydrogeologic Conceptual Model** *23 CCR §354.14*	**Basin Bottom Boundary:** Is the bottom of the basin defined as at least as deep as the deepest groundwater extractions?	
		Principal aquifers and aquitards: Are shallow aquifers adequately described, so that interconnections with surface water and vertical groundwat aquifers can be characterized?	
		Basin cross sections: Do cross-sections illustrate the relationships between GDEs, surface waters and principal aquifers?	
	2.2.2 Current & Historical Groundwater Conditions *23 CCR §354.16*	**Interconnected surface waters:**	
		Interconnected surface water maps for the basin with gaining and losing reaches defined (included as a figu as a shapefile on SGMA portal).	
		Estimates of current and historical surface water depletions for interconnected surface waters quantified ar season, and water year type.	
		Basin GDE map included (as figure in text & submitted as a shapefile on SGMA Portal).	
		If NC Dataset *was* used:	Basin GDE map denotes which polygons were kept, removed, and ad (Worksheet 1, can be attached in GSP section 6.0).

			The basin's GDE shapefile, which is submitted via the SGMA Portal, includ attribute table denoting: 1) which polygons were kept/removed/added, an (e.g., why polygons were removed).
			GDEs polygons are consolidated into larger units and named for easier id GSP.
		If NC Dataset *was not* used:	Description of why NC dataset was not used, and how an alternative d approach used is best available information.
		Description of GDEs included:	
		Historical and current groundwater conditions and variability are described in each GDE unit.	
		Historical and current ecological condition and variability are described in each GDE unit and adequate to 2015.	
		Each GDE unit has been characterized as having high, moderate, or low ecological value.	
		Inventory of species, habitats, and protected lands for each GDE unit with ecological importance (Workshee GSP section 6.0).	
	2.2.3 Water Budget *23 CCR §354.18*	Groundwater inputs and outputs (e.g., evapotranspiration) of native vegetation and managed wetlands are historical and current water budget.	
		Potential impacts to groundwater conditions due to land use changes, climate change, and population grow ecosystems are considered in the projected water budget.	
Sustainable Management Criteria	**3.1 Sustainability Goal** *23 CCR §354.24*	**Environmental stakeholders/representatives were consulted.**	
		Sustainability goal mentions GDEs or species and habitats that are of particular concern or interest.	
		Sustainability goal mentions whether the intention is to address pre-SGMA impacts, maintain or improve co species and habitats that are of particular concern or interest.	
	3.2 Measurable Objectives *23 CCR §354.30*	**Description of how GDEs were considered and whether the measurable objectives and interim achieve the sustainability goal as it pertains to the environment, beneficial uses and managed ar**	
	3.3 Minimum Thresholds *23 CCR §354.28*	**Description of how GDEs and environmental uses of surface water were considered when setting for relevant sustainability indicators:**	
		Will adverse impacts to GDEs and/or aquatic ecosystems dependent on interconnected surface waters (be water) be avoided with the selected minimum thresholds?	
		Are there any differences between the selected minimum threshold and state, federal, or local standards rel habitats residing in GDEs or aquatic ecosystems dependent on interconnected surface waters?	
	3.4 Undesirable Results *23 CCR §354.26*	**For GDEs, hydrological data are compiled and synthesized for each GDE unit:**	
		If hydrological data *are available* within/nearby the GDE	Hydrological datasets are plotted and provided for each GDE unit attached in GSP Section 6.0).
			Baseline period in the hydrologic data is defined.
			GDE unit is classified as having high, moderate, or low suscep groundwater.

			Cause-and-effect relationships between groundwater changes and GD
		If hydrological data *are not available* within/nearby the GDE	Data gaps/insufficiencies are described.
			Plans to reconcile data gaps in the monitoring network are stated.
		For GDEs, biological data are compiled and synthesized for each GDE unit:	
		Biological datasets are plotted and provided for each GDE unit, and provide baseline conditions for assessme variability.	
		Data gaps/insufficiencies are described.	
		Plans to reconcile data gaps in the monitoring network are stated.	
		Description of potential effects on GDEs, land uses and property interests:	
		Cause-and-effect relationships between GDE and groundwater conditions are described.	
		Impacts to GDEs that are considered to be "significant and unreasonable" are described.	
		Known hydrological thresholds or triggers (e.g., instream flow criteria, groundwater depths, water quality pa significant impacts to relevant species or ecological communities are reported.	
		Land uses include and consider recreational uses (e.g., fishing/hunting, hiking, boating).	
		Property interests include and consider privately and publicly protected conservation lands and opens spaces refuges, parks, and natural preserves.	
Sustainable Management Criteria	**3.5 Monitoring Network** *23 CCR §354.34*	Description of whether hydrological data are spatially and temporally sufficient to monitor groundwater cond unit.	
		Description of how hydrological data gaps and insufficiencies will be reconciled in the monitoring network.	
		Description of how impacts to GDEs and environmental surface water users, as detected by biological respo and which GDE monitoring methods will be used in conjunction with hydrologic data to evaluate cause-and-e groundwater conditions.	
Projects & Mgmt Actions	**4.0. Projects & Mgmt Actions to Achieve Sustainability Goal** *23 CCR §354.44*	Description of how GDEs will benefit from relevant project or management actions.	
		Description of how projects and management actions will be evaluated to assess whether adverse impa mitigated or prevented.	

* In reference to DWR's GSP annotated outline guidance document, available at: https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/GD_GSP_Outline_Final_2016-12-23.pdf

Attachment B

TNC Evaluation of the
Madera Subbasin Groundwater Sustainability Plan, Chapters 1 and 2

This attachment summarizes our comments on Chapters 1 and 2 of the Madera Subbasin GSP. Major sections of Chapter 2 were not included in the review draft, including many figures, key sections of the document, and appendices with supporting information. The missing sections are critical to TNCs review of this GSP. Therefore, please view the comments on Chapter 2 as preliminary, and take them into consideration as you finalize Chapter 2.

Section 2.1.5.2 Description of Beneficial Uses and Users in the Basin (p.16) [Checklist Item #1]:

- Although environmental agencies and environmental groups are listed as one of the beneficial users of groundwater in the Subbasin, no specific uses are given. The types and locations of environmental uses, species and habitats supported, and the designated beneficial environmental uses of surface waters that may be affected by groundwater extraction in the Subbasin should be specified. To identify environmental users, **please refer to the following**:
    - Natural Communities Commonly Associated with Groundwater dataset (NC Dataset) - https://gis.water.ca.gov/app/NCDatasetViewer/
    - The list of freshwater species located in the Madera Subbasin in **Attachment C** of this letter. This list was previously sent to the GSA and is available online (https://groundwaterresourcehub.org/gde-tools/environmental-surface-water-beneficiaries/). Please take particular note of the species with protected status.
    - Lands that are protected as open space preserves, habitat reserves, wildlife refuges, etc. or other lands protected in perpetuity and supported by groundwater or interconnected surface waters should be identified and acknowledged.
- In Table 2-5 (p. 17), Environmental and Ecosystem Uses Category: Stakeholders representing State and Federal agencies should include the United States Fish and Wildlife Service and National Marine Fisheries Service. Environmental groups should be expanded in a manner similar to the environmental justice groups in the Human Right to Water category. **Please expand the stakeholder list associated with the Environmental and Ecosystem Uses category in Table 2-5 to include the appropriate agencies and list of environmental groups**.

Section 2.1.2 Water Resources Monitoring and Management Programs (p. 8-12) [Checklist Item #2]:

- Per the GSP Regulations (23 CCR §354.34), monitoring must address trends in groundwater *and related surface conditions*. For this section to provide the appropriate context and help assure integration of GSP implementation with other ongoing regulatory programs, **please describe jurisdictions related to aquatic resources, interconnected surface waters, instream flow requirements, and groundwater-dependent ecosystems (GDEs) that could be affected by groundwater withdrawals.**

Section 2.1.2.2 Surface Water Monitoring and Management Programs (p. 9-10) [Checklist Item #2]:

- "*Limitations on surface water deliveries will limit operational flexibility by reducing surface water supplies available for conjunctive use programs.*" (p. 10) The limitations are not defined and warrant further description, either in this section or in Section 2.1.2.4, to more specifically identify potential effects on the flows of interconnected surface waters and potential stress to the groundwater system. **Please ensure that description of the surface water monitoring system in Appendix 2H clarifies the limitations and please specify whether these limitations could affect the surface water conditions of any GDEs or instream habitat in interconnected surface waters that may be present in the area.**

Section 2.1.3 Land Use Elements or Topic Categories of Applicable General Plans (p. 13-15) [Checklist Item #2]:

- Policy 1.A.5 of the Madera County General Plan restricts development in "areas with sensitive environmental resources", but this is the only mention of sensitive areas in the GSP as it relates to the General Plans. This section should include a discussion of the relationship of GSP implementation to General Plan goals and policies related to GDEs and sensitive or aquatic habitat. **Please further describe General Plan goals and policies related to the protection and management of GDEs and aquatic resources that could be affected by groundwater withdrawals.**

Section 2.1.1 Summary of Jurisdictional Areas and Other Features (p. 1-8) [Checklist Item #3]:

- The GSP states "*The Madera Subbasin … contains no considerable state land or federal land*" and provides a brief description of these lands as a footnote. Other than State preserves and parks, protected lands that could contain aquatic, riparian, and other potentially groundwater-dependent habitat are not identified. **Please identify all state park land, wildlife preserves, wetlands, open space, mitigation areas, and local parks with potentially groundwater-connected aquatic resources and habitat.**

Section 2.1.3.3 Permitting Process for Wells in Madera Subbasin (p. 15) [Checklist Item #4]:

- **Please include discussion of the following in the well permitting section:**
  - Detail how future well permitting will be coordinated with the GSP to assure achievement of the Plan's sustainability goals.

- The State Third Appellate District recently found that Counties have a responsibility to consider the potential impacts of groundwater withdrawals on public trust resources when permitting new wells near surface waters with public trust uses (ELF v. SWRCB and Siskiyou County, No. C083239). The need for well permitting programs to comply with this requirement should be stated.

<u>Section 2.1.4 Additional GSP Elements (p. 15)</u>
[Checklist Items #2-4]:

- The following topics were listed, but not included in this draft of the GSP:
    - Control of saline water intrusion
    - Wellhead protection
    - Migration of contaminated groundwater
    - Well abandonment and well destruction program
    - Replenishment of groundwater extractions
    - Conjunctive use and underground storage
    - Well construction policies
    - Groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects
    - Efficient water management practice
    - Relationships with State and Federal regulatory agencies
    - Land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity
    - Impacts on groundwater dependent ecosystems
- **These topics are an important part of the GSP and should be added. Further comments may be made with respect to GDEs after discussion of these topics is added to the GSP.**

<u>Section 2.2.1.2 Lateral and Vertical Subbasin Boundaries (p. 24)</u>
[Checklist Item #5]:

- The base of the vertical boundary for the GSP should be clearly defined. The base of freshwater appears to be defined as "*considered to have total dissolved solids of less than 1,000 milligrams/liter (mg/L) or conductivity of less than 1,600 umhos/cm.*" The text states "*in general, the aquifer base is controlled mostly by the base of freshwater provided in Figure 2-17 except in the far eastern portions of the subbasin.*" In the eastern part of the subbasin, the vertical boundary appears to be the depth to bedrock, Figure 2-18. The figures are missing so the comparison of the bottom of wells to either definition cannot be made. As noted on page 9 of DWR's Hydrogeologic Conceptual Model BMP (https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_HCM_Final_2016-12-23.pdf) "the definable bottom of the basin should be at least as deep as the deepest groundwater extractions". **Thus, groundwater extraction well depth data should also be included in the determination of the basin bottom.** This will prevent the possibility of extractors with wells deeper than the basin boundary (defined by the base of freshwater) from claiming exemption from SGMA due to their well residing outside the vertical extent of the basin boundary.

Section 2.2.1 Hydrogeologic Conceptual Model (p. 22)
[Checklist Item #6-7]:

- Numerous figures (Figures 2-9 through 2-72) and Appendices 2F, 2G, 2H, and 6E are not included in the review draft, so it is difficult to confirm the information stated in the text. The two principal aquifers are the Upper and Lower Aquifers. The Upper Aquifer is unconfined, and the Lower Aquifer is semi-confined in the eastern part of the basin and confined in the western part by the Corcoran Clay. The relationship of the aquifers to surface water is not defined, given the missing figures. **Please ensure that the cross-sections include example near-surface cross section details that depict the conceptual understanding of shallow or perched groundwater and stream, riparian and other GDE interactions at different locations.**

Section 2.2.2.6 Groundwater Dependent Ecosystems (p. 36-37)
[Checklist Item #11-20]:

- Page 37 states that the GDE analysis is in progress. **Please ensure that Best Practices for using the NC Dataset, included as Attachment D in this letter, is followed when identifying GDEs.**
- The text states (p. 37) "*However, the presence of perched water at a given location will not be affected by regional groundwater pumping, and therefore potential impacts to perched groundwater are not a consideration in evaluation of GDEs and sustainable yield for the Subbasin.*" The GSP discounts the perched water zones as derived from surface water, and therefore they were not considered in evaluation of GDEs. **The GSP should provide clear evidence of hydraulic disconnection where shallow groundwater is considered perched or identify hydraulic connection as a data gap. In addition, the GSP should consider perched water as a shallow aquifer, because even though it may not be pumped at present, it could be in the future.**
- The GSP indicates "*that there may be small isolated areas along the San Joaquin River on the southern boundary of Madera Subbasin and possibly at the extreme western tip of Madera Subbasin*" (p. 37) that will be evaluated for potential GDEs. **Please include maps and detailed near-surface cross-sections of these areas and refer to the figures in this section.**

Section 2.2.3.1 Water Budget Conceptual Model (p. 37-46)
[Checklist Item #21-22]:

- In the Land Surface System component of the water budget, ET is split into ET of applied irrigation water and ET of precipitation (Table 2-10, p. 43). ET of groundwater (ETg) is not included. **Please include ETg in the water budget or explain where it is included.**

Section 2.2.3.2 Water Budget Analysis Period (p. 46)

[Checklist Item #21-22]:

- The projected period for the water budget was selected as 2017-2090. The DWR mean 2030 climate change factors were used to adjust hydrologic data for 1965-2015. The land use was adjusted in urban areas based on the projected growth from 2017 to 2070. However, the results are not provided. The simulations were run with the MCSim model with and without projects and/or demand reductions actions to achieve sustainability yields by 2040. The results are needed to see how the projected water budget might impact any GDEs and aquatic ecosystems. **Please provide the complete water budget and supporting analysis for the projected period.**

Section 2.2.3.3 Water Budget Components and Uncertainties (p. 50)
[Checklist Item #21-22]:

- **Please clarify how the IDC model of the root zone budget was used to differentiate ET among the agricultural, urban, and native vegetation land uses (p. 52). Please explain how any native vegetation present in GDEs was handled in the water budget process.**

Attachment C

Freshwater Species Located in the Madera Subbasin

To assist in identifying the beneficial users of surface water necessary to assess the undesirable result "depletion of interconnected surface waters", Attachment C provides a list of freshwater species located in the Madera Subbasin. To produce the freshwater species list, we used ArcGIS to select features within the California Freshwater Species Database version 2.0.9 within the GSA's boundary. This database contains information on ~4,000 vertebrates, macroinvertebrates and vascular plants that depend on fresh water for at least one stage of their life cycle. The methods used to compile the California Freshwater Species Database can be found in Howard et al. 2015[3]. The spatial database contains locality observations and/or distribution information from ~400 data sources. The database is housed in the California Department of Fish and Wildlife's BIOS[4] as well as on The Nature Conservancy's science website[5].

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
BIRDS				
Actitis macularius	Spotted Sandpiper			
Aechmophorus occidentalis	Western Grebe			
Agelaius tricolor	Tricolored Blackbird	Bird of Conservation Concern	Special Concern	BSSC - First priority
Aix sponsa	Wood Duck			
Anas acuta	Northern Pintail			
Anas americana	American Wigeon			
Anas clypeata	Northern Shoveler			
Anas crecca	Green-winged Teal			
Anas cyanoptera	Cinnamon Teal			
Anas discors	Blue-winged Teal			
Anas platyrhynchos	Mallard			
Anas strepera	Gadwall			
Anser albifrons	Greater White-fronted Goose			
Ardea alba	Great Egret			
Ardea herodias	Great Blue Heron			
Aythya affinis	Lesser Scaup			
Aythya americana	Redhead		Special Concern	BSSC - Third priority
Aythya collaris	Ring-necked Duck			
Aythya marila	Greater Scaup			
Aythya valisineria	Canvasback		Special	
Botaurus lentiginosus	American Bittern			
Bucephala albeola	Bufflehead			
Bucephala clangula	Common Goldeneye			
Butorides virescens	Green Heron			
Calidris alpina	Dunlin			
Calidris mauri	Western Sandpiper			
Calidris minutilla	Least Sandpiper			
Chen caerulescens	Snow Goose			
Chen rossii	Ross's Goose			
Chlidonias niger	Black Tern		Special Concern	BSSC - Second priority

[3] Howard, J.K. et al. 2015. Patterns of Freshwater Species Richness, Endemism, and Vulnerability in California. PLoSONE, 11(7). Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0130710
[4] California Department of Fish and Wildlife BIOS: https://www.wildlife.ca.gov/data/BIOS
[5] Science for Conservation: https://www.scienceforconservation.org/products/california-freshwater-species-database

Chroicocephalus philadelphia	Bonaparte's Gull			
Cistothorus palustris palustris	Marsh Wren			
Egretta thula	Snowy Egret			
Empidonax traillii	Willow Flycatcher	Bird of Conservation Concern	Endangered	
Fulica americana	American Coot			
Gallinago delicata	Wilson's Snipe			
Geothlypis trichas trichas	Common Yellowthroat			
Grus canadensis	Sandhill Crane			
Haliaeetus leucocephalus	Bald Eagle	Bird of Conservation Concern	Endangered	
Himantopus mexicanus	Black-necked Stilt			
Limnodromus scolopaceus	Long-billed Dowitcher			
Lophodytes cucullatus	Hooded Merganser			
Megaceryle alcyon	Belted Kingfisher			
Mergus merganser	Common Merganser			
Mergus serrator	Red-breasted Merganser			
Numenius americanus	Long-billed Curlew			
Numenius phaeopus	Whimbrel			
Nycticorax nycticorax	Black-crowned Night-Heron			
Oxyura jamaicensis	Ruddy Duck			
Pelecanus erythrorhynchos	American White Pelican		Special Concern	BSSC - First priority
Phalacrocorax auritus	Double-crested Cormorant			
Phalaropus tricolor	Wilson's Phalarope			
Plegadis chihi	White-faced Ibis		Watch list	
Pluvialis squatarola	Black-bellied Plover			
Podiceps nigricollis	Eared Grebe			
Podilymbus podiceps	Pied-billed Grebe			
Porzana carolina	Sora			
Rallus limicola	Virginia Rail			
Recurvirostra americana	American Avocet			
Riparia riparia	Bank Swallow		Threatened	
Setophaga petechia	Yellow Warbler			BSSC - Second priority
Tachycineta bicolor	Tree Swallow			
Tringa melanoleuca	Greater Yellowlegs			
Tringa semipalmata	Willet			
Tringa solitaria	Solitary Sandpiper			
Xanthocephalus xanthocephalus	Yellow-headed Blackbird		Special Concern	BSSC - Third priority
CRUSTACEANS				
Branchinecta lynchi	Vernal Pool Fairy Shrimp	Threatened	Special	IUCN - Vulnerable
Lepidurus packardi	Vernal Pool Tadpole Shrimp	Endangered	Special	IUCN - Endangered
Linderiella occidentalis	California Fairy Shrimp		Special	IUCN - Near Threatened
FISH				
Catostomus occidentalis occidentalis	Sacramento sucker			Least Concern - Moyle 2013
Cottus asper ssp. 1	Prickly sculpin			Least Concern - Moyle 2013
Cottus gulosus	Riffle sculpin		Special	Near-Threatened - Moyle 2013
Gasterosteus aculeatus microcephalus	Inland threespine stickleback		Special	Least Concern - Moyle 2013

Lampetra hubbsi	Kern brook lamprey		Special Concern	Vulnerable - Moyle 2013
Lavinia exilicauda exilicauda	Sacramento hitch		Special	Near-Threatened - Moyle 2013
Lavinia symmetricus symmetricus	Central California roach		Special Concern	Near-Threatened - Moyle 2013
Mylopharodon conocephalus	Hardhead		Special Concern	Near-Threatened - Moyle 2013
Mylopharodon conocephalus	Hardhead		Special Concern	Near-Threatened - Moyle 2013
Oncorhynchus mykiss irideus	Coastal rainbow trout			Least Concern - Moyle 2013
Oncorhynchus tshawytscha - CV fall	Central Valley fall Chinook salmon	Species of Special Concern	Special Concern	Vulnerable - Moyle 2013
Oncorhynchus tshawytscha - CV late fall	Central Valley late fall Chinook salmon	Species of Special Concern		Endangered - Moyle 2013
Orthodon microlepidotus	Sacramento blackfish			Least Concern - Moyle 2013
Ptychocheilus grandis	Sacramento pikeminnow			Least Concern - Moyle 2013
HERPS				
Actinemys marmorata marmorata	Western Pond Turtle		Special Concern	ARSSC
Ambystoma californiense californiense	California Tiger Salamander	Threatened	Threatened	ARSSC
Anaxyrus boreas boreas	Boreal Toad			
Pseudacris regilla	Northern Pacific Chorus Frog			
Rana draytonii	California Red-legged Frog	Threatened	Special Concern	ARSSC
Spea hammondii	Western Spadefoot	Under Review in the Candidate or Petition Process	Special Concern	ARSSC
Taricha torosa	Coast Range Newt		Special Concern	ARSSC
Thamnophis couchii	Sierra Gartersnake			
Thamnophis gigas	Giant Gartersnake	Threatened	Threatened	
Thamnophis sirtalis sirtalis	Common Gartersnake			
INSECTS & OTHER INVERTEBRATES				
Ablabesmyia spp.	Ablabesmyia spp.			
Agapetus malleatus	A Caddisfly			
Baetidae fam.	Baetidae fam.			
Baetis spp.	Baetis spp.			
Baetis tricaudatus	A Mayfly			
Callibaetis spp.	Callibaetis spp.			
Centroptilum spp.	Centroptilum spp.			
Chironomidae fam.	Chironomidae fam.			
Chironomus spp.	Chironomus spp.			
Corixidae fam.	Corixidae fam.			
Cricotopus spp.	Cricotopus spp.			
Cryptotendipes spp.	Cryptotendipes spp.			
Dicrotendipes spp.	Dicrotendipes spp.			
Eubrianax edwardsii				Not on any status lists
Eukiefferiella spp.	Eukiefferiella spp.			
Fallceon spp.	Fallceon spp.			
Heptageniidae fam.	Heptageniidae fam.			
Hetaerina americana	American Rubyspot			

Hydropsyche spp.	Hydropsyche spp.			
Laccobius spp.	Laccobius spp.			
Laccophilus spp.	Laccophilus spp.			
Leptoceridae fam.	Leptoceridae fam.			
Libellula luctuosa	Widow Skimmer			
Limnophyes spp.	Limnophyes spp.			
Mideopsis spp.	Mideopsis spp.			
Nanocladius spp.	Nanocladius spp.			
Nectopsyche spp.	Nectopsyche spp.			
Parakiefferiella spp.	Parakiefferiella spp.			
Paratendipes spp.	Paratendipes spp.			
Phaenopsectra spp.	Phaenopsectra spp.			
Polypedilum spp.	Polypedilum spp.			
Procladius spp.	Procladius spp.			
Pseudochironomus spp.	Pseudochironomus spp.			
Pseudosmittia spp.	Pseudosmittia spp.			
Rheotanytarsus spp.	Rheotanytarsus spp.			
Robackia spp.	Robackia spp.			
Serratella micheneri	A Mayfly			
Sigara spp.	Sigara spp.			
Simulium spp.	Simulium spp.			
Stenochironomus spp.	Stenochironomus spp.			
Tanytarsus spp.	Tanytarsus spp.			
Tipulidae fam.	Tipulidae fam.			
Tramea lacerata	Black Saddlebags			
Tricoryhyphes spp.	Tricoryhyphes spp.			
Tropisternus spp.	Tropisternus spp.			
MAMMALS				
Castor canadensis	American Beaver			Not on any status lists
Lontra canadensis canadensis	North American River Otter			Not on any status lists
Neovison vison	American Mink			Not on any status lists
Ondatra zibethicus	Common Muskrat			Not on any status lists
MOLLUSKS				
Anodonta californiensis	California Floater		Special	
Lymnaea spp.	Lymnaea spp.			
Margaritifera falcata	Western Pearlshell		Special	
Menetus spp.	Menetus spp.			
Physa spp.	Physa spp.			
Sphaeriidae fam.	Sphaeriidae fam.			
PLANTS				
Alnus rhombifolia	White Alder			
Alopecurus carolinianus	Tufted Foxtail			
Alopecurus saccatus	Pacific Foxtail			
Anemopsis californica	Yerba Mansa			
Arundo donax	NA			
Azolla filiculoides	NA			
Bergia texana	Texas Bergia			
Brodiaea nana				Not on any status lists
Callitriche fassettii	NA			Not on any status lists
Callitriche heterophylla bolanderi	Large Water-starwort			
Callitriche longipedunculata	Longstock Water-starwort			
Callitriche marginata	Winged Water-starwort			
Callitriche trochlearis	Waste-water Water-starwort			

Carex alma	Sturdy Sedge			
Carex amplifolia	Bigleaf Sedge			
Carex densa	Dense Sedge			
Carex diandra	Lesser Panicled Sedge			
Carex feta	Green-sheath Sedge			
Carex hirtissima	Fuzzy Sedge			
Carex integra	Smooth-beak Sedge			
Carex lemmonii	Lemmon's Sedge	Endangered		
Carex senta	Western Rough Sedge			
Carex simulata	Copycat Sedge			
Carex utriculata	Beaked Sedge			
Castilleja campestris succulenta	Fleshy Owl's-clover	Threatened	Endangered	CRPR - 1B.2
Castilleja miniata miniata	Greater Red Indian-paintbrush			
Cephalanthus occidentalis	Common Buttonbush			
Chloropyron palmatum	NA	Endangered	Special	CRPR - 1B.1
Cicendia quadrangularis	Oregon Microcala			
Crassula aquatica	Water Pygmyweed			
Crypsis vaginiflora	NA			
Cyperus acuminatus	Short-point Flatsedge			
Cyperus erythrorhizos	Red-root Flatsedge			
Darmera peltata	Umbrella Plant			
Downingia bella	Hoover's Downingia			
Downingia cuspidata	Toothed Calicoflower			
Downingia ornatissima	NA			
Downingia pusilla	Dwarf Downingia		Special	CRPR - 2B.2
Echinodorus berteroi	Upright Burhead			
Elatine brachysperma	Shortseed Waterwort			
Elatine californica	California Waterwort			
Eleocharis acicularis acicularis	Least Spikerush			
Eleocharis atropurpurea	Purple Spikerush			
Eleocharis macrostachya	Creeping Spikerush			
Elodea canadensis	Broad Waterweed			
Epilobium campestre	NA			Not on any status lists
Epilobium cleistogamum	Cleistogamous Spike-primrose			
Eriophorum crinigerum	Fringed Cotton-grass			
Eryngium spinosepalum	Spiny Sepaled Coyote-thistle		Special	CRPR - 1B.2
Eryngium vaseyi vaseyi	Vasey's Coyote-thistle			Not on any status lists
Euthamia occidentalis	Western Fragrant Goldenrod			
Gratiola ebracteata	Bractless Hedge-hyssop			
Gratiola heterosepala	Boggs Lake Hedge-hyssop		Endangered	CRPR - 1B.2
Helenium bigelovii	Bigelow's Sneezeweed			
Hydrocotyle verticillata verticillata	Whorled Marsh-pennywort			
Hypericum anagalloides	Tinker's-penny			
Isoetes howellii	NA			
Isoetes nuttallii	NA			
Isoetes orcuttii	NA			
Juncus acuminatus	Sharp-fruit Rush			
Juncus dubius	Mariposa Rush			
Juncus effusus pacificus				
Juncus exiguus				Not on any status lists
Juncus uncialis	Inch-high Rush			

Juncus usitatus	NA			Not on any status lists
Juncus xiphioides	Iris-leaf Rush			
Lasthenia fremontii	Fremont's Goldfields			
Leersia oryzoides	Rice Cutgrass			
Lemna aequinoctialis	Lesser Duckweed			
Lemna minuta	Least Duckweed			
Leucothoe davisiae	Western Doghobble			
Limnanthes douglasii douglasii	Douglas' Meadowfoam			
Limnanthes douglasii nivea	Douglas' Meadowfoam			
Limnanthes douglasii rosea	Douglas' Meadowfoam			
Limnanthes montana	Mountain Meadowfoam			
Limosella acaulis	Southern Mudwort			
Lipocarpha micrantha	Dwarf Bulrush			
Ludwigia palustris	Marsh Seedbox			
Ludwigia peploides peploides	NA			Not on any status lists
Lythrum californicum	California Loosestrife			
Marsilea vestita vestita	NA			Not on any status lists
Mimulus guttatus	Common Large Monkeyflower			
Mimulus latidens	Broad-tooth Monkeyflower			
Mimulus tricolor	Tricolor Monkeyflower			
Myosurus minimus	NA			
Najas guadalupensis guadalupensis	Southern Naiad			
Navarretia intertexta	Needleleaf Navarretia			
Navarretia leucocephala bakeri	Baker's Navarretia		Special	CRPR - 1B.1
Navarretia leucocephala leucocephala	White-flower Navarretia			
Navarretia leucocephala minima	Least Navarretia			
Neostapfia colusana	Colusa Grass	Threatened	Endangered	CRPR - 1B.1
Oenanthe sarmentosa	Water-parsley			
Orcuttia inaequalis	San Joaquin Valley Orcutt Grass	Threatened	Endangered	CRPR - 1B.1
Orcuttia pilosa	Hairy Orcutt Grass	Endangered	Endangered	CRPR - 1B.1
Panicum acuminatum acuminatum				Not on any status lists
Panicum dichotomiflorum	NA			
Paspalum distichum	Joint Paspalum			
Perideridia bacigalupii	Bacigalupi's Perideridia		Special	CRPR - 4.2
Perideridia howellii	Howell's False Caraway			
Perideridia lemmonii	Lemmon's Yampah			
Perideridia parishii latifolia	Parish's Yampah			
Persicaria hydropiper	NA			Not on any status lists
Persicaria hydropiperoides				Not on any status lists
Persicaria lapathifolia				Not on any status lists
Persicaria maculosa	NA			Not on any status lists
Phacelia distans	NA			
Phalacroseris bolanderi	NA			
Phalaris arundinacea	Reed Canarygrass			
Phyla nodiflora	Common Frog-fruit			
Pilularia americana	NA			

Plagiobothrys acanthocarpus	Adobe Popcorn-flower			
Plagiobothrys austiniae	Austin's Popcorn-flower			
Plagiobothrys distantiflorus	California Popcorn-flower			
Plagiobothrys greenei	Greene's Popcorn-flower			
Plagiobothrys humistratus	Dwarf Popcorn-flower			
Plagiobothrys leptocladus	Alkali Popcorn-flower			
Plagiobothrys undulatus	NA			Not on any status lists
Plantago elongata elongata	Slender Plantain			
Platanus racemosa	California Sycamore			
Pogogyne douglasii	NA			
Potamogeton diversifolius	Water-thread Pondweed			
Potamogeton foliosus foliosus	Leafy Pondweed			
Potamogeton nodosus	Longleaf Pondweed			
Potamogeton pusillus pusillus	Slender Pondweed			
Psilocarphus brevissimus brevissimus	Dwarf Woolly-heads			
Psilocarphus oregonus	Oregon Woolly-heads			
Psilocarphus tenellus	NA			
Puccinellia simplex	Little Alkali Grass			
Ranunculus bonariensis	NA			
Rhododendron occidentale occidentale	Western Azalea			
Rorippa palustris palustris	Bog Yellowcress			
Rotala ramosior	Toothcup			
Sagittaria latifolia latifolia	Broadleaf Arrowhead			
Sagittaria longiloba	Longbarb Arrowhead			
Sagittaria sanfordii	Sanford's Arrowhead		Special	CRPR - 1B.2
Salix exigua exigua	Narrowleaf Willow			
Salix exigua hindsiana				Not on any status lists
Salix gooddingii	Goodding's Willow			
Salix laevigata	Polished Willow			
Salix lasiolepis lasiolepis	Arroyo Willow			
Salix melanopsis	Dusky Willow			
Schoenoplectus acutus occidentalis	Hardstem Bulrush			
Scirpus congdonii	Congdon's Bulrush			
Scirpus microcarpus	Small-fruit Bulrush			
Senecio triangularis	Arrow-leaf Groundsel			
Sidalcea calycosa calycosa	Annual Checker-mallow			
Sidalcea hirsuta	Hairy Checker-mallow			
Sidalcea reptans	Creeping Checker-mallow			
Solidago elongata				Not on any status lists
Stachys ajugoides	Bugle Hedge-nettle			
Stachys albens	White-stem Hedge-nettle			
Stachys stricta	Sonoma Hedge-nettle			
Tuctoria greenei	Green's Awnless Orcutt Grass	Endangered	Rare	CRPR - 1B.1
Typha domingensis	Southern Cattail			
Typha latifolia	Broadleaf Cattail			
Veronica americana	American Speedwell			
Veronica anagallis-aquatica	NA			
Viola macloskeyi	NA			
Wolffia columbiana	Columbian Watermeal			
Wolffia globosa	Asian Watermeal			

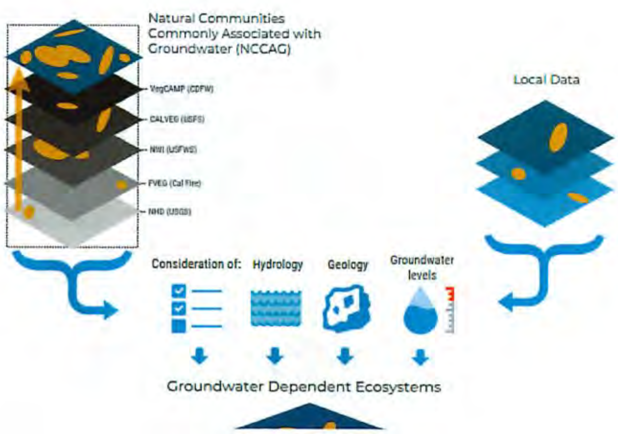
Attachment D

The Nature Conservancy
Protecting nature. Preserving life.

IDENTIFYING GDEs UNDER SGMA
Best Practices for using the NC Dataset

The Sustainable Groundwater Management Act (SGMA) requires that groundwater dependent ecosystems (GDEs) be identified in Groundwater Sustainability Plans (GSPs). As a starting point, the Department of Water Resources (DWR) is providing the Natural Communities Commonly Associated with Groundwater Dataset (NC Dataset) online[6] to help Groundwater Sustainability Agencies (GSAs), consultants, and stakeholders identify GDEs within individual groundwater basins. To apply information from the NC Dataset to local areas, GSAs should combine it with the best available science on local hydrology, geology, and groundwater levels to verify whether polygons in the NC dataset are likely supported by groundwater in an aquifer (Figure 1)[7]. This document highlights six best practices for using local groundwater data to confirm whether a potential GDE identified in the NC dataset is supported to groundwater.

The NC Dataset identifies vegetation and wetland features that are good indicators of a GDE. The dataset is comprised of 48 publicly available state and federal datasets that map vegetation, wetlands, springs, and seeps commonly associated with groundwater in California[8]. It was developed through a collaboration between DWR, the Department of Fish and Wildlife, and The Nature Conservancy (TNC). TNC has also provided detailed guidance on identifying GDEs from the NC dataset[9] on the Groundwater Resource Hub, a website dedicated to GDEs[10].



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[6] *NC Dataset Online Viewer is available at: https://gis.water.ca.gov/app/NCDatasetViewer/*

[7] California Department of Water Resources (DWR). 2018. Summary of the "Natural Communities Commonly Associated with Groundwater" Dataset and Online Web Viewer. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Data-and-Tools/Files/Statewide-Reports/Natural-Communities-Dataset-Summary-Document.pdf

[8] *For more details on the mapping methods, refer to: Klausmeyer, K., J. Howard, T. Keeler-Wolf, K. Davis-Fadtke, R. Hull, A. Lyons. 2018. Mapping Indicators of Groundwater Dependent Ecosystems in California: Methods Report. San Francisco, California. Available at: https://groundwaterresourcehub.org/public/uploads/pdfs/iGDE_data_paper_20180423.pdf*

[9] "Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act: Guidance for Preparing Groundwater Sustainability Plans" is available at https://groundwaterresourcehub.org/gde-tools/gsp-guidance-document/

[10] *The Groundwater Resource Hub is available at: www.GroundwaterResourceHub.org*

BEST PRACTICE #1. Establishing a Connection to Groundwater

Groundwater basins can be comprised of one continuous aquifer (Figure 2A) or multiple aquifers stacked on top of each other (Figure 2B). In unconfined aquifers (Figure 2A), using the depth to groundwater and the rooting depth of the vegetation is a reasonable method to determine groundwater dependence for GDEs. If groundwater is well below the rooting (and capillary) zone of the plants and any wetland features, the ecosystem is considered disconnected and groundwater management is not likely to affect the ecosystem (Figure 2D). However, it is important to consider local conditions (soil type, groundwater flow gradients, and aquifer parameters) and to review groundwater depth data from multiple seasons and water year types (wet and dry) because intermittent periods of high groundwater levels can replenish perched clay lenses that serve as the water source for GDEs (Figure 2C). Maintaining these natural groundwater fluctuations are important to sustaining GDE health.

Basins with a stacked series of aquifers (Figure 2B) may have varying levels of pumping across aquifers in the basin, depending on the production capacity or water quality associated with each aquifer. If pumping is concentrated in deeper aquifers, SGMA still requires GSAs to sustainably manage groundwater resources in shallow aquifers, such as perched aquifers, that support springs, surface water, domestic wells, and groundwater dependent ecosystems (Figure 2). This is because vertical groundwater gradients across aquifers may result in pumping from deeper aquifers to cause adverse impacts onto beneficial users reliant on shallow aquifers or interconnected surface water. The goal of SGMA is to sustainably manage groundwater resources for current and future social, economic, and environmental benefits. While groundwater pumping may not be currently occurring in a shallower aquifer, use of this water may become more appealing and economically viable in future years as pumping restrictions are placed on the deeper production aquifers in the basin to meet the sustainable yield and criteria. Thus, identifying GDEs in the basin should done irrespective to the amount of current pumping occurring in a particular aquifer, so that future impacts on GDEs due to new production can be avoided. A good rule of thumb to follow is: *if groundwater can be pumped from a well - it's an aquifer.*

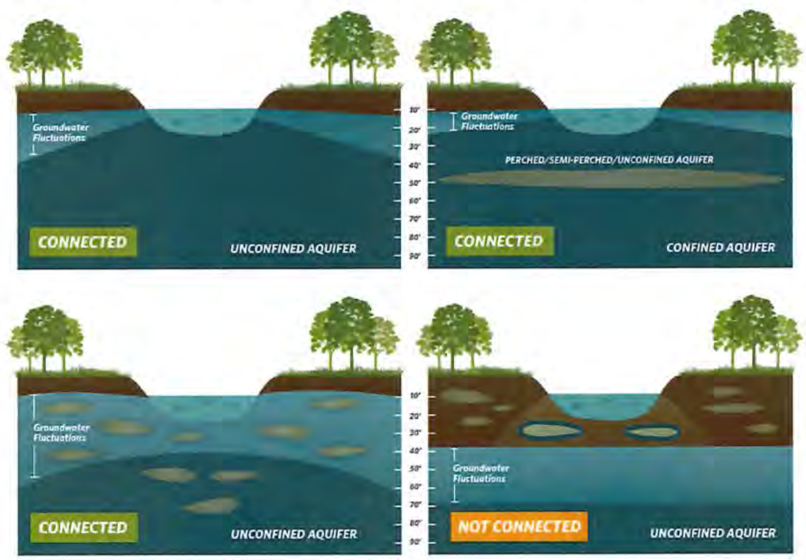

Figure 2. Confirming whether an ecosystem is connected to groundwater in a principal aquifer. Top: (Left) Depth to Groundwater in the aquifer under the ecosystem is an unconfined aquifer with depth to groundwater fluctuating seasonally and interannually within 30 feet from land surface. **(Right)** Depth to Groundwater in the shallow aquifer is connected to overlying ecosystem. Pumping predominately occurs in the confined aquifer, but pumping is possible in the shallow aquifer. **Bottom: (Left)** Depth to groundwater fluctuations are seasonally and interannually large, however, clay layers in the near surface prolong the ecosystem's connection to groundwater. **(Right)** Groundwater is disconnected from surface water, and any water in the vadose (unsaturated) zone is due to direct recharge from precipitation and indirect recharge under surface water feature. These areas typically support species that do not require access to groundwater to survive.

BEST PRACTICE #2. Characterize Seasonal and Interannual Groundwater Conditions

SGMA requires GSAs to describe current and historical groundwater conditions when identifying GDEs [23 CCR §354.16(g)]. Relying solely on the SGMA benchmark date (January 1, 2015) or any other single point in time to characterize groundwater conditions (e.g., depth-to-groundwater) is inadequate because managing groundwater conditions with data from one time point fails to capture the seasonal and interannual variability typical of California's climate. DWR's Best Management Practices document on water budgets[11] recommends using 10 years of water supply and water budget information to describe how historical conditions have impacted the operation of the basin within sustainable yield, implying that a baseline[12] could be determined based on data between 2005 and 2015. Using this or a similar time period, depending on data availability, is recommended for determining the depth-to-groundwater.

GDEs depend on groundwater levels being close enough to the land surface to interconnect with surface water systems or plant rooting networks. The most practical approach[13] for a GSA to assess whether polygons in the NC dataset are connected to groundwater is to rely on groundwater elevation data. As detailed in TNC's GDE guidance document[4], one of the key factors to consider when mapping GDEs is to contour depth-to-groundwater in the aquifer that is supporting the ecosystem (See Best Practice #5).

Groundwater levels fluctuate over time and space due to California's Mediterranean climate (dry summers and wet winters), climate change (flood and drought years), and subsurface heterogeneity in the subsurface (Figure 3). Many of California's GDEs have adapted to dealing with intermittent periods of water stress, however, if these groundwater conditions are prolonged adverse impacts to GDEs can result. While depth-to-groundwater levels within 30 feet[4] are generally accepted as being a proxy for confirming that polygons in the NC dataset are supported by groundwater, it is highly advised that fluctuations in the groundwater regime be characterized to understand the seasonal and interannual groundwater variability in GDEs. Utilizing groundwater data from one point in time can misrepresent groundwater levels required by GDEs, and inadvertently result in adverse impacts to the GDEs. Time series data on groundwater elevations and depths are available on the SGMA Data Viewer[14]. However, if insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons in the GSP until data gaps are reconciled in the monitoring network (See Best Practice #6).

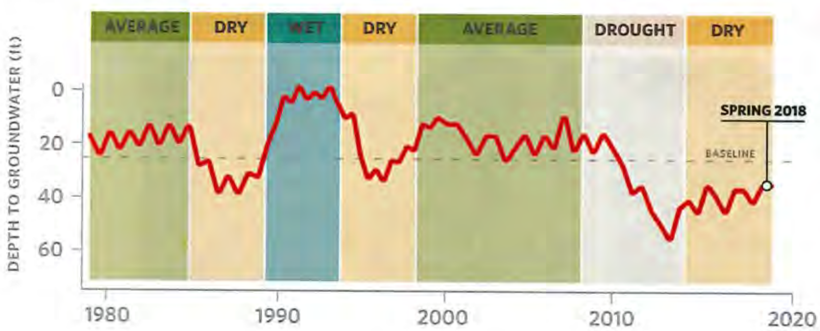

Figure 3. Example seasonality and interannual variability in depth to groundwater over time. Selecting one point in time, such as Spring 2018, to characterize groundwater conditions in GDEs fails to capture what groundwater conditions are necessary to maintain the ecosystem status into the future so adverse impacts are avoided.

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[11] DWR. 2016. Water Budget Best Management Practice. Available at: https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_Water_Budget_Final_2016-12-23.pdf

[12] *Baseline is defined under the GSP regulations as "historic information used to project future conditions for hydrology, water demand, and availability of surface water and to evaluate potential sustainable management practices of a basin." [23 CCR §351(e)]*

[13] Groundwater reliance can also be confirmed via stable isotope analysis and geophysical surveys. For more information see The GDE Assessment Toolbox (Appendix IV, GDE Guidance Document for GSPs - link in footnote above).

[14] *SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer*

BEST PRACTICE #3. Ecosystems Often Rely on Both Groundwater and Surface Water

GDEs are plants and animals that rely on groundwater for all or some of its water needs, and thus can be supported by multiple water sources. The presence of non-groundwater sources (e.g., surface water, soil moisture in the vadose zone, applied water, treated wastewater effluent, urban stormwater, irrigated return flow) within and around NC polygons does not preclude the possibility that a connection to groundwater exists. SGMA defines GDEs as "ecological communities and species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" [23 CCR §351(m)]. Hence, depth-to-groundwater data should be used to identify whether NC polygons are supported by groundwater and should be considered GDEs. In addition, SGMA requires that significant and undesirable adverse impacts to beneficial users of surface water be avoided. Beneficial users of surface water include environmental users such as plants or animals[15], which therefore must be considered when developing minimum thresholds for depletions of interconnected surface water.

GSAs are only responsible for impacts to GDEs resulting from groundwater conditions in the basin, so if adverse impacts to GDEs result from the diversion of applied water, treated wastewater, or irrigation return flow away from the GDE, then those impacts will be evaluated by other permitting requirements (e.g., CEQA) and may not be the responsibility of the GSA. However, if adverse impacts occur to the GDE due to changing groundwater conditions resulting from pumping or groundwater management activities, then the GSA would be responsible (Figure 4).

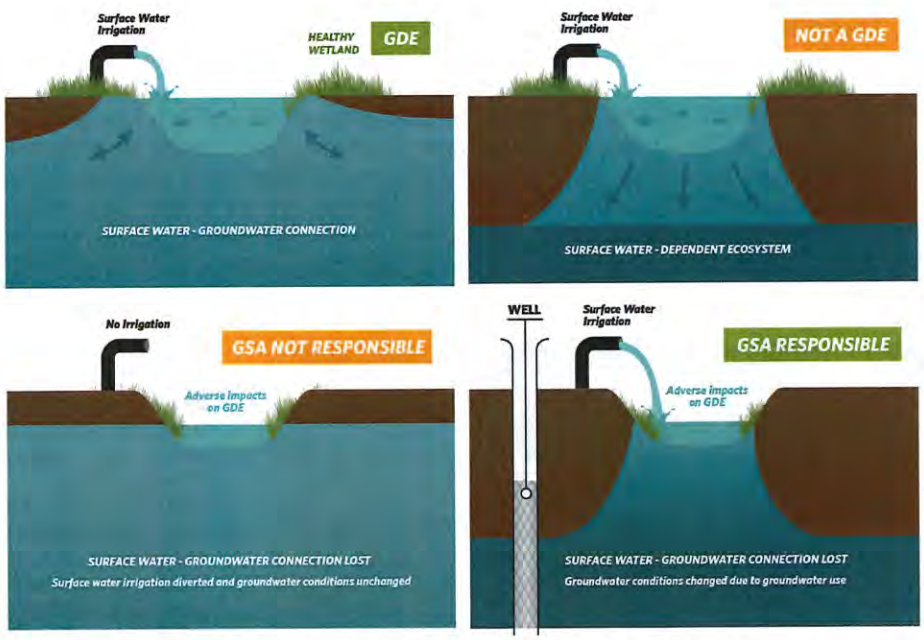


Figure 4. Ecosystems often depend on multiple sources of water. Top: (Left) Surface water and groundwater are interconnected, meaning that the GDE is supported by both groundwater and surface water. **(Right)** Ecosystems that are only reliant on non-groundwater sources are not groundwater-dependent. **Bottom: (Left)** An ecosystem that was once dependent on an interconnected surface water, but loses access to groundwater solely due to surface water diversions may not be the GSA's responsibility. **(Right)** Groundwater dependent ecosystems once dependent on an interconnected surface water system, but loses that access due to groundwater pumping is the GSA's responsibility.

[15] *For a list of environmental beneficial users of surface water by basin, visit:* https://groundwaterresourcehub.org/gde-tools/environmental-surface-water-beneficiaries/

BEST PRACTICE #4. Select Representative Groundwater Wells

Identifying GDEs in a basin requires that groundwater conditions are characterized to confirm whether polygons in the NC dataset are supported by the underlying aquifer. To do this, proximate groundwater wells should be identified to characterize groundwater conditions (Figure 5). When selecting representative wells, it is particularly important to consider the subsurface heterogeneity around NC polygons, especially near surface water features where groundwater and surface water interactions occur around heterogeneous stratigraphic units or aquitards formed by fluvial deposits. The following selection criteria can help ensure groundwater levels are representative of conditions within the GDE area:

- Choose wells that are within 5 kilometers (3.1 miles) of each NC Dataset polygons because they are more likely to reflect the local conditions relevant to the ecosystem. If there are no wells within 5km of the center of a NC dataset polygon, then there is insufficient information to remove the polygon based on groundwater depth. Instead, it should be retained as a potential GDE until there are sufficient data to determine whether or not the NC Dataset polygon is supported by groundwater.

- Choose wells that are screened within the surficial unconfined aquifer and capable of measuring the true water table.

- Avoid relying on wells that have insufficient information on the screened well depth interval for excluding GDEs because they could be providing data on the wrong aquifer. This type of well data should not be used to remove any NC polygons.

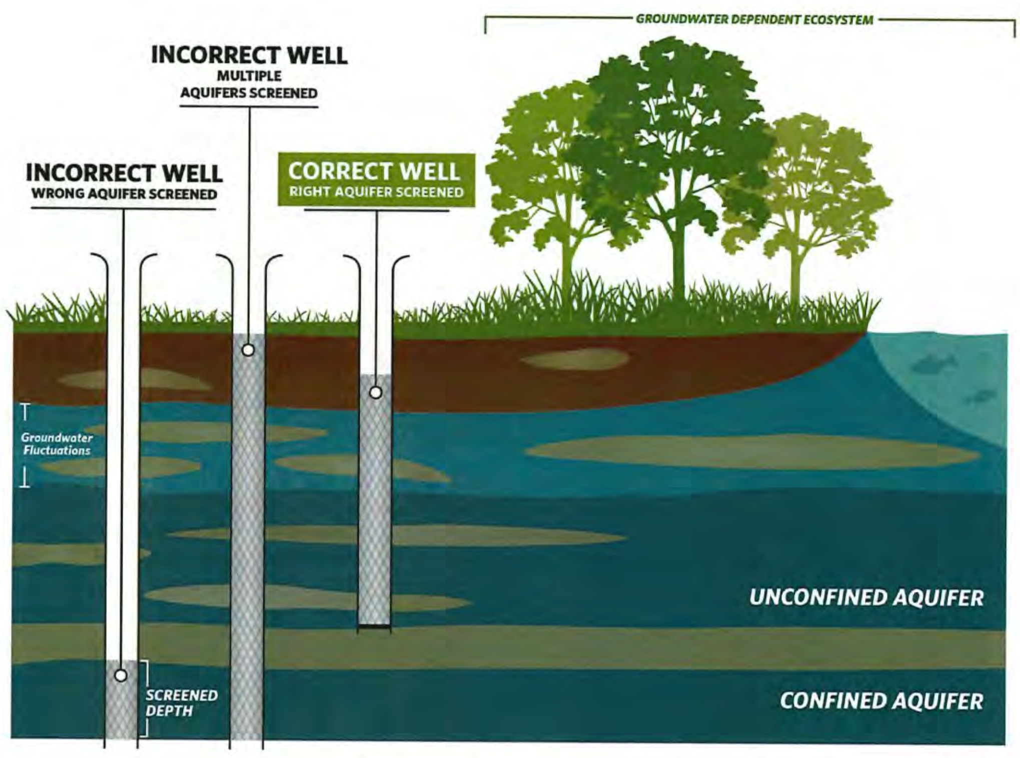


Figure 5. Selecting representative wells to characterize groundwater conditions near GDEs.

BEST PRACTICE #5. Contouring Groundwater Elevations

The common practice to contour depth-to-groundwater over a large area by interpolating measurements at monitoring wells is unsuitable for assessing whether an ecosystem is supported by groundwater. This practice causes errors when the land surface contains features like streams and wetlands depressions because it assumes the land surface is constant across the landscape and depth-to-groundwater is constant below these low-lying areas (Figure 6 - left panel). A more accurate approach is to interpolate **groundwater elevations** at monitoring wells to get an estimate of groundwater elevation across the landscape. This layer can then be subtracted from the land surface elevation from a Digital Elevation Model (DEM)[16] to estimate depth to groundwater contours across the landscape (Figure 6 – right panel; Figure 7). This will provide a much more accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found.

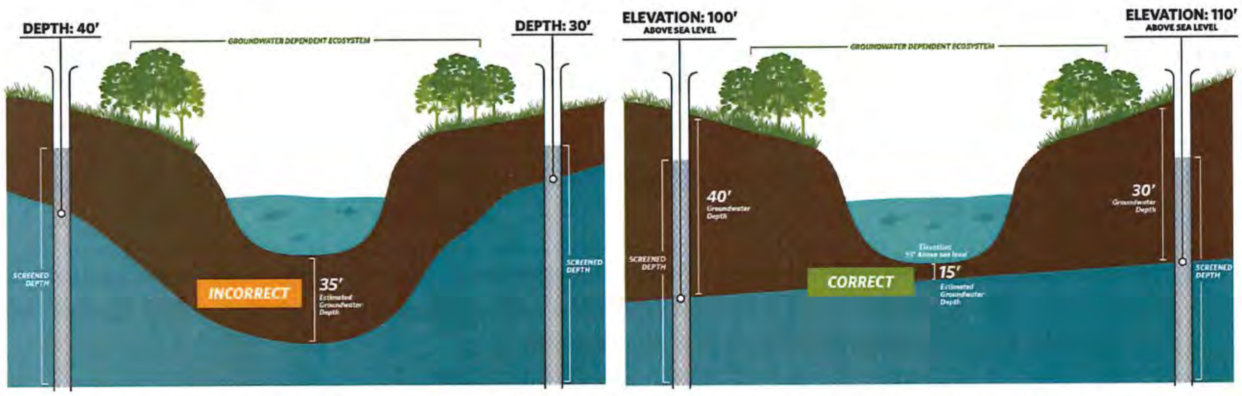


Figure 6. Contouring depth-to-groundwater around surface water features and GDEs. (Left) Groundwater level interpolation using depth-to-groundwater data from monitoring wells. **(Right)** Groundwater level interpolation using groundwater elevation data from monitoring wells and DEM data.

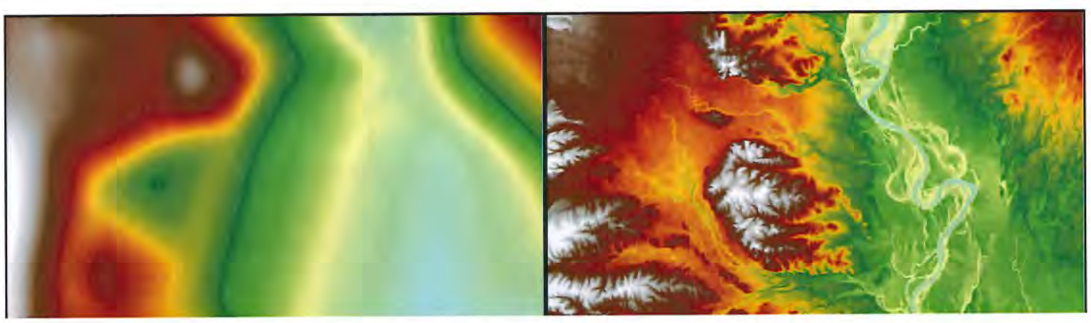


Figure 7. Depth to Groundwater Contours in Northern California. (Left) Contours were interpolated using depth to groundwater measurements determined at each well. **(Right)** Contours were determined by interpolating groundwater elevation measurements at each well and superimposing ground surface elevation from DEM spatial data to generate depth to groundwater contours. The image on the right shows a more accurate depth to groundwater estimate because it takes the local topography and elevation changes into account.

[16] USGS Digital Elevation Model data products are described at: https://www.usgs.gov/core-science-systems/ngp/3dep/about-3dep-products-services and can be downloaded at: https://viewer.nationalmap.gov/basic/

BEST PRACTICE #6. Best Available Science

Adaptive management is embedded within SGMA and provides a process to work toward sustainability over time by beginning with the best available information to make initial decisions, monitoring the results of those decisions, and using the data collected through monitoring to revise decisions in the future. In many situations, the hydrologic connection of NC dataset polygons will not initially be clearly understood if site-specific groundwater monitoring data are not available. If sufficient data are not available in time for the 2020/2022 plan, **The Nature Conservancy strongly advises that questionable polygons from the NC dataset be included in the GSP until data gaps are reconciled in the monitoring network.** Erring on the side of caution will help minimize inadvertent impacts to GDEs as a result of groundwater use and management actions during SGMA implementation.

KEY DEFINITIONS

Groundwater basin is an aquifer or stacked series of aquifers with reasonably well-defined boundaries in a lateral direction, based on features that significantly impede groundwater flow, and a definable bottom. *23 CCR §341(g)(1)*

Groundwater dependent ecosystem (GDE) are ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface. *23 CCR §351(m)*

Interconnected surface water (ISW) surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. *23 CCR §351(o)*

Principal aquifers are aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems. *23 CCR §351(aa)*

ABOUT US

The Nature Conservancy is a science-based nonprofit organization whose mission is *to conserve the lands and waters on which all life depends*. To support successful SGMA implementation that meets the future needs of people, the economy, and the environment, TNC has developed tools and resources (www.groundwaterresourcehub.org) intended to reduce costs, shorten timelines, and increase benefits for both people and nature.

Attachment E

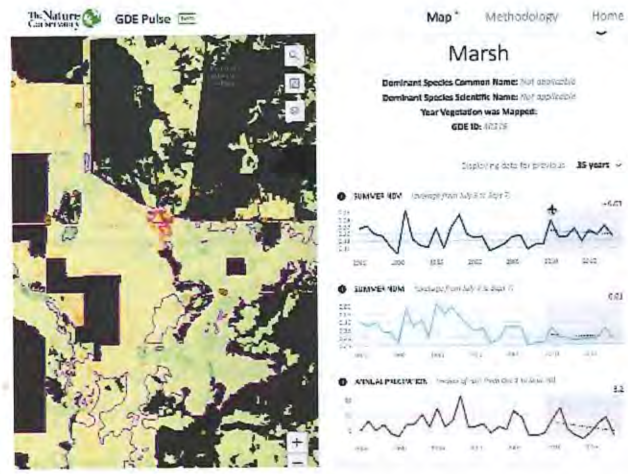
GDE Pulse

A new, free online tool that allows Groundwater Sustainability Agencies to assess changes in groundwater dependent ecosystem (GDE) health using satellite, rainfall, and groundwater data.

The Nature Conservancy

Protecting nature. Preserving life.

Visit
https://gde.codefornature.org/



Remote sensing data from satellites has been used to monitor the health of vegetation all over the planet. GDE pulse has compiled 35 years of satellite imagery from NASA's Landsat mission for every polygon in the Natural Communities Commonly Associated with Groundwater Dataset[17]. The following datasets are included:

Normalized Difference Vegetation Index (NDVI) is a satellite-derived index that represents the greenness of vegetation. Healthy green vegetation tends to have a higher NDVI, while dead leaves have a lower NDVI. We calculated the average NDVI during the driest part of the year (July - Sept) to estimate vegetation health when the plants are most likely dependent on groundwater.

Normalized Difference Moisture Index (NDMI) is a satellite-derived index that represents water content in vegetation. NDMI is derived from the Near-Infrared (NIR) and Short-Wave Infrared (SWIR) channels. Vegetation with adequate access to water tends to have higher NDMI, while vegetation that is water stressed tends to have lower NDMI. We calculated the average NDVI during the driest part of the year (July–September) to estimate vegetation health when the plants are most likely dependent on groundwater.

Annual Precipitation is the total precipitation for the water year (October 1st – September 30th) from the PRISM dataset[18]. The amount of local precipitation can affect vegetation with more precipitation generally leading to higher NDVI and NDMI.

Depth to Groundwater measurements provide an indication of the groundwater levels and changes over time for the surrounding area. We used groundwater well measurements from nearby (<1km) wells to estimate the depth to groundwater below the GDE based on the average elevation of the GDE (using a digital elevation model) minus the measured groundwater surface elevation.

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[17] *The Natural Communities Commonly Associated with Groundwater Dataset is hosted on the California Department of Water Resources' website: https://gis.water.ca.gov/app/NCDatasetViewer/#*

[18] The PRISM dataset is hosted on Oregon State University's website: http://www.prism.oregonstate.edu/

Valley Children's HEALTHCARE

9300 Valley Children's Place
Madera, CA 93636

(559) 353-3000
valleychildrens.org

November 8, 2019

VIA EMAIL ONLY

Stephanie Anagnoson
Madera County
200 W. Fourth Street
Madera, CA 93637
Email: MaderaGSPComments@maderacounty.com
Stephanie.Anagnoson@maderacounty.com

Re: Public Review Draft Joint Groundwater Sustainability Plan – Madera Subbasin

Dear Ms. Anagnoson:

Valley Children's Hospital appreciates the opportunity to provide comments on the Public Review Draft Joint Groundwater Sustainability Plan ("Draft GSP") prepared for the Madera Subbasin on behalf of the Madera Subbasin Coordination Committee, which includes the Madera County Groundwater Sustainability Agency ("GSA"). The Draft GSP represents a critical first step toward Madera County's sustainable management of the Madera Subbasin to protect beneficial users of groundwater.

For nearly seventy years, Valley Children's Hospital (or "Hospital") has provided pediatric specialty and primary care to children of the Central Valley. The Valley Children's Hospital campus includes the main hospital and related medical uses, such as laboratories, outpatient health services, and extended stay accommodations like Ronald McDonald House. In addition to its critical medical services and community benefits, the Valley Children's Hospital also is Madera County's largest private sector employer.

Three wells located in the vicinity of the Hospital campus will meet its water demand. These wells are the only source of water for the Valley Children's Hospital's water system. In light of Valley Children's Hospital's reliance on groundwater to support its operations, we respectfully submit the following comments on the Draft GSP.

A. Adequacy of GSP to Protect Valley Children's Hospital's Beneficial Uses

The Sustainable Groundwater Management Act ("SGMA") requires GSAs to consider all beneficial uses and users of groundwater, including public water systems, municipal well operators and domestic users. (Water Code, § 10723.2.) Under SGMA, a GSA is tasked with managing groundwater in a manner that does not cause "significant and unreasonable impacts" to beneficial users. (See Water Code, §§ 10723.2, 10721(w); see also Cal. Code Regs., tit. 23, § 354.26.) To achieve sustainable groundwater management, the Department of Water Resources ("DWR") developed regulations that require a GSP to establish sustainable management criteria that set undesirable results, minimum thresholds and measurable objectives. (Cal. Code Regs., tit. 23, §§ 354.22 *et seq.*) These sustainable management criteria must be set to protect all beneficial users, including Valley Children's Hospital.

The Draft GSP currently sets a uniform approach for establishing sustainable management criteria without regard for the beneficial users. (See Draft GSP, Table ES-3, p. ES-9; Table 3-8, p. 3-35.) Although the Madera County GSA represents a disparate and disconnected territory and acknowledges variable geologic and hydrogeologic conditions, the Draft GSP makes no attempt to set sustainable management criteria that account for these differences. The Draft GSP defines an undesirable result as "30 percent of wells below the minimum threshold for two consecutive fall measurements."[1] (Draft GSP, pp. 3-35–3-36.) It is not clear what impact this could have on beneficial users, like Valley Children's Hospital, and the Draft GSP does not contain this analysis. The Draft GSP must evaluate the impact of undesirable results on drinking water users, including Valley Children's Hospital, and change the undesirable results to prevent drinking water impacts.

Further, the Draft GSP only proposes to monitor sustainable management criteria at "representative monitoring sites." (Draft GSP, Section 3.5.3, p. 3-53–3-54.) DWR regulations allow for representative monitoring sites, however, these sites must reflect the "general conditions in the area."[2] (Cal. Code Regs., tit. 23, § 354.36.) Valley Children's Hospital reviewed the nearest wells to its campus (MCE-RMS-9, MCE-RMS-7 and MCE-RMS-4). These wells are not representative of the Valley Children's Hospital's wells. We are concerned that the County's monitoring of these representative wells will not adequately reflect the conditions in the Hospital's wells.

To address our concerns, we request that Madera County set sustainable management criteria sufficient to protect Valley Children's Hospital's water supply. One approach could be to develop specific management areas within the Madera Subbasin to protect specific beneficial uses of water and facilitate implementation of the GSP. (See Cal. Code Regs., tit. 23, § 354.20.) Alternatively,

[1] The GSP defines minimum thresholds as either the lowest of (a) projected lowest future groundwater level at the end of estimated 10-year drought or (b) the lowest modeled groundwater level from projected with projects model simulation (2019-2090)." (Draft GSP, pp. 3-35–3-36.) This defines a minimum threshold that is highly dependent on model assumptions and allows for water levels to continue to decline below historical conditions.

[2] DWR regulations also state that monitoring networks must include a sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table for each aquifer. (Cal. Code Regs., tit. 23, § 354.37(c)(1)(A).)

Madera County should consider including Valley Children's Hospital's wells, or nearby wells, in its representative monitoring network. We would be happy to work with the County to ensure the final GSP sets sufficient sustainable management criteria and establishes appropriate monitoring sites to maintain groundwater levels in Valley Children's Hospital's wells.

B. Vague Demand Reduction Project and Management Action

Madera County's proposed "Demand Management" or "Demand Reduction" management action is the crucial Project and Management Action for the basin to achieve sustainable groundwater management. (Draft GSP, Section 4.4.4, pp. 4-40–4-45.) The Demand Management program plans to reduce groundwater consumption by 90,000 acre feet accounting for approximately 42 percent of the total reduced groundwater use from all the proposed Projects and Management Actions. (Draft GSP, Table ES-4, p. ES-14.) As a result, the scope and details of the County's Demand Management program are critical for implementation of the GSP.

As written, the Draft GSP is unclear about whether the Demand Management program applies to only to Madera County GSA territory or to all GSAs within the Madera Subbasin.[3] The Demand Management program proposes to decrease average annual groundwater use by 10 percent by 2025 followed by an additional 6 percent decrease per year between 2026 and 2040. (Draft GSP, Section 4.4.4.2, p. 4-41.) This is an ambitious target. If the Demand Reduction program only applies to Madera County and is implemented immediately, beneficial users in the County will bear the burden of SGMA compliance, while other GSAs in the Subbasin choose to defer implementation.

Further, the Draft GSP does not clarify whether the Demand Management will apply to agricultural users or to all beneficial users. Although Valley Children's Hospital is taking steps to increase groundwater replenishment and reduce its irrigation demand, the proposed Demand Management program could create substantial hardship for the Hospital. Unlike agricultural users, the Hospital has relatively low water usage, cannot fallow land or change crops to reduce demand, and must continue to use its water supply for essential medical services. Any Demand Management program should contemplate how each type of beneficial users can achieve demand reductions and incorporate credits for activities like the Hospital's wastewater treatment and replenishment facilities.

Accordingly, we request that Madera County clarify whether the Demand Management program will apply to non-agricultural users and, if so, consider exempting Valley Children's Hospital from any such program. We hope Madera County will continue to coordinate with Valley Children's Hospital as it develops the Demand Management Program.

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[3] The Draft GSP states that "Madera County's primary approach to demand management is to set demand reduction targets for *the GSA service area as a whole*, based on conditions in the Subbasin." (Draft GSP, Section 4.4.4.1, p. 4-40 [emphasis added].) In Section 4.4.4.3, the Draft GSP indicates that "is currently working with GSA stakeholders and other GSAs in the subbasin to define the demand management program including the potential for a within-GSA groundwater market." (Draft GSP, p. 4-44.) These statements make it unclear whether Demand Management will apply subbasin-wide or only lands within the Madera County GSA.

C. Coordination with other GSAs

Valley Children's Hospital is located on the southwestern edge of Madera County between the Root Creek Water District ("RCWD") and the Madera Subbasin boundary with the North Kings Subbasin. This position makes Valley Children's Hospital vulnerable to the groundwater management decisions in the RCWD and North Kings Draft GSPs.[4] We request that Madera County take an active role in evaluating and commenting on the RCWD and North Kings Draft GSPs to ensure neither of these GSPs will impact the County's ability to achieve sustainable groundwater management and protect the Hospital's water supply under the Draft GSP.

For example, we note that Section 4.2.1.1 of the North Kings Draft GSP also proposes sustainable management criteria at levels below the historical groundwater levels. Setting sustainable management criteria below levels in the Draft GSP could impact Madera County's ability to achieve sustainable management by altering groundwater conditions near the subbasin boundary. In effect, this would shift the burden of complying with SGMA from the North Kings GSA to the Madera County GSA.

Under the California Water Code, a GSP shall not adversely affect the ability of an adjacent basin to implement their GSP or impede sustainable groundwater management. (Water Code, § 10733(c).) Further, the DWR regulations specify that the description of minimum thresholds shall include how the threshold has been selected to "avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals." (Cal. Code of Regs., tit. 23, § 354.28(b)(3).)

To ensure that the North Kings GSP does not affect the Valley Children's Hospital's groundwater resources or impact Madera County's ability to implement its Draft GSP, we request that the County closely scrutinize the North Kings GSP and consider entering into a an interbasin agreement with the North Kings GSA.[5] (Cal. Code of Regs., tit. 23, § 357.2.) Close coordination and collaboration is necessary to establish compatible sustainability goals in both the Madera and Kings subbasins to protect beneficial users in Madera County.

We request that the Madera County take a leading role in coordination within the Madera Subbasin and with neighboring GSAs to implement SGMA in a manner that protects all beneficial users.

* * *

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[4] For example, RCWD proposes measurable objectives at water levels that may impact the groundwater levels in Valley Children's Hospital's wells. (RCWD Draft GSP, pp. 4-6–4-9, available at https://ppeng.sharefile.com/share/view/s0f1b15d40e34a349.)

[5] We note that the Draft GSP indicates interbasin and coordination agreements, as applicable, will be included in Appendix 6. However, it is unclear from the GSP whether the Madera Subbasin Coordination Committee or Madera County is pursing these agreements at this time. Further, the RWCD Draft GSP indicates that the "other Madera Subbasin GSAs asked that there be regional cooperation rather than discussions between GSAs." (RCWD Draft GSP, Section 1.4, p. 1-4.)

We appreciate the opportunity to provide these comments on the Draft GSP. If you have any questions or concerns, regarding these comments please contact me at (559) 353-5008 or wchaltraw@valleychildrens.org.

Sincerely,

Will E Chalt

William Chaltraw, Jr.
Senior Vice-President and Chief Legal Officer
Valley Children's Hospital
(559) 353-5008

Jason Howard presented a verbal review of a letter submitted to the Joint GSP on behalf of Gunner Ranch West. The comment requests that management areas be formed within the Madera County GSA to tailor allocations and other demand reduction efforts based upon the geologic, and therefore groundwater, variability within the GSA. Mr. Howard requested that the GSP state explicitly that non-agricultural users will not be the focus of demand reduction.

Madeline Harris, Leadership Counsel for Justice and Accountability, said that the GSP, as written, prioritizes agriculture as the highest use of water, whereas State law requires the human right to water be protected as the highest use of water. The mitigation program, while an important consideration, is not sufficient. Ms. Harris said that the plan does not adequately lay out how projects and management actions will balance the overdraft and protect domestic well users. Communities that rely on domestic wells will bear the economic burden of continued overdraft by losing their source of drinking water.

Wonderful citrus

November 8, 2019

Stephanie Anagnoson, Director
Water and Natural Resources Department
200 W. Fourth Street
Madera, CA 93637
MaderaGSPComments@maderacounty.com

Comments on Madera Subbasin Joint GSP Draft Groundwater Sustainability Plan

Dear Stephanie Anagnoson,

Thank you for all the hard work you have put into preparing the draft Groundwater Sustainability Plan (GSP), and for the opportunity to provide comments.

In order to best execute the GSP's goal to achieve sustainability by 2040, we encourage all GSAs in the subbasin to initiate stakeholder-driven processes and to work together cooperatively to achieve subbasin-wide coordination as GSPs are finalized and implementation begins. To that end, we submit the following comments.

Groundwater Allocations

Should allocation of the native yield be a necessary management action, the GSAs should use a stakeholder-driven process to develop a methodology of allocation that is consistent with the various legal considerations drawn from applicable case law. More information on allocation methodologies can be found in *Groundwater Pumping Allocations Under California's Sustainable Groundwater Management Act – EDF and NCWL, dated July 2018*. If pumping restrictions are required to achieve sustainability, they should be implemented with the most gradual ramp-down possible while still avoiding any undesirable results. This will help to ensure landowners have adequate time to plan, and it will help to prevent any sudden disruption to economic activity in the region.

Water Measurement, Data Management Systems and Groundwater Markets

GSAs should develop a coordinated, basin-wide data management system (DMS) that is capable

Wonderful citrus

of tracking groundwater and surface water use at the landowner, field or parcel level, and a coordinated methodology for measuring landowner-level use of groundwater. The DMS should also include, or be capable of interfacing with, a groundwater market platform. If landowner-level groundwater allocations are made, those should be accompanied with a market system that is as flexible as possible in allowing for broad geographic movement and carry-over from one year to the next. Markets are essential in facilitating the highest and best use of a limited resource and will be most effective if there is trust in the accuracy of measurements and consistency in data sources, and flexibility available to allow for transactions across the basin. GSAs using remote sensing to calculate crop ET as a measurement of consumptive use of groundwater should develop methodologies and quality assurance elements to allow for grower provided information to be included into the ET calculation and calibration. Additionally, GSAs should establish criteria and procedures to address any apparent inaccuracies in the ET calculations (for example: if calculated ET is greater than applied water).

Water Banking and Recharge

Where possible, GSPs should identify management areas that may benefit from additional recharge and banking and develop incentives for public or private investment to expand recharge and banking capacity as these facilities help to achieve multiple benefits (for example: habitat, water quality, drinking water, etc.). To do this, GSAs must develop clear and understandable policies and conditions that protect existing groundwater banking and banked inventory and allow them to continue operating as they have been under their existing rules and regulations without interference. They must also incentivize additional investment and allow flexibility for recharged or banked water to be freely transferrable subject to the rights and conditions of use associated with the source water and the avoidance of undesirable results.

Thank you for your consideration.

David Krause

President, Wonderful Citrus

1701 South Lexington Street, Delano, California 93215 · 661.720.2400 · Fax 661.720.2402

APPENDIX 2.D. HYDROGEOLOGIC CONCEPTUAL MODEL

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

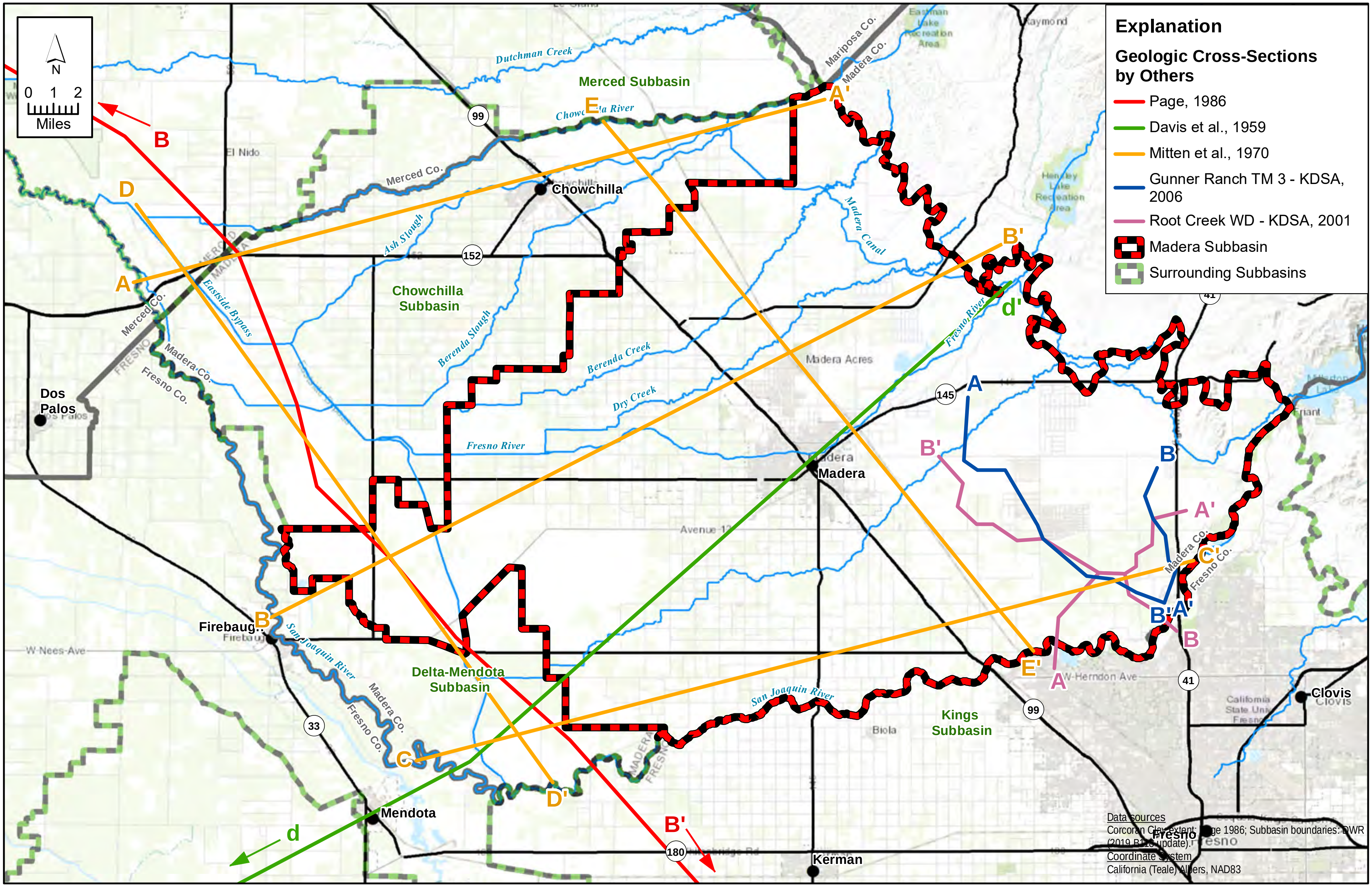
January 2020

GSP Team:

Davids Engineering, Inc
Luhdorff & Scalmanini
ERA Economics
Stillwater Sciences and
California State University, Sacramento

Existing Geologic

Cross-Sections



X:\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\REPORT map files\Chapter 2\Appendix 2.D Madera Subbasin CrossSection Location Map.mxd

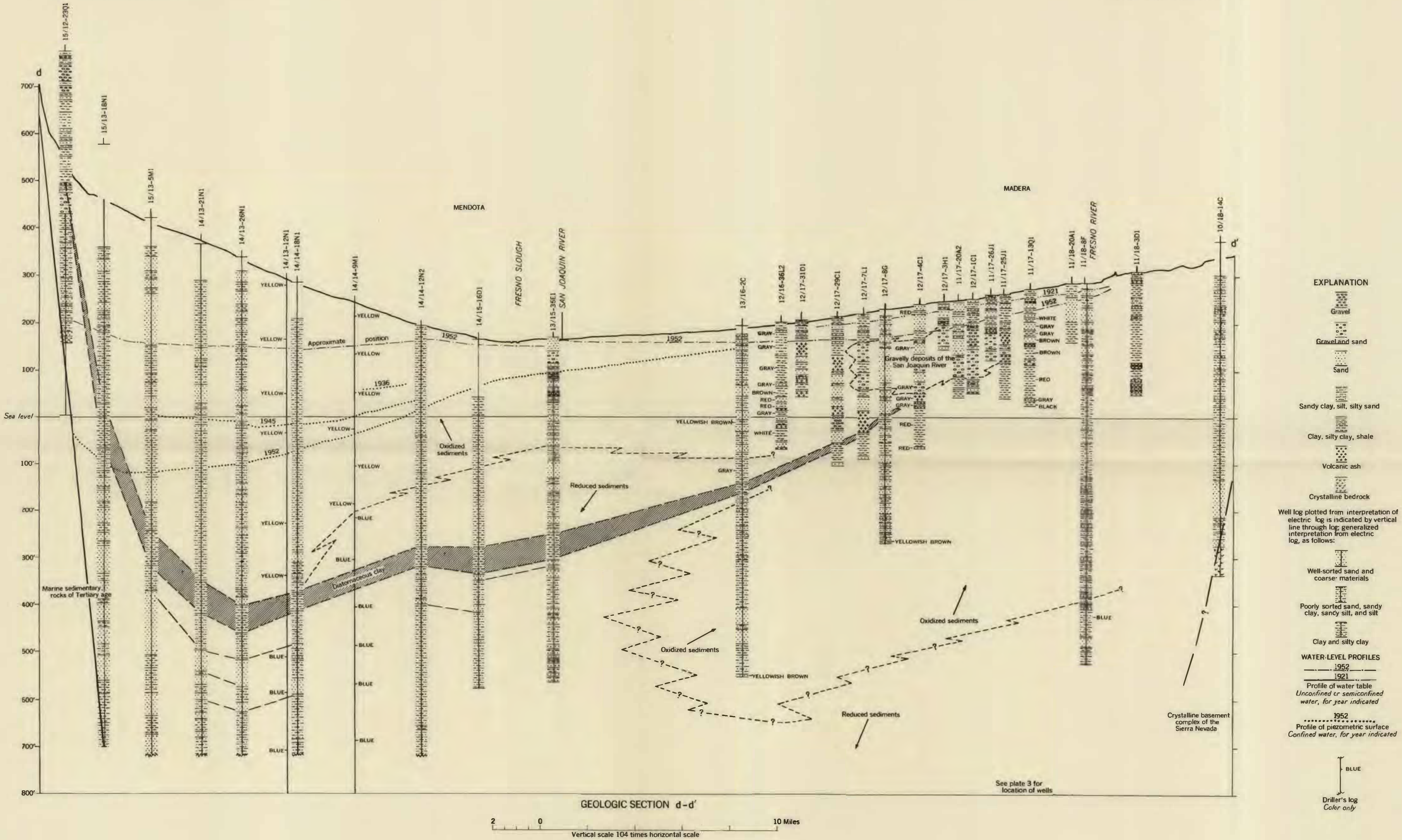
DAVIDS ENGINEERING, INC

Luhdorff & Scalmanini Consulting Engineers

APPENDIX 2.D

Existing Geologic Cross-Section Location Map

Davis et al., 1959



GEOLOGIC SECTION d–d'

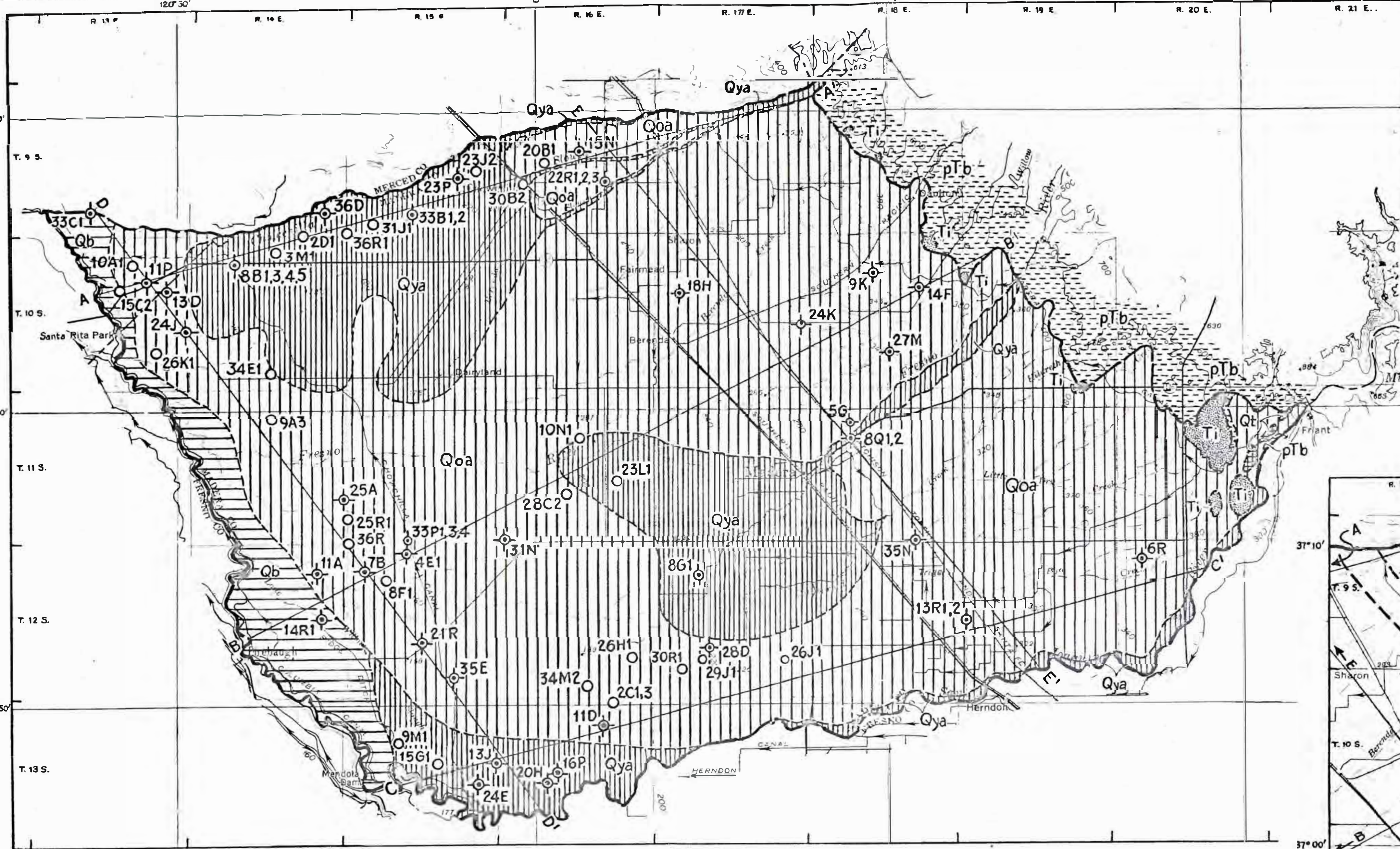
Mitten et al., 1970

70-228

U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
CALIFORNIA DEPARTMENT OF WATER RESOURCES

PLATE 1



GEOLOGIC MAP

EXPLANATION

UNCONSOLIDATED DEPOSITS

Qb Flood-basin deposits; Qya Younger alluvium; Qt Terrace deposits; Qoa Older alluvium — Pleistocene and Holocene(?) Holocene — QUATERNARY

UNCONFORMITY

CONSOLIDATED ROCKS

Ti Ione Formation — Eocene — TERTIARY

UNCONFORMITY

pTb Basement complex — PRE-TERTIARY

Geologic contact

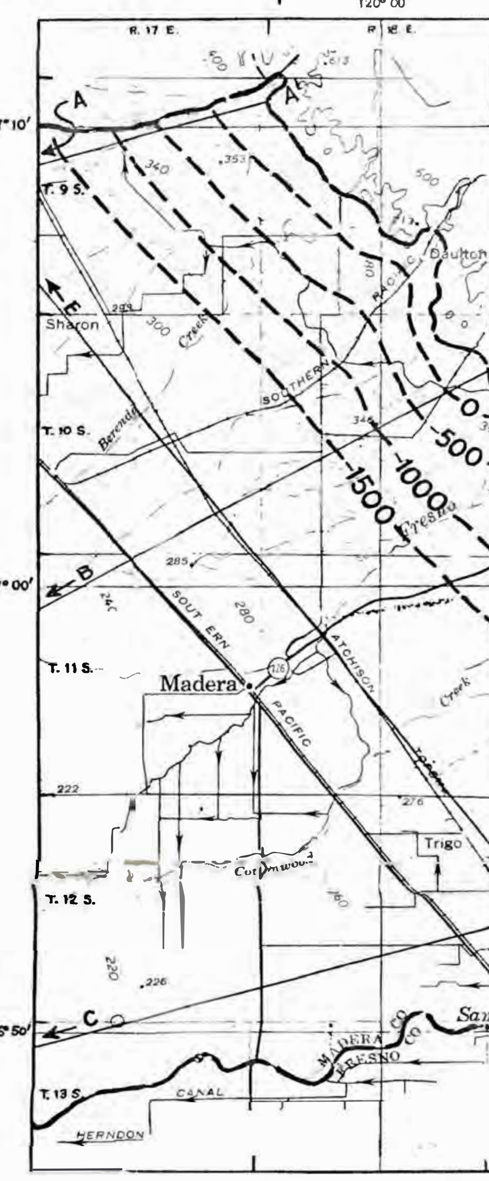
13D1 Water well and number

33B1 Test well and number

Oil well or oil-test well and number

A—A' Line of geologic section

Boundary of Madera area

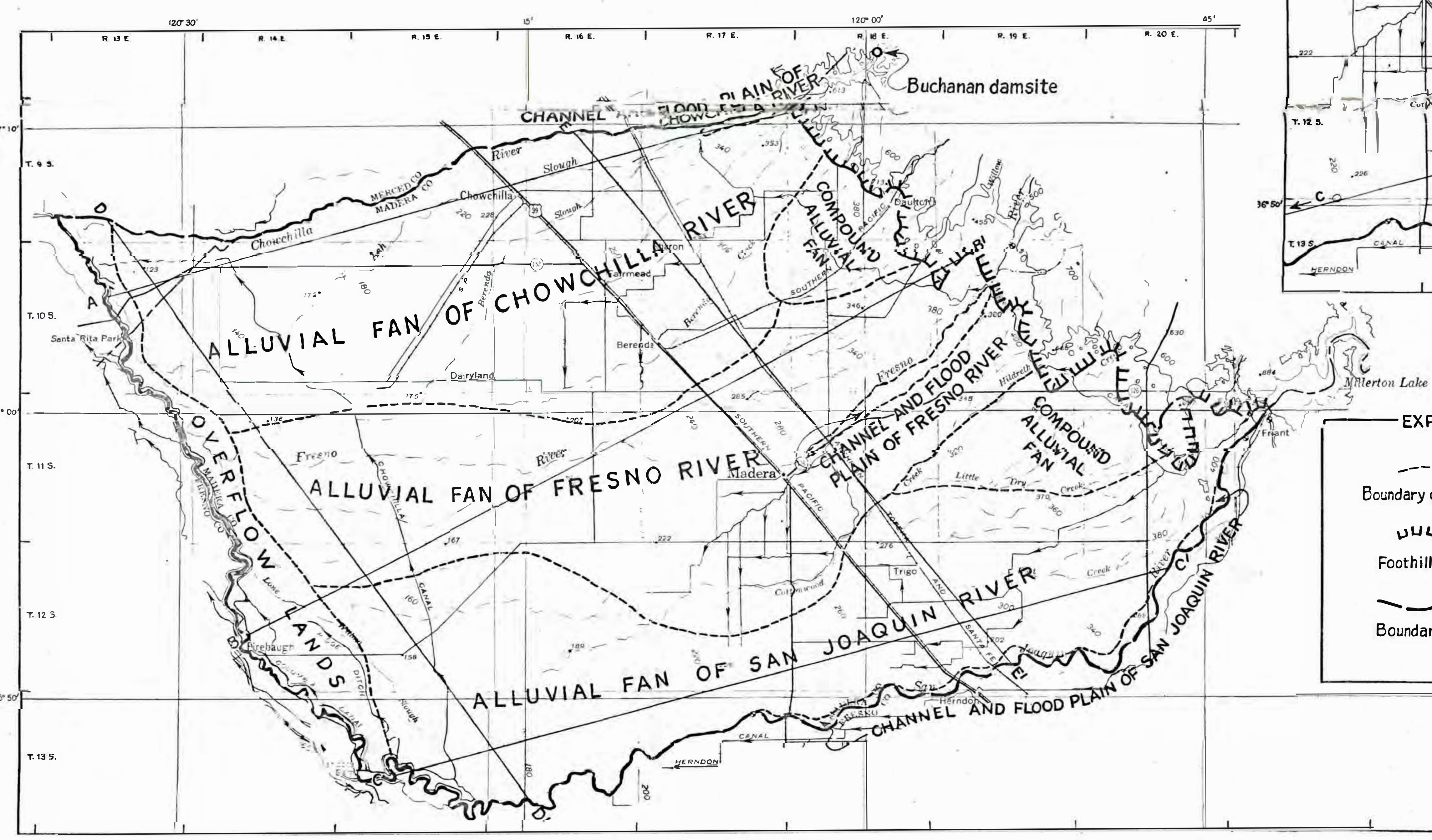


EXPLANATION

-500 Structure contour
Drawn on top of the basement complex; queried where data are inconclusive; contour interval 500 feet. Datum is mean sea level

Boundary of Madera area

CONTOURS ON BASEMENT COMPLEX



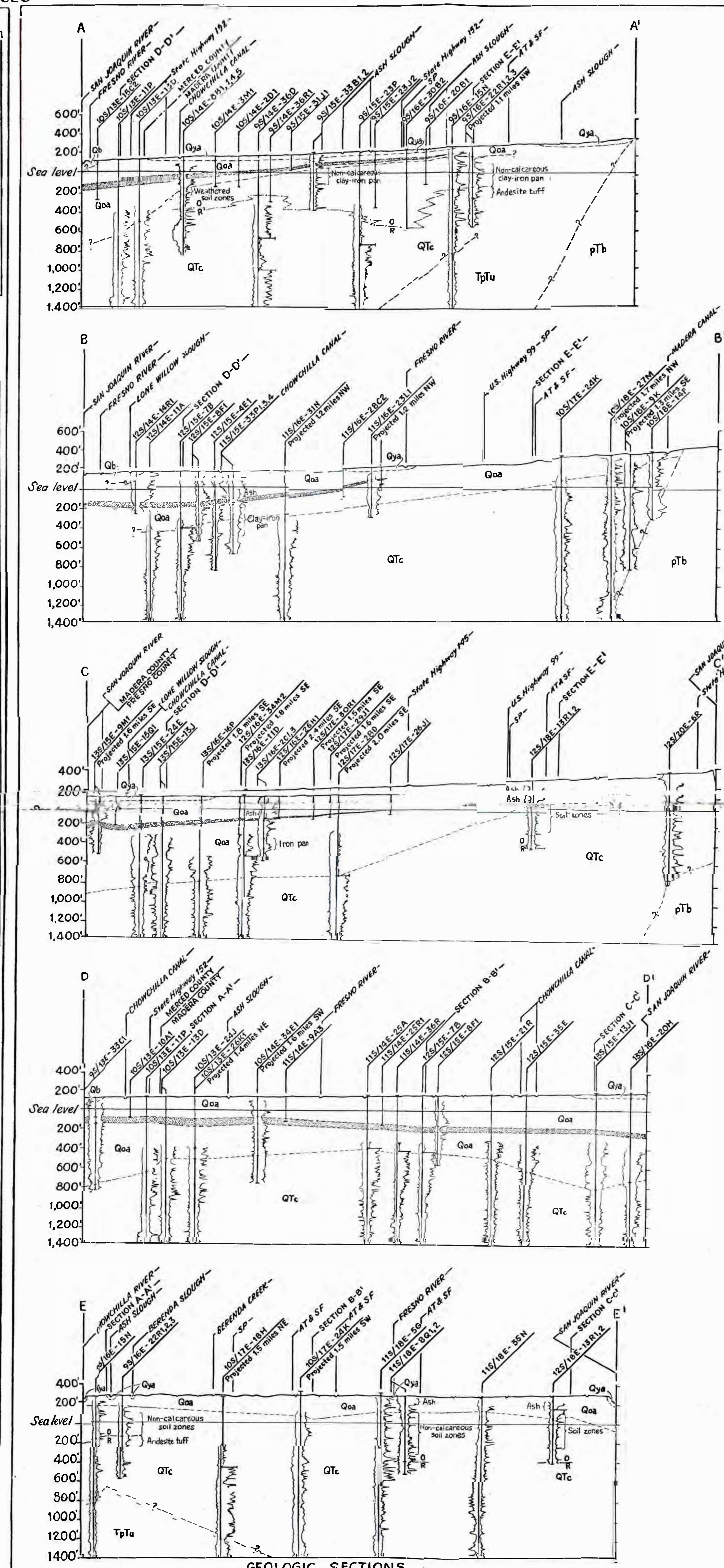
GEOMORPHIC MAP

EXPLANATION

Boundary of geomorphic units

Foothills of Sierra Nevada

Boundary of Madera area



GEOLOGIC SECTIONS

EXPLANATION

UNCONSOLIDATED DEPOSITS

Qb Flood-basin deposits; Qya Younger alluvium; Ql Lacustrine and marsh deposits; Qoa Older alluvium — Pleistocene(?) Holocene(?) Holocene — QUATERNARY

QTc Continental deposit of Tertiary and Quaternary (?) age — TERTIARY AND QUATERNARY

UNCONFORMITY

CONSOLIDATED ROCKS

TpTu Marine and continental sedimentary rocks, undifferentiated — PRE-TERTIARY AND TERTIARY

UNCONFORMITY

pTb Basement complex — PRETERTIARY

Contact
Queried where evidence is inconclusive

Contact between oxidized (O) and reduced (R) deposits

E-clay (Ql)

TOP OF WELL — BOTTOM OF WELL — Well symbol

CHANGE IN RESISTIVITY SCALE — Well with electric log

Horizontal scale same as scale of maps; vertical scale X 26.4. Datum is mean sea level

Base from U.S. Geological Survey Central Valley, California, Delta Area, 1958 1:250,000

5 0 5 10 MILES

Contour interval 100 feet
Contours at 20 foot interval are shown in valley area where space permits
Datum is mean sea level

TRUE NORTH — MAGNETIC NORTH — 16½°
APPROXIMATE MEAN DECLINATION, 1970

GEOMORPHIC AND GEOLOGIC MAPS AND SECTIONS, AND CONTOURS ON BASEMENT COMPLEX, MADERA AREA, SAN JOAQUIN VALLEY, CALIFORNIA

A2.D-4

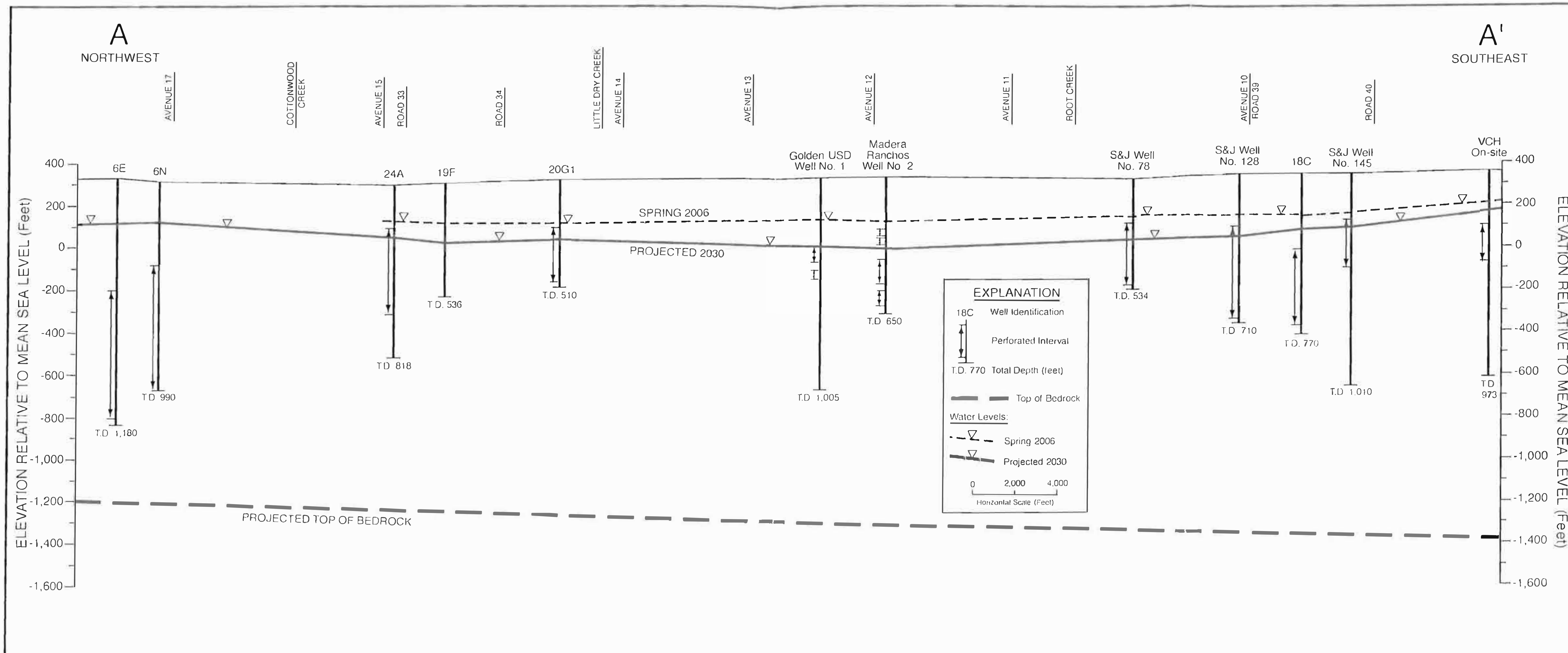


FIGURE 2 - SUBSURFACE GEOLOGIC CROSS SECTION A- A'

Gunner Ranch TM 3 - KDSA, 2006

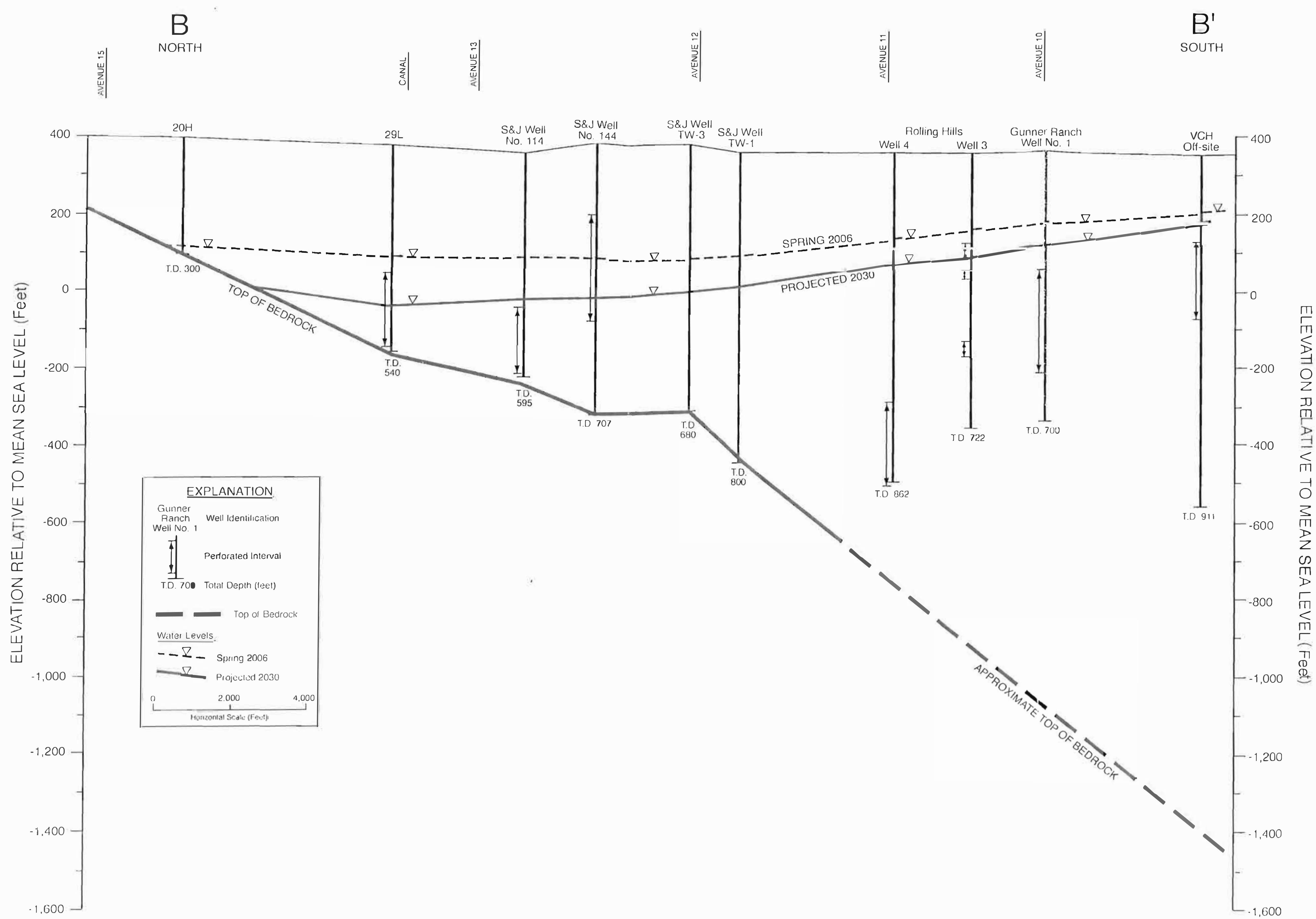
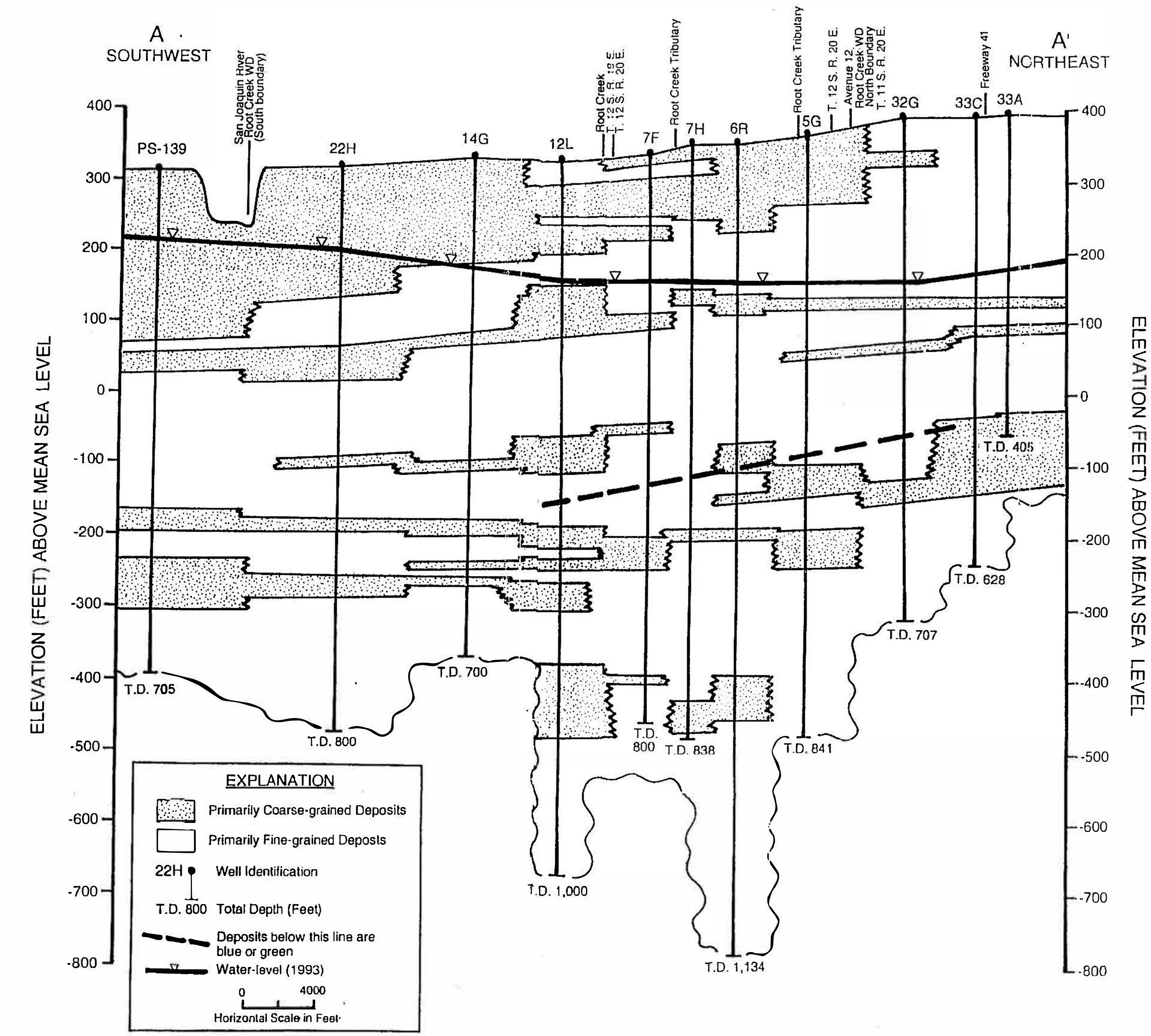


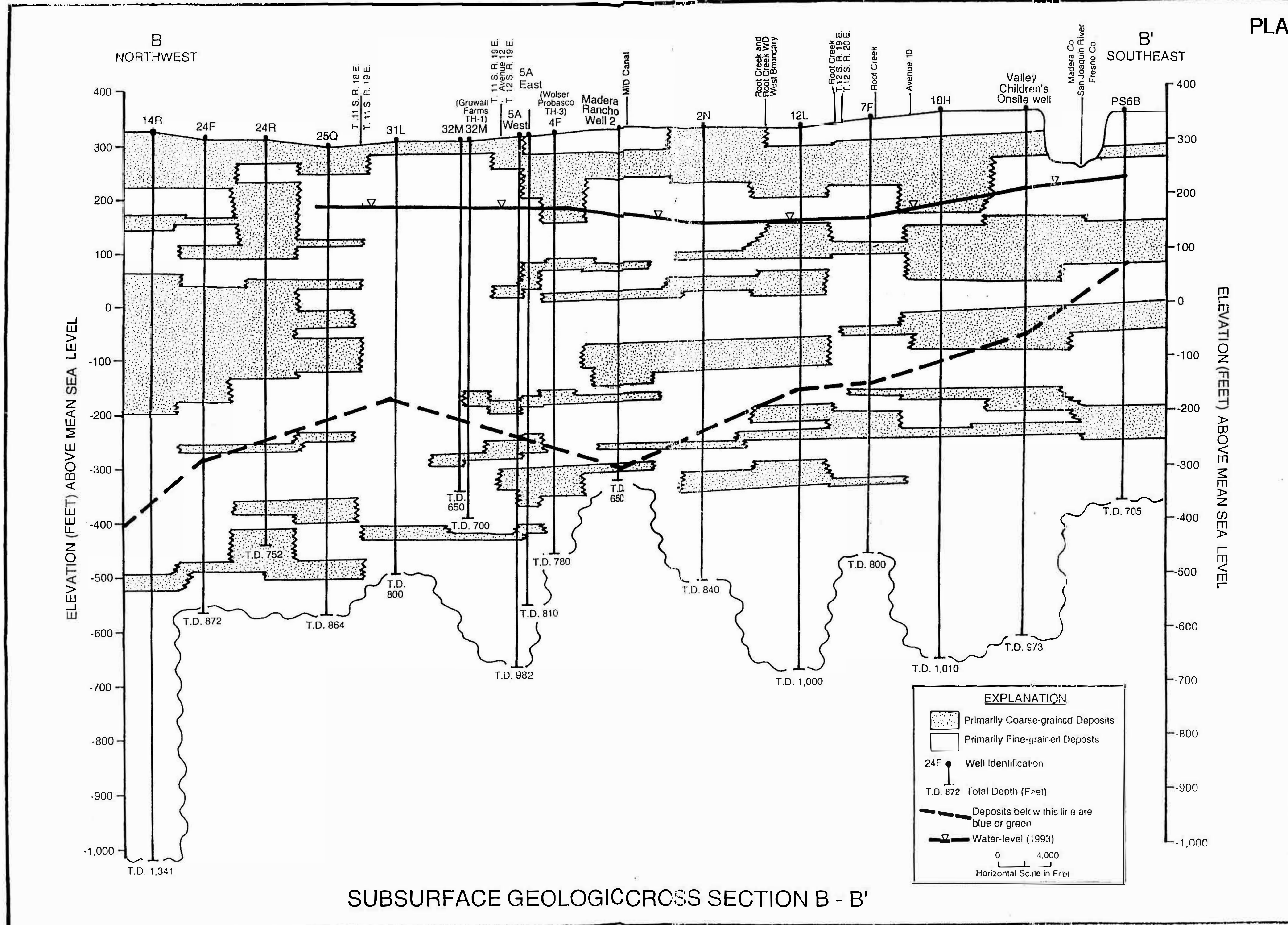
FIGURE 3 - SUBSURFACE GEOLOGIC CROSS SECTION B - B'

PLATE 10



SUBSURFACE GEOLOGIC CROSS SECTION A - A'

PLATE 11



SUBSURFACE GEOLOGIC CROSS SECTION B - B'

Table of Aquifer

Property Data

Well_ID	Data Source	Subbasin	Latitude	Longitude	Town-ship	Range	Sec	Depth Zone	Well Type	Total Depth (ft)	Top of Perforations (ft)	Bottom of Perforations (ft)	Well Casing Diameter (in)	Test Date	Test Discharge rate (gpm)	Test Duration (hr)	Well Specific Capacity (gpm/ft)	Transmissivity from Aquifer Test (gpd/ft)	Transmissivity from Well Specific Capacity (x1500) (gpd/ft)	Transmissivity from Well Specific Capacity (x2000) (gpd/ft)	Note
10S/16E-08E01	USGS-Mitten et al., 1970	Madera	37.07666	-120.24761				Lower Aquifer		405						20.8		30,000			Hantush (Jacob T=59,000)
9S/17E-30F01	USGS-Mitten et al., 1970	Madera	37.11988	-120.15648				Lower Aquifer		580						5.8		24,000			Jacob method
CityOfMadera15	City of Madera	Madera						Lower Aquifer	Municipal/Public Supply	465	195	465					65.0		97,500	130,000	
CityOfMadera16	City of Madera	Madera	36.981514	-120.051809				Lower Aquifer	Municipal/Public Supply	535	190	504					<15				and falling
CityOfMadera17	City of Madera	Madera						Lower Aquifer	Municipal/Public Supply	620	260	620					22.0		33,000	44,000	and rising
CityOfMadera18	City of Madera	Madera	36.968026	-120.067265				Lower Aquifer	Municipal/Public Supply	610	280	610					44.0		66,000	88,000	
CityOfMadera20	City of Madera	Madera	36.973446	-120.074201				Lower Aquifer	Municipal/Public Supply	600	252	576					90.0		135,000	180,000	
CityOfMadera21	City of Madera	Madera						Lower Aquifer	Municipal/Public Supply	600	230	600					70.0		105,000	140,000	and falling
CityOfMadera22	City of Madera	Madera						Lower Aquifer	Municipal/Public Supply	540	240	520					45.0		67,500	90,000	
CityOfMadera23	City of Madera	Madera	36.982384	-120.066497				Lower Aquifer	Municipal/Public Supply	790	210	770					37.0		55,500	74,000	
CityOfMadera24	City of Madera	Madera	36.970787	-120.051338				Lower Aquifer	Municipal/Public Supply	510	210	510					32.0		48,000	64,000	
CityOfMadera25	City of Madera	Madera	36.981462	-120.09204				Lower Aquifer	Municipal/Public Supply	513	275	505					40.0		60,000	80,000	and falling
CityOfMadera26	City of Madera	Madera						Lower Aquifer	Municipal/Public Supply	600	240	600					40.0		60,000	80,000	
CityOfMadera28	City of Madera	Madera	36.974102	-120.038885				Lower Aquifer	Municipal/Public Supply	522	270	540					15.0		22,500	30,000	
CityOfMadera29	City of Madera	Madera	36.967009	-120.089832				Lower Aquifer	Municipal/Public Supply	600	370	590					25.0		37,500	50,000	Variable
CityOfMadera30	City of Madera	Madera						Lower Aquifer	Municipal/Public Supply	720	430	720					35.0		52,500	70,000	and falling
CityOfMadera31	City of Madera	Madera						Lower Aquifer	Municipal/Public Supply	520	265	500					43.0		64,500	86,000	
CityOfMadera32	City of Madera	Madera						Lower Aquifer	Municipal/Public Supply	700	320	680					65.0		97,500	130,000	and rising
CityOfMadera33	City of Madera	Madera	36.930297	-120.043967				Lower Aquifer	Municipal/Public Supply	620	310	600					20.0		30,000	40,000	and falling
CityOfMadera34	City of Madera	Madera						Lower Aquifer	Municipal/Public Supply	588	433	568					12.0		18,000	24,000	
GunnerRanch AgWellB1-1	Gunner Ranch	Madera	36.89531111	-119.8019444				Composite			220			7/13/2000	485	3	7.8	9,000	11,700	15,600	Step test; T=9,000gpd/ft; Step 1
GunnerRanch AgWellB1-1	Gunner Ranch	Madera						Composite			220			7/13/2000	805	3	7.8		11,700	15,600	Step test; Step 2
GunnerRanch AgWellB1-1	Gunner Ranch	Madera						Composite			220			7/13/2000	1,115	3	7.2		10,800	14,400	Step test; Step 3
GunnerRanch NewWellNo1	Gunner Ranch	Madera	36.89534444	-119.7966667				Composite			300			6/28/2000	660	3	20.4	37,000	30,600	40,800	Step test; Step 1
GunnerRanch NewWellNo1	Gunner Ranch	Madera						Composite			300			6/28/2000	1,010	3	19.1		28,650	38,200	Step test; Step 2
GunnerRanch NewWellNo1	Gunner Ranch	Madera						Composite			300			6/28/2000	1,385	3	20.3		30,450	40,600	Step test; Step 3
GunnerRanch_VCH OffSiteSupplyWell	Gunner Ranch	Madera	36.8837	-119.7994444				Composite						1/23/1997	705	3	10.2	14,000	15,300	20,400	Step test; Step 1
GunnerRanch_VCH OffSiteSupplyWell	Gunner Ranch	Madera						Composite						1/23/1997	1,015	3	9.0		13,500	18,000	Step test; Step 2
GunnerRanch_VCH OffSiteSupplyWell	Gunner Ranch	Madera						Composite						1/23/1997	1,395	2.5	8.6		12,900	17,200	Step test; Step 3
GunnerRanch_VCH OffSiteSupplyWell	Gunner Ranch	Madera						Composite						1/23/1997	885	15.5	8.3		12,450	16,600	Step test/CRT; Step 4
MaderaWD1	Madera WD	Madera						Lower Aquifer		460				6/27/1994	692		16.2		24,252	32,336	
MaderaWD1	Madera WD	Madera						Lower Aquifer		460				7/8/2003	749		19.1		28,602	38,135	
MaderaWD10	Madera WD	Madera	37.05120263	-120.0477255				Lower Aquifer		515	200	515		8/15/2014	204		2.7		4,050	5,400	
MaderaWD13	Madera WD	Madera						Lower Aquifer		600	180	570		10/19/1994	1,661		45.9		68,826	91,768	
MaderaWD14	Madera WD	Madera	37.04279883	-120.0519634				Lower Aquifer		780	300	770		7/8/2003	1,006		9.9		14,801	19,734	
MaderaWD15	Madera WD	Madera	37.04337604	-120.0338995				Lower Aquifer		680	300	670		10/19/1994	1,176		22.7		34,120	45,493	
MaderaWD15	Madera WD	Madera	37.04337604	-120.0338995				Lower Aquifer		680	300	670		9/12/2003	886		16.7		25,005	33,340	
MaderaWD15	Madera WD	Madera	37.04337604	-120.0338995				Lower Aquifer		680	300	670		8/28/2014	403		2.4		3,600	4,800	
MaderaWD16	Madera WD	Madera						Lower Aquifer		990	345	970		10/20/1994	862		16.9		25,353	33,804	
MaderaWD17	Madera WD	Madera	37.03604729	-120.0182401				Lower Aquifer		870	250	870		8/14/2014	684		21.4		32,100	42,800	
MaderaWD18	Madera WD	Madera	37.04893632	-120.0065634				Lower Aquifer		840	240	840		8/15/2014	364		36.4		54,600	72,800	
MaderaWD19	Madera WD	Madera	37.05062171	-120.0272379				Lower Aquifer		800	250	800		8/14/2014	467		2.0		3,000	4,000	
MaderaWD2	Madera WD	Madera	37.03994604	-120.0110626				Lower Aquifer		500	200	500		10/20/1994	1,225		23.6		35,337	47,115	
MaderaWD2	Madera WD	Madera	37.03994604	-120.0110626				Lower Aquifer		500	200	500		7/8/2003	982		18.5		27,733	36,977	
MaderaWD2	Madera WD	Madera	37.03994604	-120.0110626				Lower Aquifer		500	200	500		8/14/2014	499		6.2		9,300	12,400	
MaderaWD20	Madera WD	Madera	37.05020483	-120.0700147				Lower Aquifer		800	380	800		8/15/2014	1,012		14.3		21,450	28,600	
MaderaWD21	Madera WD	Madera	37.0393923	-120.0425934				Lower Aquifer		760	259	759		8/14/2014	805		12.6		18,900	25,200	
MaderaWD23	Madera WD	Madera	37.0416332	-120.0246562				Lower Aquifer		720	460	720		8/14/2014	741		12.8		19,200	25,600	
MaderaWD3	Madera WD	Madera	37.03279621	-120.0109302				Lower Aquifer		500	200	500		10/20/1994	1,419		258.0		387,000	516,000	
MaderaWD3	Madera WD	Madera	37.03279621	-120.0109302				Lower Aquifer		500	200	500		7/8/2003	1,192		17.8		26,682	35,576	
MaderaWD4	Madera WD	Madera	37.04728778	-120.0248286				Lower Aquifer		500	200	500		10/20/1994	797		13.2		19,728	26,304	
MaderaWD4	Madera WD	Madera	37.04728778	-120.0248286				Lower Aquifer		500	200	500		7/8/2003	627		4.9		7,407	9,876	
MaderaWD4	Madera WD	Madera	37.04728778	-120.0248286				Lower Aquifer		500	200	500		8/15/2014	219		4.8		7,200	9,600	
MaderaWD5	Madera WD	Madera						Lower Aquifer		500	200	500		10/19/1994	933		23.0		34,556	46,074	
MaderaWD6	Madera WD	Madera	37.04367229	-120.042988				Lower Aquifer		500	200	500		10/19/1994	984		164.0		246,000	328,000	
MaderaWD6	Madera WD	Madera	37.04367229	-120.042988				Lower Aquifer		500	200	500		7/8/2003	998		11.1		16,623	22,164	
MaderaWD6	Madera WD	Madera	37.04367229	-120.042988				Lower Aquifer		500	200	500		8/15/2014	307		9.6		14,400	19,200	
MaderaWD7	Madera WD	Madera	37.03632255	-120.0429737				Lower Aquifer		500	200	500		10/20/1994	772		10.3		15,440	20,587	
MaderaWD7	Madera WD	Madera	37.03632255	-120.0429737				Lower Aquifer		500	200	500		7/8/2003	612		3.6		5,370	7,159	
MaderaWD7	Madera WD	Madera	37.03632255	-120.0429737				Lower Aquifer		500	200	500		8/14/2014	230		2.8		4,200	5,600	
MaderaWD8	Madera WD	Madera	37.04388206	-120.0614653				Lower Aquifer		537	200	537		9/12/2003	797		6.4		9,583	12,777	
MaderaWD8	Madera WD	Madera	37.04388206	-120.0614653				Lower Aquifer		537	200	537		8/28/2014	362		2.4		3,600	4,800	
MaderaWD9	Madera WD	Madera	37.05117795	-120.0614226				Lower Aquifer		536	200	536		10/19/1994	1,057		26.9		40,344	53,791	
MaderaWD9	Madera WD	Madera	37.05117795	-120.0614226				Lower Aquifer		536	200	536		9/12/2003	1,087		17.4		26,141	34,855	
MaderaWD9	Madera WD	Madera	37.05117795	-120.0614226				Lower Aquifer		536	200	536		8/27/2014	724		5.8		8,700	11,600	
NewStone1	New Stone WD	Madera						Unknown						9/28/1998	1,023		85.3		127,950	170,600	
NewStone10	New Stone WD	Madera						Unknown													
NewStone11	New Stone WD	Madera						Unknown						9/18/2004	678		67.8		101,655	135,540	
NewStone12	New Stone WD	Madera						Unknown						1/29/2009	961		21.7		32,550	43,400	
NewStone13	New Stone WD	Madera						Unknown						3/28/2015	2,200	1.25	56.4		84,615	112,821	Step test; Step 1

Well_ID	Data Source	Subbasin	Latitude	Longitude	Town-ship	Range	Sec	Depth Zone	Well Type	Total Depth (ft)	Top of Perforations (ft)	Bottom of Perforations (ft)	Well Casing Diameter (in)	Test Date	Test Discharge rate (gpm)	Test Duration (hr)	Well Specific Capacity (gpm/ft)	Transmissivity from Aquifer Test (gpd/ft)	Transmissivity from Well Specific Capacity (x1500) (gpd/ft)	Transmissivity from Well Specific Capacity (x2000) (gpd/ft)	Note
NewStone13	New Stone WD	Madera						Unknown						3/28/2015	1,750	1.5					Step test; Step 2
NewStone13	New Stone WD	Madera						Unknown						3/28/2015	1600 to 1200	1.25					Step test; Step 3
NewStone13	New Stone WD	Madera						Unknown						3/28/2015	1,100	1.5					Step test; Step 4
NewStone14	New Stone WD	Madera						Unknown						3/7/2011	1,139		41.4		62,100	82,800	Run 1
NewStone14	New Stone WD	Madera						Unknown						3/7/2011	1,048		46.6		69,900	93,200	Run 2
NewStone16	New Stone WD	Madera						Unknown						4/27/2000	1,272		70.7		106,013	141,350	Questionable data
NewStone17	New Stone WD	Madera						Unknown						5/8/2000	1,186	0.25	25.2		37,849	50,466	
NewStone19	New Stone WD	Madera						Unknown						6/15/2013	1,337		40.5		60,750	81,000	
NewStone2	New Stone WD	Madera						Unknown						1/26/2011	1,300						
NewStone2	New Stone WD	Madera						Unknown						6/1/2011	1,300						
NewStone20	New Stone WD	Madera						Unknown						2/16/2011	1,003		26.4		39,600	52,800	Run 1
NewStone20	New Stone WD	Madera						Unknown						2/16/2011	1,287		26.8		40,200	53,600	Run 2
NewStone21	New Stone WD	Madera						Unknown						1/30/2009	913		29.0		43,500	58,000	
NewStone23	New Stone WD	Madera						Unknown						5/17/2000	1,505		18.1		27,199	36,265	
NewStone24	New Stone WD	Madera						Unknown						1/3/2011	950						
NewStone24	New Stone WD	Madera						Unknown						6/1/2011	950						
NewStone25	New Stone WD	Madera						Unknown						7/18/1998	636		39.8		59,625	79,500	
NewStone26	New Stone WD	Madera						Unknown						11/21/2015	1,000	1	27.0		40,541	54,054	Step test; Step 1
NewStone26	New Stone WD	Madera						Unknown						11/21/2015	1,250	1					Step test; Step 2
NewStone28	New Stone WD	Madera						Unknown						4/5/2012	1,134		26.4		39,600	52,800	
NewStone3	New Stone WD	Madera						Unknown						4/27/2000	1,353	0.25	225.4				
NewStone34	New Stone WD	Madera						Unknown						9/10/2016	1,300	2.25	108.3		162,500	216,667	
NewStone35	New Stone WD	Madera						Unknown						5/2/1997	1,298		20.3		30,450	40,600	
NewStone36	New Stone WD	Madera						Unknown						7/16/2010	868		13.6		20,400	27,200	Questionable
NewStone37	New Stone WD	Madera						Unknown						4/6/2011	2,175		26.9		40,350	53,800	
NewStone38	New Stone WD	Madera						Unknown						8/17/2013	2,479		44.3		66,450	88,600	
NewStone39	New Stone WD	Madera						Unknown						11/24/2014	2,600	6.5	26.3		39,394	52,525	Development
NewStone39	New Stone WD	Madera						Unknown						11/24/2014	2,600	8	26.8		40,206	53,608	Development
NewStone39	New Stone WD	Madera						Unknown						11/26/2014	1,000	2	33.3		49,950	66,600	Step 1
NewStone39	New Stone WD	Madera						Unknown						11/26/2014	1,225	2	26.0		39,000	52,000	Step 2
NewStone39	New Stone WD	Madera						Unknown						11/26/2014	1,500	2	24.6		36,900	49,200	Step 3
NewStone39	New Stone WD	Madera						Unknown						11/26/2014	1,750	2	26.6		39,900	53,200	Step 4
NewStone41	New Stone WD	Madera						Unknown						1/29/2013	2,261		23.8		35,700	47,600	
NewStone5	New Stone WD	Madera						Unknown						9/18/2004	749		32.6		48,840	65,120	
NewStone7	New Stone WD	Madera						Unknown						4/27/2000	1,280	0.25	40.0		60,009	80,013	
NewStone9	New Stone WD	Madera						Unknown						5/9/2012	910		33.7		50,550	67,400	
RootCk RiverstoneWell	Root Creek WD	Madera	36.89005479	-119.8216184				Composite		900				10/15/2014	1,000	4	36.2	48,000	54,300	72,400	Step test; Step 1
RootCk RiverstoneWell	Root Creek WD	Madera	36.89005479	-119.8216184				Composite		900				10/15/2014	1,195	4	33.9		50,850	67,800	Step test; Step 2
RootCk RiverstoneWell	Root Creek WD	Madera	36.89005479	-119.8216184				Composite		900				10/15/2014	1,400	4	32.9		49,350	65,800	Step test; Step 3
RootCk RiverstoneWell	Root Creek WD	Madera	36.89005479	-119.8216184				Composite		900				10/16/2014	1,310	10	33.9	45,000	50,850	67,800	Constant rate test
RootCk2	Root Creek WD	Madera	36.89454879	-119.8297171				Lower Aquifer		930				1/9/2015	2,100	9	10.1		15,144	20,192	Constant rate test
WCR0021774	WCR	Madera	36.9752	-120.26513	11S	16E	18	Upper Aquifer	Agriculture/Irrigation		200	376			4,095	10	117.0		175,500	234,000	
WCR0040326	WCR	Madera	37.01856	-120.15656	10S	17E	31	Lower Aquifer	Agriculture/Irrigation	420	160	420	18		1,000	12	35.7		53,571	71,429	
WCR0076505	WCR	Madera	37.061111	-120.155833	10S	17E	18	Lower Aquifer	Agriculture/Irrigation	970	520	960			2,400	14	19.5		29,268	39,024	
WCR0081505	WCR	Madera	36.93075	-119.79397	11S	20E	33	Unknown	Agriculture/Irrigation	450	330	430	16		145		1.0		1,440	1,921	
WCR0081859	WCR	Madera	36.93099	-120.0101	11S	18E	33	Unknown	Agriculture/Irrigation	312	172	299	14		1,100	11	32.4		48,529	64,706	
WCR0083529	WCR	Madera	36.91645	-119.81206	12S	20E	5	Unknown	Agriculture/Irrigation	900	340	880	16		1,300	10	33.3		50,000	66,667	
WCR0086494	WCR	Madera	36.9355	-119.8643	11S	19E	35	Unknown	Municipal/Public Supply	545	454	540			1,000	48	20.4		30,612	40,816	
WCR0103540	WCR	Madera	36.91655	-119.86705	12S	19E	2	Unknown	Municipal/Public Supply	535	405	525	16		600	10	8.1		12,162	16,216	
WCR0105316	WCR	Madera	36.93055	-119.90317	11S	19E	33	Unknown	Municipal/Public Supply	580	384	560	16		650	72	9.3		13,929	18,571	
WCR0121774	WCR	Madera	36.93055	-119.90317	11S	19E	33	Unknown	Other/Unknown	600	500	578	16		350	72	6.7		10,096	13,462	
WCR0137826	WCR	Madera	36.96034	-120.06498	11S	17E	24	Upper Aquifer	Domestic	520	240	520	18		3,500	17	875.0		1,312,500	1,750,000	
WCR0142752	WCR	Madera	36.9889	-119.99201	11S	18E	10	Upper Aquifer	Agriculture/Irrigation	900	290	898	16		2,000	10	200.0		300,000	400,000	
WCR0146316	WCR	Madera	37.064765	-119.992976	10S	18E	15	Lower Aquifer	Agriculture/Irrigation	900	320	890	16		1,300		5.4		8,125	10,833	
WCR0157249	WCR	Madera	37.085	-120.039722	10S	18E	8	Lower Aquifer	Agriculture/Irrigation	747	500	736			360	11.8	1.4		2,151	2,869	
WCR0159720	WCR	Madera	37.03316	-120.13775	10S	17E	29	Lower Aquifer	Agriculture/Irrigation	920	420	920	24		1,500	12	83.3		125,000	166,667	
WCR0164973	WCR	Madera	37.00387	-120.11951	11S	17E	4	Upper Aquifer	Agriculture/Irrigation	600	300	600	16		1,500	12	30.6		45,918	61,224	
WCR0170305	WCR	Madera	36.94511	-119.83034	11S	20E	30	Unknown	Agriculture/Irrigation	750	341	730	16		1,000	7	43.5		65,217	86,957	
WCR0177595	WCR	Madera	36.930277	-119.978333	11S	18E	35	Unknown	Agriculture/Irrigation	850	290	850			1,500	6	11.9		17,857	23,810	
WCR0181977	WCR	Madera	36.98919	-120.06496	11S	17E	12	Upper Aquifer	Domestic	790	210	770	18		3,500	12	145.8		218,750	291,667	
WCR0187970	WCR	Madera	36.93099	-120.0101	11S	18E	33	Unknown	Agriculture/Irrigation	289	134	170	14		1,500	10	10.7		16,071	21,429	
WCR0197460	WCR	Madera	36.927722	-120.103527	11S	17E	34	Unknown	Municipal/Public Supply	860	590	840	30		2,000	10	31.7		47,619	63,492	
WCR0200017	WCR	Madera	36.85861	-120.17377	12S	16E	25	Unknown	Agriculture/Irrigation	384	220	312			300		30.0		45,000	60,000	
WCR0211893	WCR	Madera	36.9745	-120.01013	11S	18E	16	Upper Aquifer	Agriculture/Irrigation	1020	420	1000			1,000		19.6		29,412	39,216	
WCR0236799	WCR	Madera	37.00368	-120.01028	11S	18E	4	Upper Aquifer	Agriculture/Irrigation		235	410	14		2,325	16	18.3		27,461	36,614	
WCR0238030	WCR	Madera	37.055277	-120.197777	10S	16E	14	Lower Aquifer	Agriculture/Irrigation	1011	350	1000			2,000	2	35.1		52,632	70,175	
WCR0240012	WCR	Madera	36.96072	-120.24696	11S	16E	20	Upper Aquifer	Agriculture/Irrigation	560	345	556	16		800	10	22.2		33,333	44,444	
WCR0242857	WCR	Madera	36.98946	-120.1932	11S	16E	11	Lower Aquifer	Agriculture/Irrigation	600	200	460	18		2,700	24	77.1		115,714	154,286	
WCR0266651	WCR	Madera	36.93113	-120.08329	11S	17E	35	Upper Aquifer	Agriculture/Irrigation	580	320	487	18		300	2	75.0		112,500	150,000	
WCR0268176	WCR	Madera	36.9889	-119.99201	11S	18E	10	Unknown	Agriculture/Irrigation	960	380	940			1,000		25.0		37,500	50,000	
WCR0294524	WCR	Madera	36.87339	-119.8481	12S	19E	24	Unknown	Agriculture/Irrigation	676	292	666			1,200	3	11.1		16,667	22,222	
WCR0307423	WCR	Madera	37.0762	-120.04714	10S	18E	7	Lower Aquifer	Domestic	680	460	660			250	8.5	1.0		1,471	1,961	
WCR0316409	WCR	Madera	36.91674	-120.0466	12S	18E	6	Unknown	Agriculture/Irrigation	218	136	172			2,400	8	17.1		25,714	34,286	
WCR0321063	WCR	Madera	37.108519	-120.142657	09S	17E	32	Lower Aquifer	Agriculture/Irrigation	1070	417	1070			1,200	4	7.1		10,588	14,118	
WCR0327216	WCR	Madera	36.91671	-120.30046	12S	15E	2	Unknown	Agriculture/Irrigation	295	150	256	14		3,400	15	100.0		150,000	200,000	
WCR0327242	WCR	Madera	36.98948	-120.17514	11S	16E	12	Composite	Agriculture/Irrigation	201			12		1,348		11.4		17,136	22,847	

Well_ID	Data Source	Subbasin	Latitude	Longitude	Town-ship	Range	Sec	Depth Zone	Well Type	Total Depth (ft)	Top of Perforations (ft)	Bottom of Perforations (ft)	Well Casing Diameter (in)	Test Date	Test Discharge rate (gpm)	Test Duration (hr)	Well Specific Capacity (gpm/ft)	Transmissivity from Aquifer Test (gpd/ft)	Transmissivity from Well Specific Capacity (x1500) (gpd/ft)	Transmissivity from Well Specific Capacity (x2000) (gpd/ft)	Note
WCR1969-000479	WCR	Madera	36.8296	-120.21401	13S	16E	3	Upper Aquifer	Agriculture/Irrigation	360	220	340	12		1,370	15	14.4		21,632	28,842	
WCR1969-000614	WCR	Madera	36.81492	-120.214	13S	16E	10	Upper Aquifer	Agriculture/Irrigation	360	220	340	12		1,370	15	14.4		21,632	28,842	
WCR1970-000456	WCR	Madera	36.81492	-120.214	13S	16E	10	Upper Aquifer	Agriculture/Irrigation	294	144	242	16		3,600	24	38.3		57,447	76,596	
WCR1970-000541	WCR	Madera	36.81492	-120.214	13S	16E	10	Upper Aquifer	Agriculture/Irrigation	294	144	242	16		3,600	24	38.3		57,447	76,596	
WCR1971-000833	WCR	Madera	36.90235	-119.83032	12S	20E	7	Unknown	Agriculture/Irrigation	492	256	490	14		1,350	15	50.0		75,000	100,000	
WCR1981-004003	WCR	Madera	36.90342	-119.79367	12S	20E	9	Unknown	Municipal/Public Supply	722	240	526	16		2,000	24	14.1		21,127	28,169	
WCR1981-004183	WCR	Madera	36.81501	-120.17789	13S	16E	12	Upper Aquifer	Domestic	192			8		150	3	10.7		16,071	21,429	
WCR1986-008048	WCR	Madera	36.90239	-119.81189	12S	20E	8	Unknown	Municipal/Public Supply	862	650	861	16		1,400	5	12.7		19,091	25,455	
WCR1988-012053	WCR	Madera	36.8296	-120.21401	13S	16E	3	Composite	Agriculture/Irrigation	448	200	440	16		3,500	2	350.0		525,000	700,000	
WCR1991-013617	WCR	Madera	36.81487	-120.23201	13S	16E	9	Composite	Agriculture/Irrigation	445	215	375	16		3,200	40.5	100.0		150,000	200,000	
WCR1997-007489	WCR	Madera	36.8296	-120.21401	13S	16E	3	Upper Aquifer	Agriculture/Irrigation	507	266	500	16		300	2	75.0		112,500	150,000	
WCR1998-006530	WCR	Madera	36.88813	-119.79457	12S	20E	16	Unknown	Domestic	400	150	365	14		1,200	12	10.9		16,364	21,818	
WCR2017-003805	WCR	Madera	36.8948	-120.41463	12S	14E	11	Unknown	Agriculture/Irrigation	320					1,800	8	17.1		25,714	34,286	
10S/16E-24H01	USGS-Mitten et al., 1970	Chowchilla	37.04771	-120.175				Composite		183						15.8		18,000			Hantush method
13S/17E-01L01	USGS-Mitten et al., 1970	Chowchilla	36.82996	-120.06942				Upper Aquifer		345						20.8		50,000			Hantush (Jacob T=99,000)
WCR0012267	WCR	Chowchilla	36.995555	-120.413333	11S	14E	11	Composite	Agriculture/Irrigation	260	90	220			900	2	50.0		75,000	100,000	
WCR0017472	WCR	Chowchilla	37.16371	-120.35615	09S	15E	8	Lower Aquifer	Agriculture/Irrigation	700	215	690	16		4,192	26	127.0		190,545	254,061	
WCR0017473	WCR	Chowchilla	37.16372	-120.31987	09S	15E	10	Lower Aquifer	Agriculture/Irrigation	540	320	530	16		4,408	30	32.9		49,343	65,791	
WCR0056165	WCR	Chowchilla	37.01816	-120.46457	10S	14E	32	Composite	Agriculture/Irrigation	260	150	250	16		6,000	24	77.9		116,883	155,844	
WCR0062850	WCR	Chowchilla	37.01816	-120.46457	10S	14E	32	Upper Aquifer	Agriculture/Irrigation	204	120	153	18		3,900	12	150.0		225,000	300,000	
WCR0068892	WCR	Chowchilla	37.09098	-120.26566	10S	16E	6	Lower Aquifer	Agriculture/Irrigation	559	277	540	16		900	8	32.1		48,214	64,286	
WCR0103900	WCR	Chowchilla	37.16362	-120.37416	09S	15E	7	Lower Aquifer	Agriculture/Irrigation	1032	220	585	16		4,500	15	66.2		99,265	132,353	
WCR0120517	WCR	Chowchilla	37.108333	-120.271944	09S	16E	31	Lower Aquifer	Municipal/Public Supply	795	475	795	16		1,500	6	24.6		36,885	49,180	
WCR0127074	WCR	Chowchilla	37.07621	-120.46439	10S	14E	8	Lower Aquifer	Agriculture/Irrigation	847	230	847	16		1,500	24	8.9		13,393	17,857	
WCR0152919	WCR	Chowchilla	36.94566	-120.35483	11S	15E	29	Composite	Agriculture/Irrigation	300	150	300	16		4,000	21	93.0		139,535	186,047	
WCR0161027	WCR	Chowchilla	36.98908	-120.46436	11S	14E	8	Upper Aquifer	Agriculture/Irrigation	186	120	173	18		3,600	10	90.0		135,000	180,000	
WCR0165177	WCR	Chowchilla	37.149	-120.17487	09S	16E	13	Lower Aquifer	Agriculture/Irrigation	790	290	790	16		600	12	10.7		16,071	21,429	
WCR0169808	WCR	Chowchilla	37.06171	-120.41003	10S	14E	14	Lower Aquifer	Agriculture/Irrigation	800	200	800	16		2,800	10	15.6		23,464	31,285	
WCR0228666	WCR	Chowchilla	37.04729	-120.28349	10S	15E	24	Lower Aquifer	Agriculture/Irrigation	650	425	645			1,800	5	20.5		30,682	40,909	
WCR0238216	WCR	Chowchilla	37.141833	-120.252083	09S	16E	14	Lower Aquifer	Agriculture/Irrigation	810	385	800	36		2,000	10	52.6		78,947	105,263	
WCR0242828	WCR	Chowchilla	37.14719	-120.28342	09S	15E	13	Lower Aquifer	Agriculture/Irrigation	444	238	438	16		3,670	14	23.8		35,747	47,662	
WCR0250233	WCR	Chowchilla	37.149	-120.17487	09S	16E	13	Lower Aquifer	Agriculture/Irrigation	700	275	275	30		700	12	10.8		16,154	21,538	
WCR0250335	WCR	Chowchilla	37.03273	-120.50163	10S	13E	25	Upper Aquifer	Agriculture/Irrigation	192			16		4,500		68.2		102,273	136,364	
WCR0254211	WCR	Chowchilla	37.07608	-120.39182	10S	14E	12	Lower Aquifer	Agriculture/Irrigation	780	210	760			1,850	1	22.6		33,841	45,122	
WCR0256821	WCR	Chowchilla	37.076635	-120.22939	10S	16E	9	Lower Aquifer	Agriculture/Irrigation	955	270	935	36		2,800	6	46.7		70,000	93,333	
WCR0277636	WCR	Chowchilla	37.047279	-120.501508	10S	13E	24	Lower Aquifer	Other/Unknown	600	300	600	30		2,100	12	8.5		12,702	16,935	
WCR0282593	WCR	Chowchilla	37.07608	-120.39182	10S	14E	12	Composite	Agriculture/Irrigation	750					2,000	18	12.8		19,231	25,641	
WCR0291776	WCR	Chowchilla	37.149027	-120.244944	09S	16E	17	Lower Aquifer	Agriculture/Irrigation	770	372	750	36		2,000	10	58.8		88,235	117,647	
WCR0310201	WCR	Chowchilla	37.06172	-120.30158	10S	15E	14	Lower Aquifer	Agriculture/Irrigation	665	375	660			1,200	5	14.3		21,429	28,571	
WCR2017-001038	WCR	Chowchilla	37.00813	-120.4909	11S	14E	6	Upper Aquifer	Agriculture/Irrigation	280					1,600	14	11.6		17,391	23,188	
WCR2017-001090	WCR	Chowchilla	36.99508	-120.42827	11S	14E	10	Upper Aquifer	Agriculture/Irrigation	270					1,200	10	16.4		24,658	32,877	
WCR2017-003791	WCR	Chowchilla	36.98672	-120.46425	11S	14E	8	Upper Aquifer	Agriculture/Irrigation	280					1,800	8	14.3		21,429	28,571	
WCR0092467	WCR	Delta-Mendota	36.85832	-120.46361	12S	14E	29	Unknown	Municipal/Public Supply	180	155	180	16		2,500	16	33.3		50,000	66,667	
WCR0218176	WCR	Delta-Mendota	36.8145	-120.39487	13S	14E	12	Unknown	Agriculture/Irrigation	311	90	303	16		3,718		45.6		68,429	91,239	
WCR0236053	WCR	Delta-Mendota	36.88743	-120.49987	12S	13E	13	Unknown	Agriculture/Irrigation	350	220	350	30		4,000	1	30.3		45,496	60,661	
WCR1987-009215	WCR	Delta-Mendota	36.81255	-120.38035	13S	15E	7	Unknown	Domestic	140	120	135	6		250	0.25	41.7		62,500	83,333	
WCR1991-013256	WCR	Delta-Mendota	36.829383	-120.358571	13S	15E	5	Unknown	Domestic	187	140	180	6		150	24	2.2		3,358	4,478	
WCR1997-007169	WCR	Delta-Mendota	36.77044	-120.30596	13S	15E	26	Upper Aquifer	Domestic	303	240	284	10		300	3	15.0		22,500	30,000	
WCR2016-001313	WCR	Delta-Mendota	36.813667	-120.302099	13S	15E	11	Unknown	Agriculture/Irrigation	380	240	360			2,000	3.75	55.6		83,333	111,111	
WCR2016-001331	WCR	Delta-Mendota	36.79998	-120.29527	13S	15E	13	Unknown	Agriculture/Irrigation	390	170	370			1,600	4	26.7		40,000	53,333	
WCR2017-000407	WCR	Delta-Mendota	36.81482	-120.28634	13S	15E	12	Unknown	Agriculture/Irrigation	390					1,608	6	23.6		35,419	47,225	
WCR0006389	WCR	Kings	36.80085	-120.01538	13S	18E	16	Lower Aquifer	Municipal/Public Supply	920	550	900	1		2,250	12	15.4		23,116	30,822	
WCR0019030	WCR	Kings	36.78402	-120.21338	13S	16E	22	Upper Aquifer	Agriculture/Irrigation	316	132	316	16		2,300		92.0		138,000	184,000	
WCR0123019	WCR	Kings	36.81578	-119.78139	13S	20E	10	Composite	Municipal/Public Supply	360	190	360	20		5,085	24	113.0		169,500	226,000	
WCR0208185	WCR	Kings	36.80141	-119.78142	13S	20E	15	Composite	Municipal/Public Supply	480	258	480			3,700	12	411.1		616,667	822,222	
WCR0280253	WCR	Kings	36.81578	-119.78139	13S	20E	10	Lower Aquifer	Municipal/Public Supply	825	350	815			600	12	42.9		64,286	85,714	
WCR1971-000764	WCR	Kings	36.78676	-119.83549	13S	20E	19	Composite	Municipal/Public Supply	480	180	480	20		4,450		130.9		196,324	261,765	
WCR1972-000938	WCR	Kings	36.87415	-119.68379	12S	21E	21	Upper Aquifer	Domestic	105			8		175	3	11.7		17,500	23,333	
WCR1981-004178	WCR	Kings	36.83023	-119.74513	13S	20E	1	Composite	Municipal/Public Supply	510	265	500	20		2,400	2	38.1		57,143	76,190	
WCR1987-009286	WCR	Kings	36.77122	-120.19618	13S	16E	26	Composite	Agriculture/Irrigation	398	180	386	14		1,500	4	166.7		250,000	333,333	
WCR1990-013873	WCR	Kings	36.87415	-119.68379	12S	21E	21	Upper Aquifer	Domestic	130	90	130	6		100	24	50.0		75,000	100,000	
WCR1990-013943	WCR	Kings	36.74216	-120.21406	14S	16E	3	Upper Aquifer	Domestic	400	170	210	6		40	12	8.0		12,000	16,000	
WCR1991-012972	WCR	Kings	36.85936	-119.79285	12S	20E	28	Unknown	Municipal/Public Supply	296	127	237			1,000	24	5.8		8,671	11,561	
WCR1991-013437	WCR	Kings	36.84403	-119.90118	12S	19E	33	Upper Aquifer	Municipal/Public Supply	780	233	263	18		2,400	24	133.3		200,000	266,667	
WCR1991-013442	WCR	Kings	36.83007	-119.85341	13S	19E	1	Composite	Municipal/Public Supply	721	180	760	18		3,000	24	96.8		145,161	193,548	
WCR1992-010869	WCR	Kings	36.84467	-119.84737	12S	19E	36	Unknown	Domestic	756	180	650	18		2,000	12	76.9		115,385	153,846	
WCR1992-010931	WCR	Kings	36.91604	-119.75621	12S	20E	2	Unknown	Agriculture/Irrigation	270	160	250	12		300		15.8		23,684	31,579	
WCR1992-010944	WCR	Kings	36.87402	-119.7567	12S	20E	23	Unknown	Municipal/Public Supply	590	270	580	16		1,860	24	25.5		38,219	50,959	
WCR1992-011108	WCR	Kings	36.83	-119.8894	13S	19E	3	Upper Aquifer	Municipal/Public Supply	330	180	310	16		2,000	24	71.4		107,143	142,857	
WCR1992-011110	WCR	Kings	36.83024	-119.72709	13S	21E	6	Unknown	Municipal/Public Supply	545	200	525	18		2,050	8	82.0		123,000	164,000	
WCR1992-011114	WCR	Kings	36.85936	-119.79285	12S	20E	28	Unknown	Municipal/Public Supply	650	150	630	16		1,800	12	48.6		72,973	97,297	
WCR1992-011259	WCR	Kings	36.87415	-119.68379	12S	21E	21	Unknown	Domestic	250			6		1	3	0.0		38	50	
WCR1993-007753	WCR	Kings	36.87415	-119.68379	12S	21E	21	Upper Aquifer	Domestic	106	60	105	2		10	24	3.3		5,000	6,667	
WCR1994-007803	WCR	Kings	36.90351	-119.73847	12S	20E	12	Unknown	Municipal/Public Supply	380	220	270	12		250		13.2		19,737	26,316	
WCR1996-006368	WCR	Kings	36.90351	-119.73847	12S	20E	12	Upper Aquifer	Agriculture/Irrigation	380	160	270	10		350	18	2.4		3,571	4,762	
WCR1996-006623	WCR	Kings	36.83019	-119.76323	13S	20E	2	Upper Aquifer	Industrial	340	300	332	4		100	1	2.0		2,941	3,922	
WCR1997-007170	WCR	Kings	36.74216	-120.21406	14S	16E	3	Composite	Agriculture/Irrigation	387	230	368	16		300	2	75.0		112,500	150,000	
WCR1997-007186	WCR	Kings	36.81582	-119.74511	13S	20E	12	Upper Aquifer	Municipal/Public Supply	400			12		350	6	70.0		105,000	140,000	
WCR1997-007409	WCR	Kings	36.91604	-119.75621	12S	20E	2	Unknown	Agriculture/Irrigation	240	130	230	12		300	5	10.3		15,517	20,690	
WCR1997-007474	WCR	Kings	36.91604	-119.75621	12S	20E	2	Upper Aquifer	Agriculture/Irrigation	350					350		5.0		7,500	10,000	

Well_ID	Data Source	Subbasin	Latitude	Longitude	Town-ship	Range	Sec	Depth Zone	Well Type	Total Depth (ft)	Top of Perforations (ft)	Bottom of Perforations (ft)	Well Casing Diameter (in)	Test Date	Test Discharge rate (gpm)	Test Duration (hr)	Well Specific Capacity (gpm/ft)	Transmissivity from Aquifer Test (gpd/ft)	Transmissivity from Well Specific Capacity (x1500) (gpd/ft)	Transmissivity from Well Specific Capacity (x2000) (gpd/ft)	Note
WCR1998-006748	WCR	Kings	36.87415	-119.68379	12S	21E	21	Upper Aquifer	Domestic	140	80	144	6		60	3	1.5		2,250	3,000	
WCR2015-002696	WCR	Kings	36.812308	-119.939128	13S	19E	7	Unknown	Agriculture/Irrigation	550					1,400	4	29.8		44,681	59,574	
WCR0017470	WCR	Merced	37.10585	-120.46452	09S	14E	32	Lower Aquifer	Agriculture/Irrigation	420	200	410	14		2,250		70.3		105,469	140,625	
WCR0045723	WCR	Merced	37.17824	-120.39225	09S	14E	1	Lower Aquifer	Agriculture/Irrigation	1000	290	834	16		5,069	18	68.5		102,750	137,000	
WCR0106662	WCR	Merced	37.17828	-120.31982	09S	15E	3	Lower Aquifer	Agriculture/Irrigation	600	250	575	14		1,500	12	75.0		112,500	150,000	
WCR0113179	WCR	Merced	37.19241	-120.17121	08S	16E	36	Lower Aquifer	Agriculture/Irrigation	1110	485	1100	16		625	8	1.8		2,741	3,655	
WCR0125374	WCR	Merced	37.22133	-120.22538	08S	16E	21	Lower Aquifer	Agriculture/Irrigation	910	439	890	16		200	2	0.9		1,415	1,887	
WCR0146944	WCR	Merced	37.13469	-120.46445	09S	14E	20	Lower Aquifer	Agriculture/Irrigation	1370	546	1206	10		3,375	31	135.0		202,500	270,000	
WCR0148517	WCR	Merced	37.09107	-120.51943	10S	13E	2	Upper Aquifer	Agriculture/Irrigation	200	114	167	16		3,575		74.5		111,719	148,958	
WCR0163697	WCR	Merced	37.17847	-120.48281	09S	14E	6	Lower Aquifer	Agriculture/Irrigation	603	315	603	12		1,447		11.0		16,569	22,092	
WCR0175115	WCR	Merced	37.217361	-120.313722	08S	15E	22	Lower Aquifer	Agriculture/Irrigation	976	400	976	16		4,000	10	333.3		500,000	666,667	
WCR0176913	WCR	Merced	37.23575	-120.26163	08S	16E	18	Lower Aquifer	Municipal/Public Supply	630	234	620			1,000	8	16.9		25,424	33,898	
WCR0179332	WCR	Merced	37.19265	-120.40674	08S	14E	35	Lower Aquifer	Agriculture/Irrigation		200	560	16		3,720	33	36.1		54,175	72,233	
WCR0191401	WCR	Merced	37.17851	-120.50093	09S	13E	1	Lower Aquifer	Agriculture/Irrigation	350	170	350	14		1,576		43.8		65,667	87,556	
WCR0223494	WCR	Merced	37.207222	-120.31375	08S	15E	22	Lower Aquifer	Agriculture/Irrigation	970	300	970	33		4,000	10	43.0		64,516	86,022	
WCR0227106	WCR	Merced	37.213611	-120.143333	08S	17E	29	Lower Aquifer	Agriculture/Irrigation	798	440	741			95	4	0.4		620	826	
WCR0232247	WCR	Merced	37.25106	-120.35227	08S	15E	8	Lower Aquifer	Agriculture/Irrigation	420	125	235	14		7,210	12	68.0		102,028	136,038	
WCR0247156	WCR	Merced	37.07641	-120.5194	10S	13E	11	Upper Aquifer	Agriculture/Irrigation				16		3,410	28	29.9		44,868	59,825	
WCR0251024	WCR	Merced	37.17825	-120.42847	09S	14E	3	Lower Aquifer	Agriculture/Irrigation	980	292	976	16		4,500	35	62.9		94,406	125,874	
WCR0251025	WCR	Merced	37.17825	-120.42847	09S	14E	3	Lower Aquifer	Agriculture/Irrigation	960	250	956	16		4,100	38	36.0		53,947	71,930	
WCR0270195	WCR	Merced	37.193055	-120.198055	08S	16E	35	Lower Aquifer	Agriculture/Irrigation	1370	320	1360			1,500	9	7.3		10,976	14,634	
WCR0305964	WCR	Merced	37.17851	-120.50093	09S	13E	1	Lower Aquifer	Agriculture/Irrigation	1220	300	1146	16		3,600	18	69.2		103,846	138,462	
WCR0305966	WCR	Merced	37.17851	-120.50093	09S	13E	1	Lower Aquifer	Agriculture/Irrigation	460	172	460	12		2,692		45.6		68,441	91,254	
WCR0323958	WCR	Merced	37.20676	-120.44292	08S	14E	28	Lower Aquifer	Agriculture/Irrigation	600	150	590	18		3,000	32	34.5		51,724	68,966	
WCR2016-006810	WCR	Merced	37.216686	-120.4298	08S	14E	22	Lower Aquifer	Domestic	640					400	3	10.4		15,666	20,888	
WCR2016-006812	WCR	Merced	37.214326	-120.420615	08S	14E	27	Lower Aquifer	Agriculture/Irrigation	790					3,300	2	21.8		32,716	43,622	

2.E. Current and Historical Groundwater Conditions

2.E.a. Existing and Historical Groundwater Monitoring Programs/Groundwater Elevation Contour Maps

2.E.b. Groundwater Elevation Hydrographs

2.E.c. Groundwater Quality Maps

APPENDIX 2.E. CURRENT AND HISTORICAL GROUNDWATER CONDITIONS

2.E.a. Existing and Historical Groundwater Monitoring Programs/Groundwater Elevation Contour Maps

Prepared as part of the

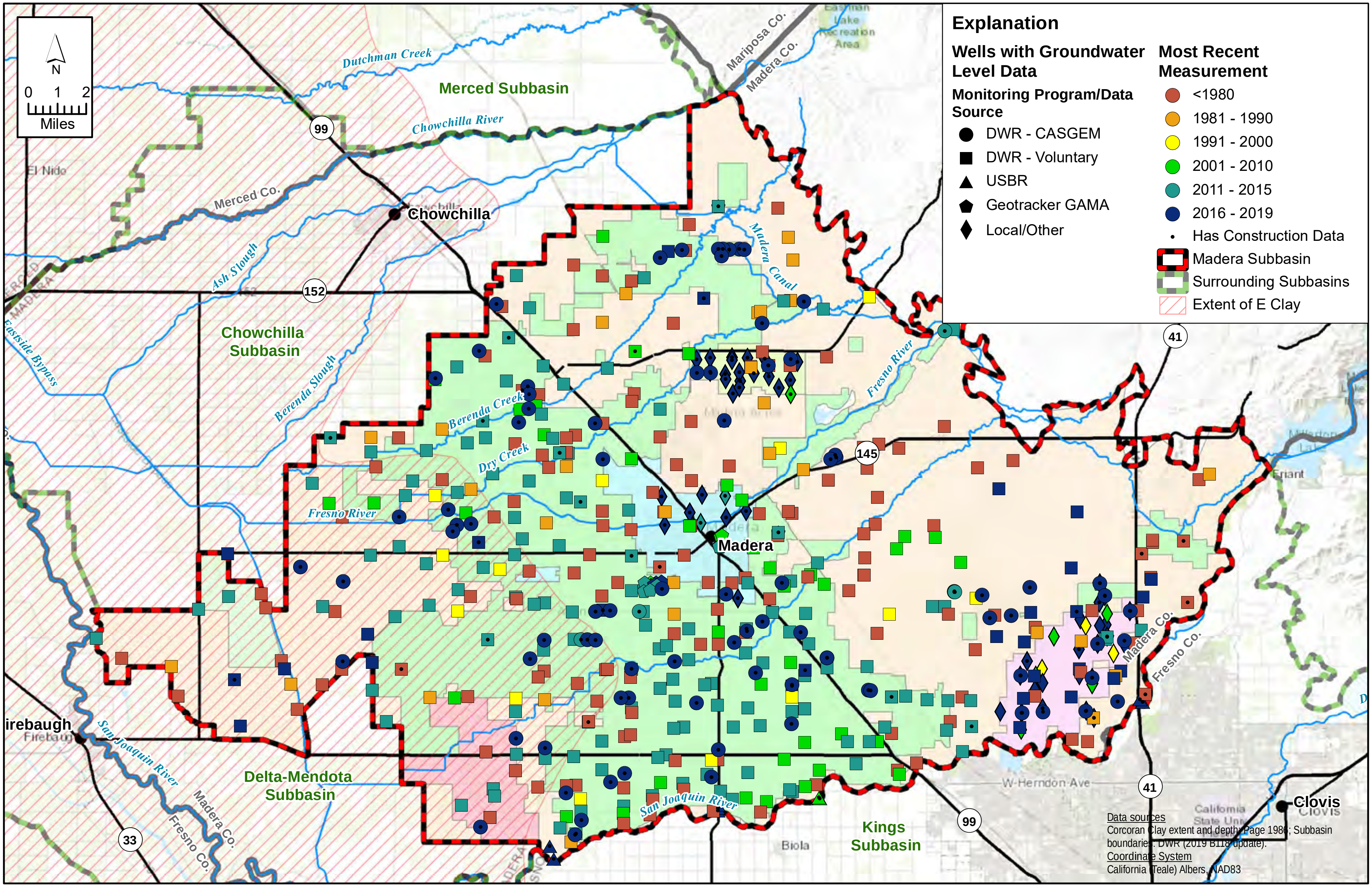
Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

GSP Team:

Davids Engineering, Inc
Luhdorff & Scalmanini
ERA Economics
Stillwater Sciences and
California State University, Sacramento

Existing and Historical Groundwater Monitoring Programs



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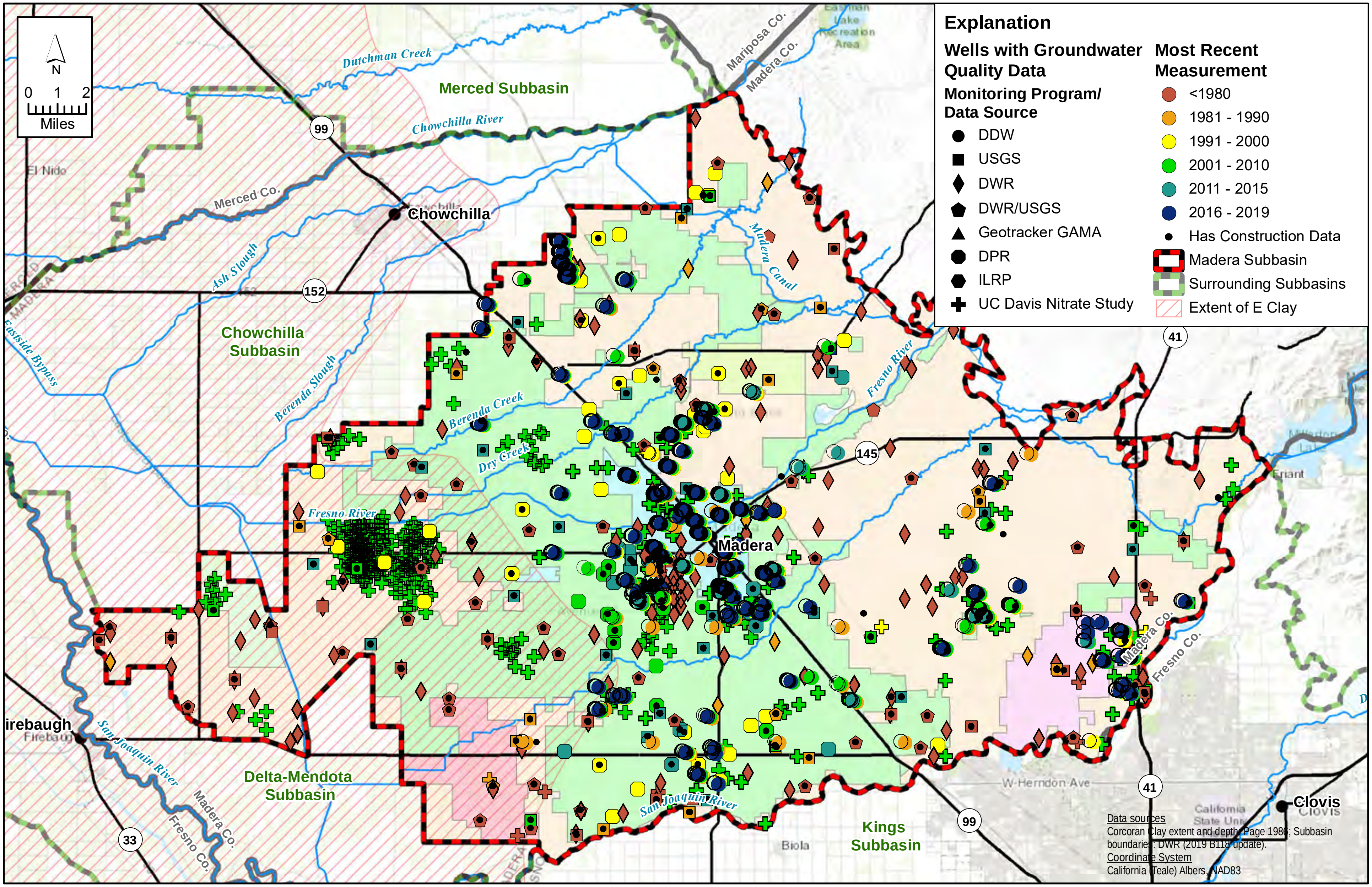
DAVIDS ENGINEERING, INC

Luhdorff & Scalmanini Consulting Engineers

APPENDIX 2.E
Existing and Historical Groundwater Level Monitoring Programs



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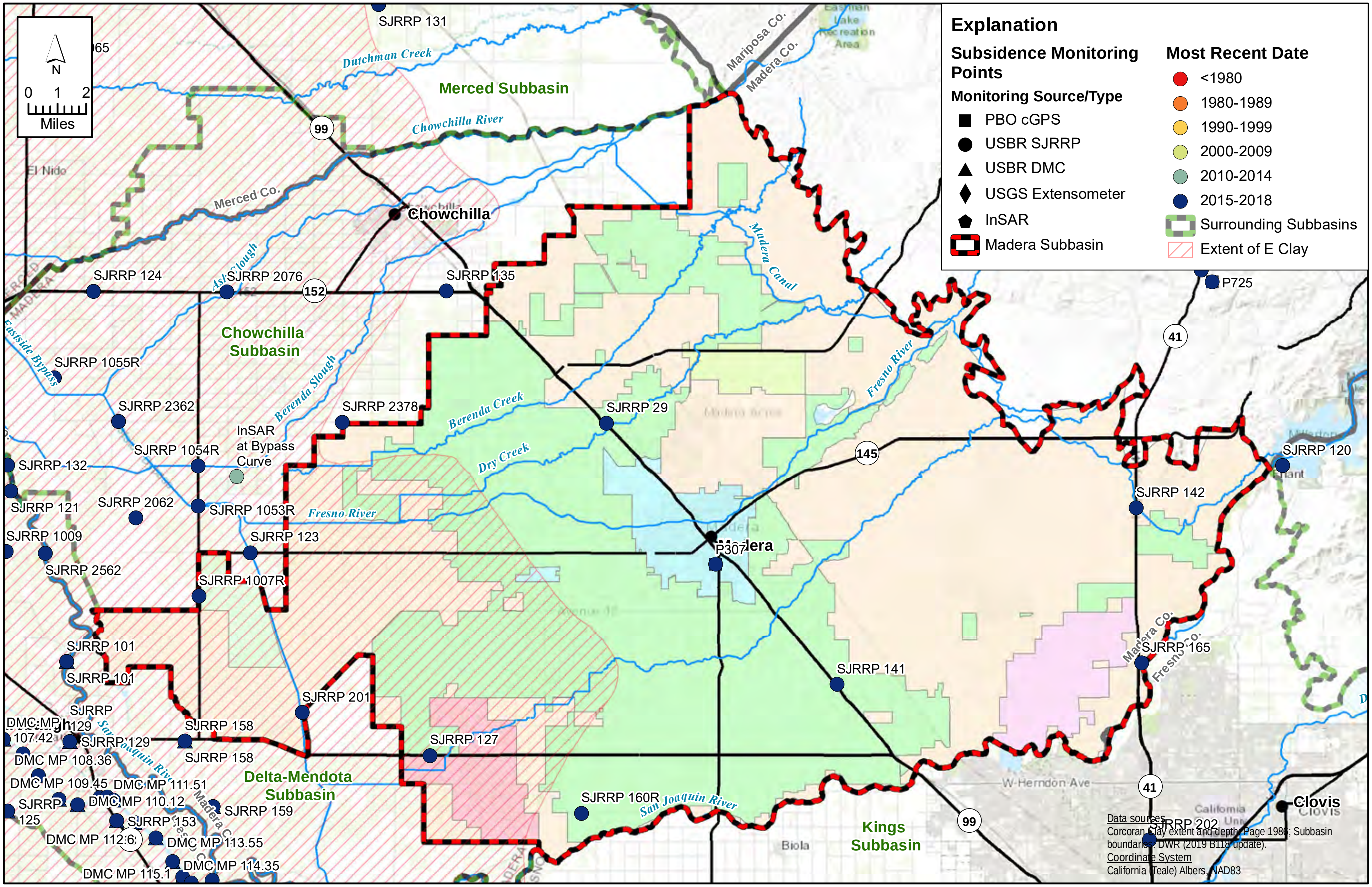
APPENDIX 2.E
Existing and Historical Groundwater Quality Monitoring Programs



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DAVIDS ENGINEERING, INC

Luhdorff & Scalmanini Consulting Engineers

APPENDIX 2.E

Existing and Historical Land Subsidence Monitoring

Madera Subbasin Groundwater Sustainability Plan

Groundwater Elevation

Contour Maps

Base from map prepared by W. C. Mendenhall. Corrected from U.S.G.S. topographic atlas sheets

MAP OF SAN JOAQUIN VALLEY, CALIFORNIA

SHOWING ARTESIAN AREAS, GROUND-WATER LEVELS AND LOCATION OF PUMPING PLANTS

Artesian areas and ground-water levels by W. C. Mendenhall. Pumping plants by Herman Stabler

Scale 500,000

5 0 5 10 15 20 Miles

10 0 10 20 Kilometers

1915

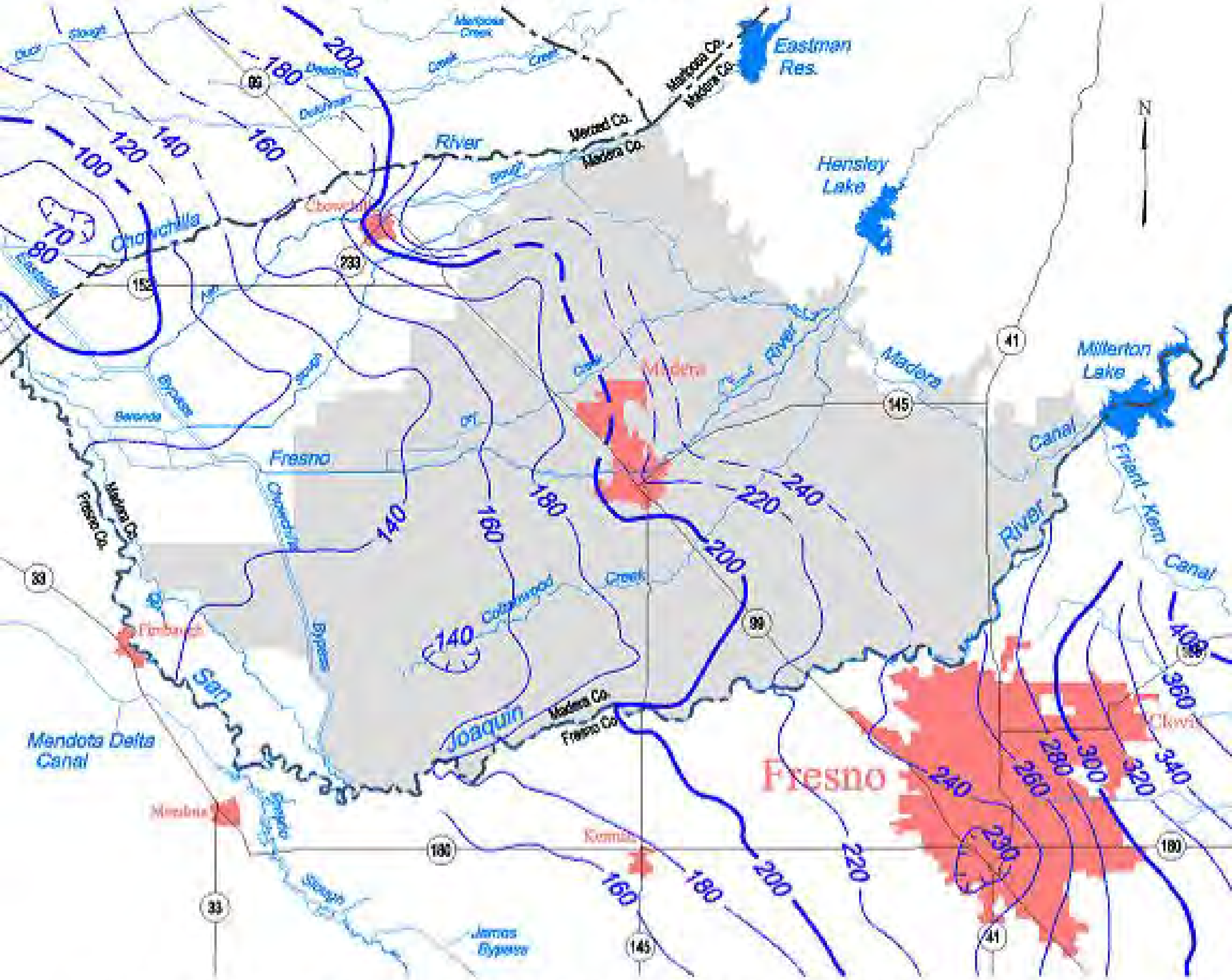
A2.E.a-6

Madera Groundwater Basin

Spring 1958, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer

Scale of Miles
2 0 2 4 6 8

Disclaimer: Base map created from current USGS 1:24,000 and 1:100,000 maps. Some base map features may not have been present (i.e. roads, canals, reservoirs) for the water year shown.



Contours are dashed where inferred. Contour interval is 10, 20 and 40 feet.

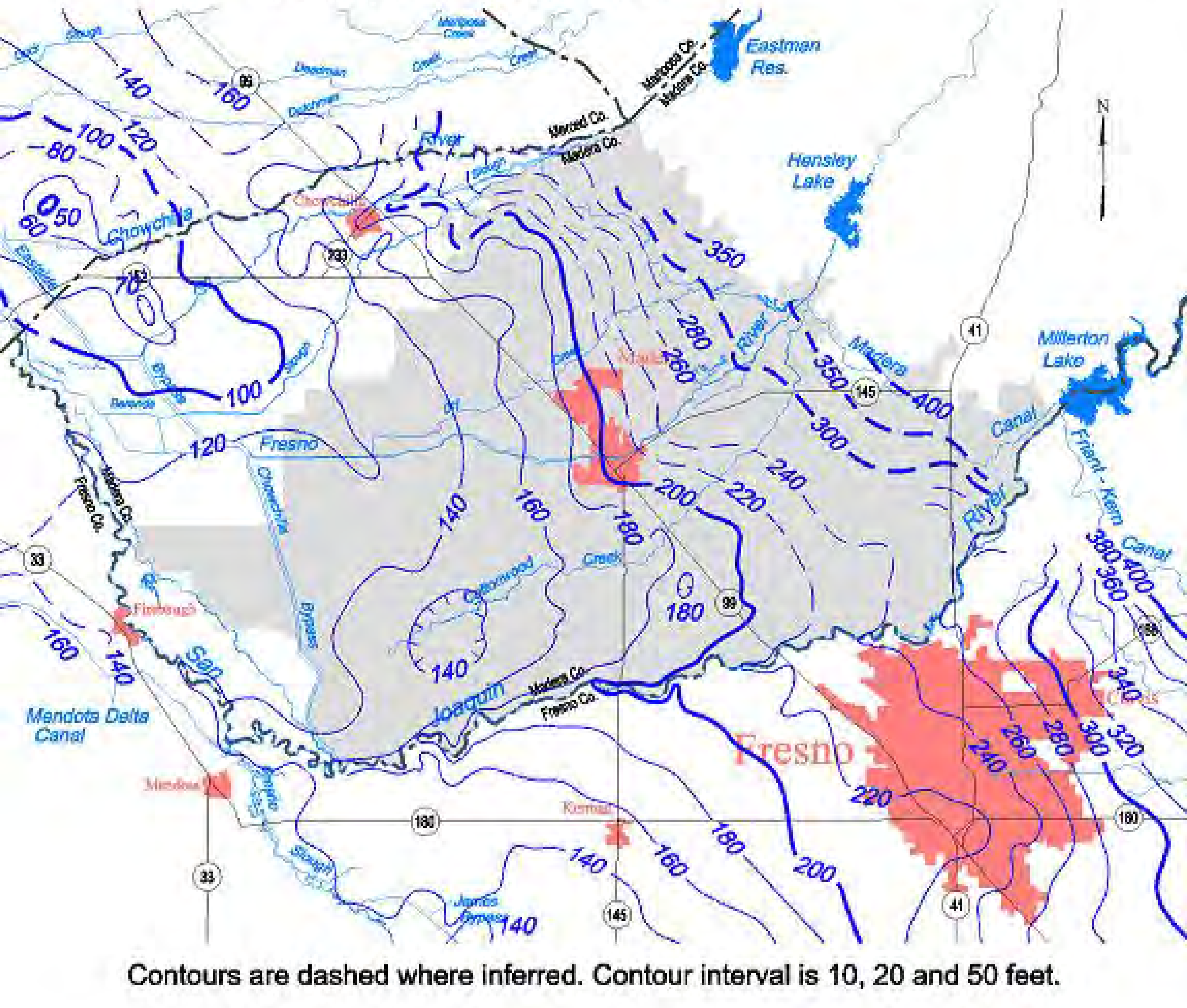
Madera Groundwater Basin

Spring 1962, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer

Scale of Miles

2 0 2 4 6 8

Disclaimer: Base map created from current USGS 1:24,000 and 1:100,000 maps. Some base map features may not have been present (i.e. roads, canals, reservoirs) for the water year shown.



Contours are dashed where inferred. Contour interval is 10, 20 and 50 feet.

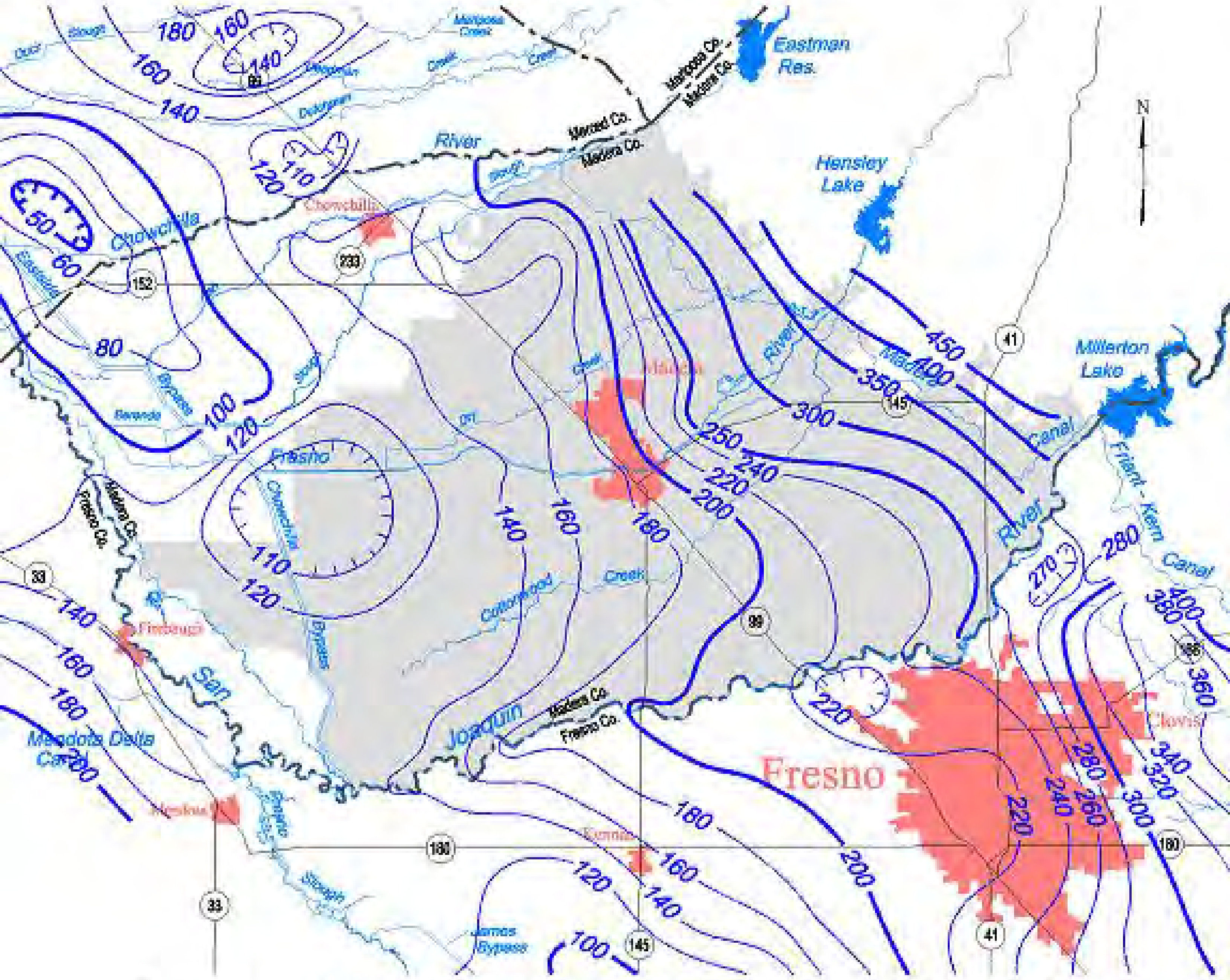
Madera Groundwater Basin

Spring 1969, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer

Scale of Miles

2 0 2 4 6 8

Disclaimer: Base map created from current USGS 1:24,000 and 1:100,000 maps. Some base map features may not have been present (i.e. roads, canals, reservoirs) for the water year shown.



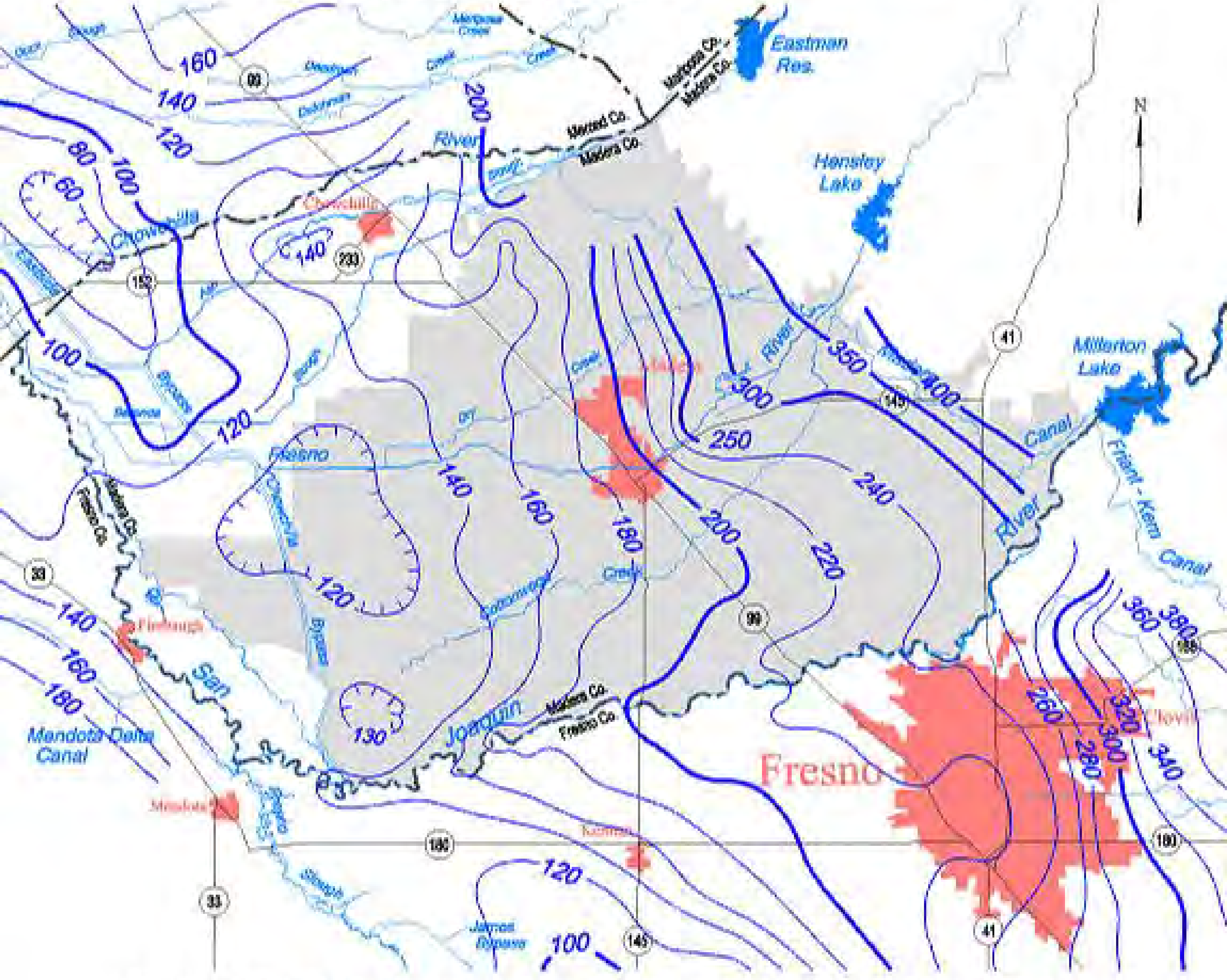
Contours are dashed where inferred. Contour interval is 10, 20 and 50 feet.

Madera Groundwater Basin

Spring 1970, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer

Scale of Miles
2 0 2 4 6 8

Disclaimer: Base map created from current USGS 1:24,000 and 1:100,000 maps. Some base map features may not have been present (i.e. roads, canals, reservoirs) for the water year shown.



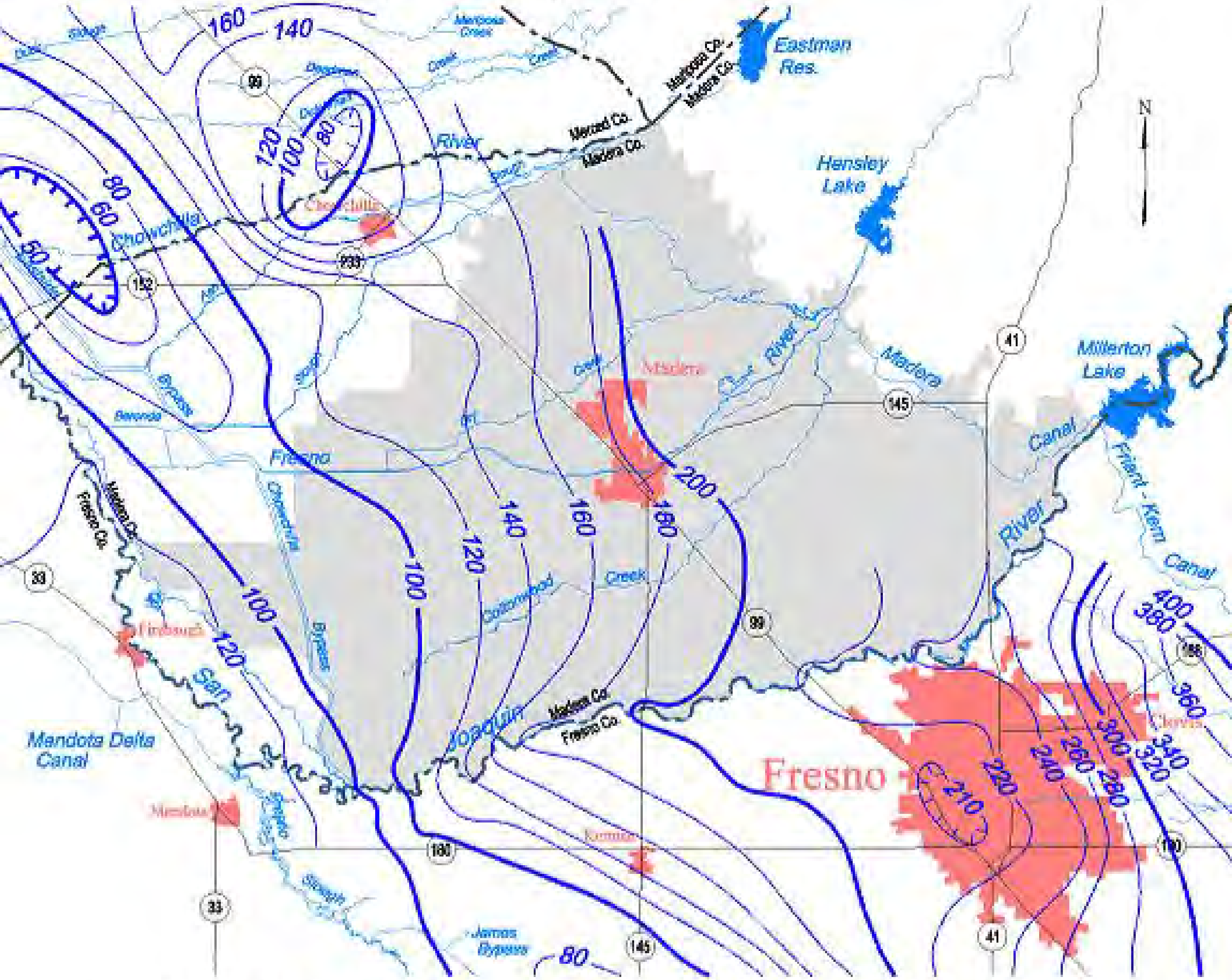
Contours are dashed where inferred. Contour interval is 10, 20 and 50 feet.

Madera Groundwater Basin

Spring 1976, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer

Scale of Miles
2 0 2 4 6 8

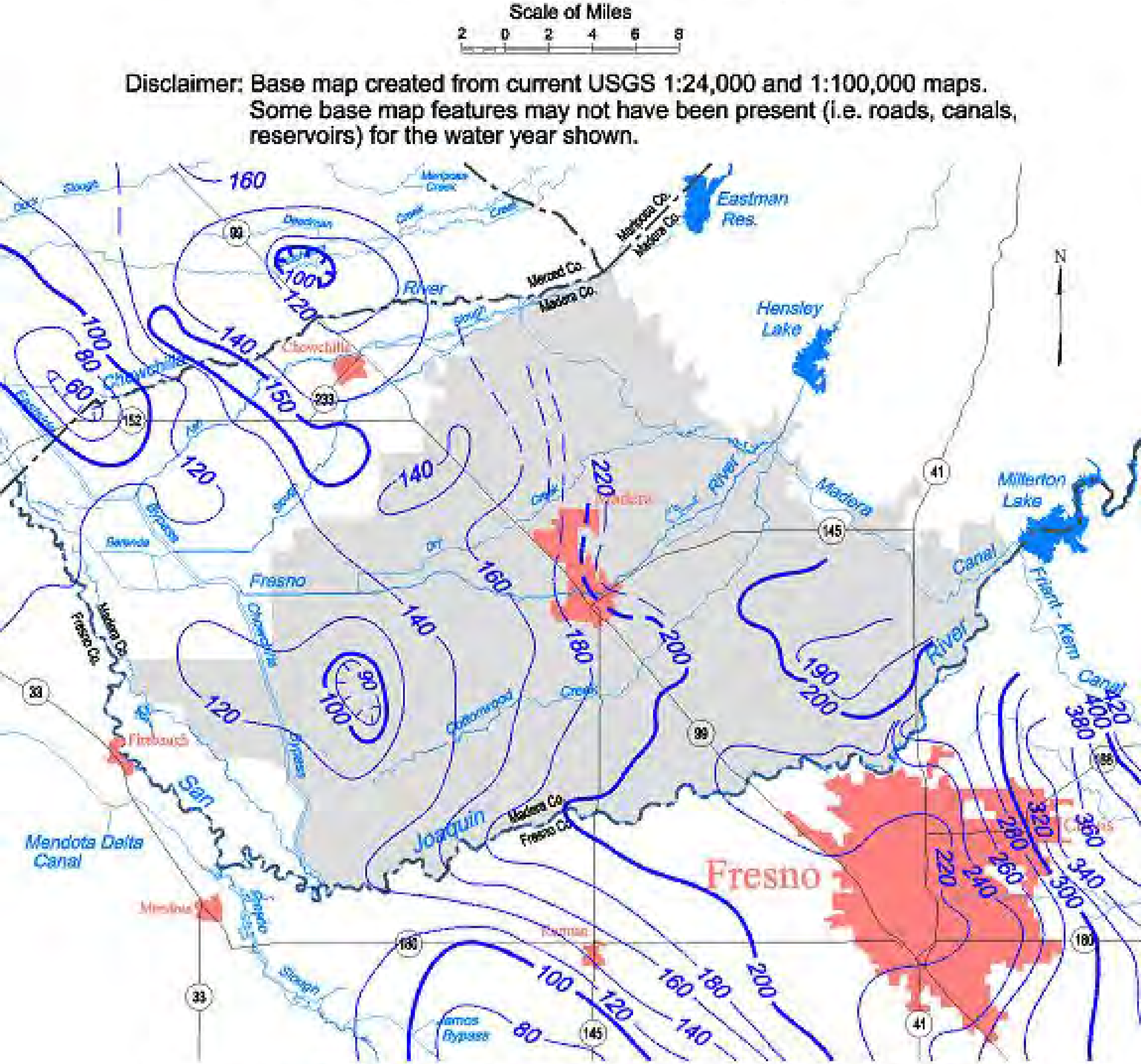
Disclaimer: Base map created from current USGS 1:24,000 and 1:100,000 maps. Some base map features may not have been present (i.e. roads, canals, reservoirs) for the water year shown.



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

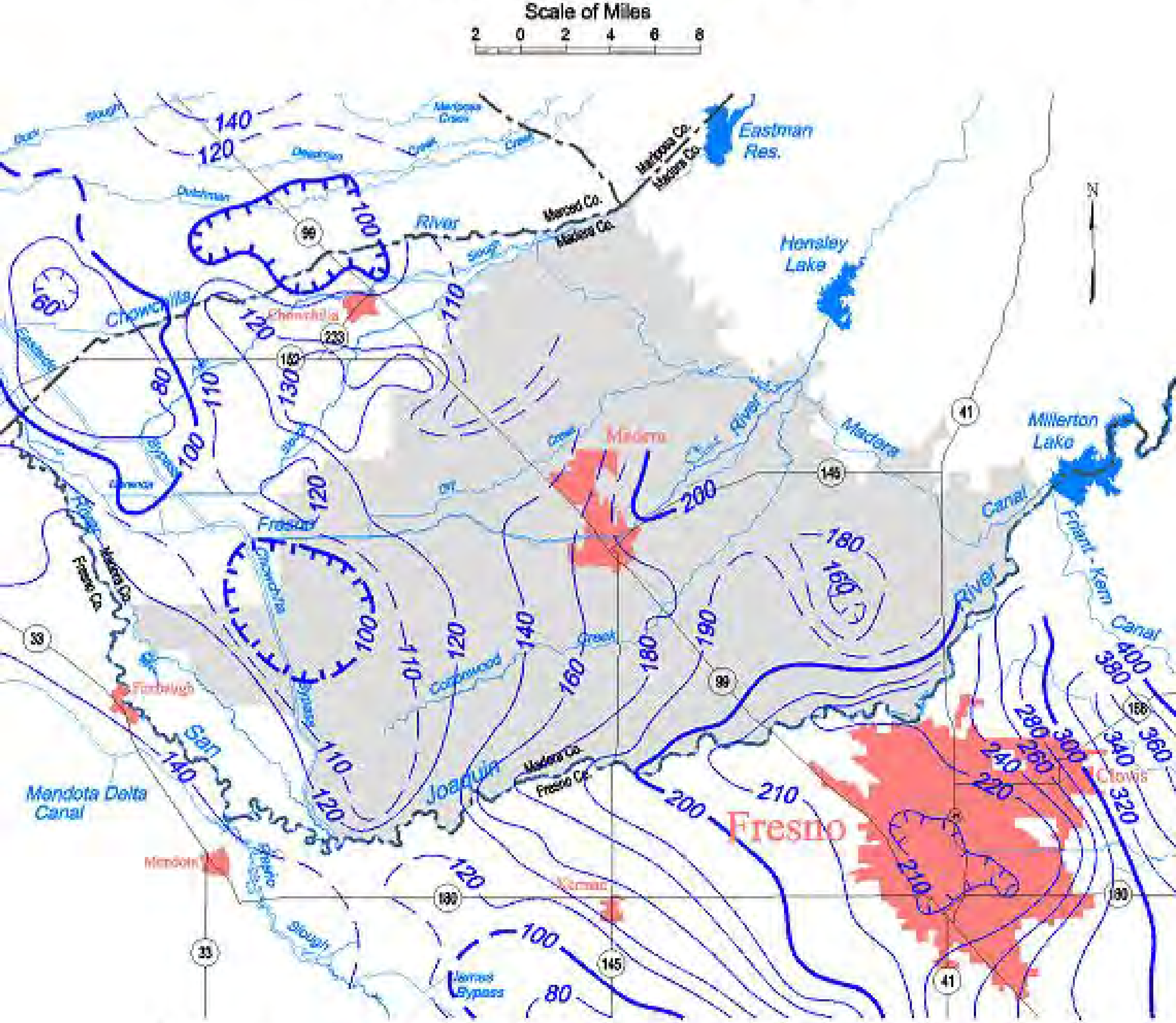
Spring 1984, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

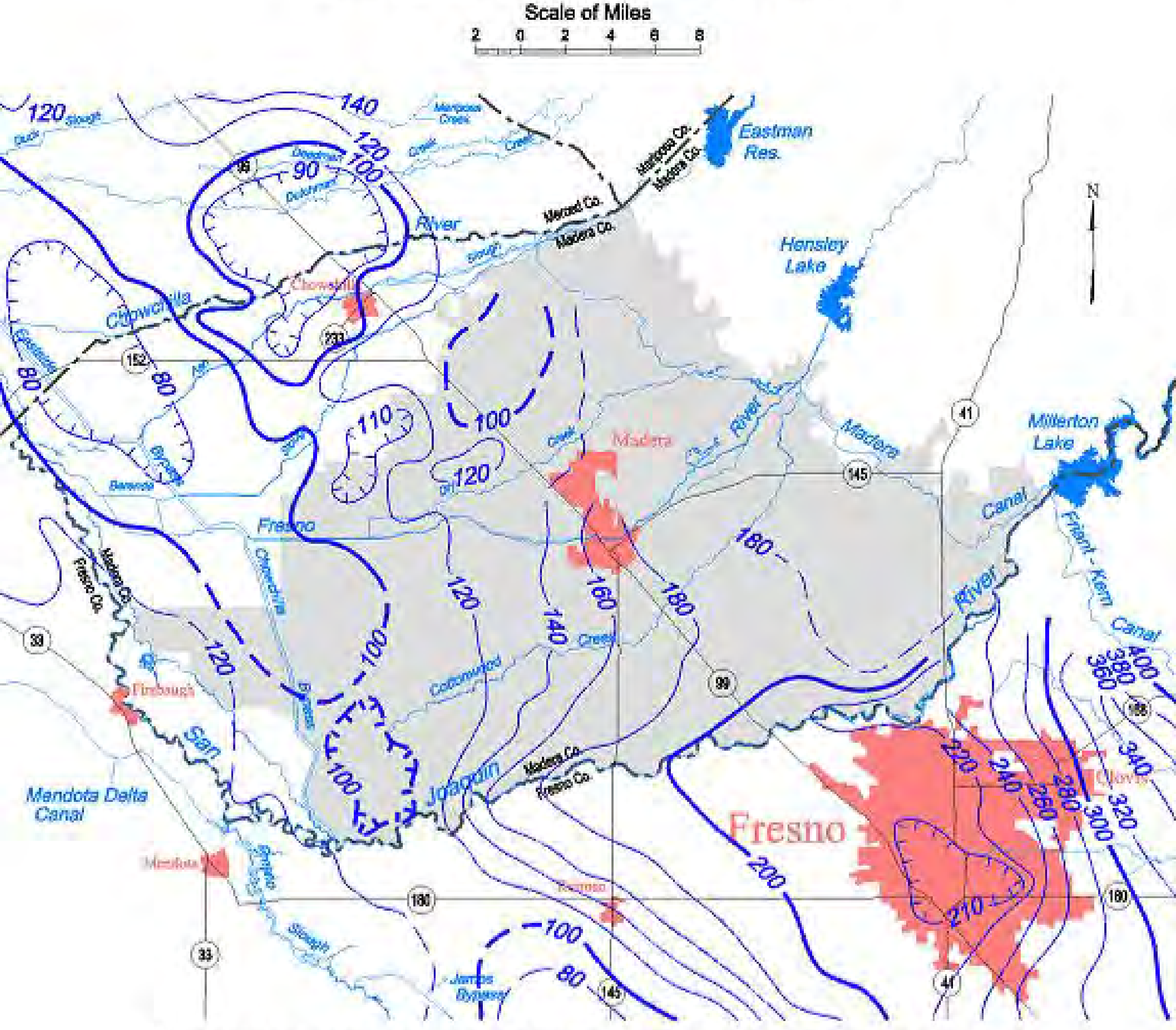
Spring 1989, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

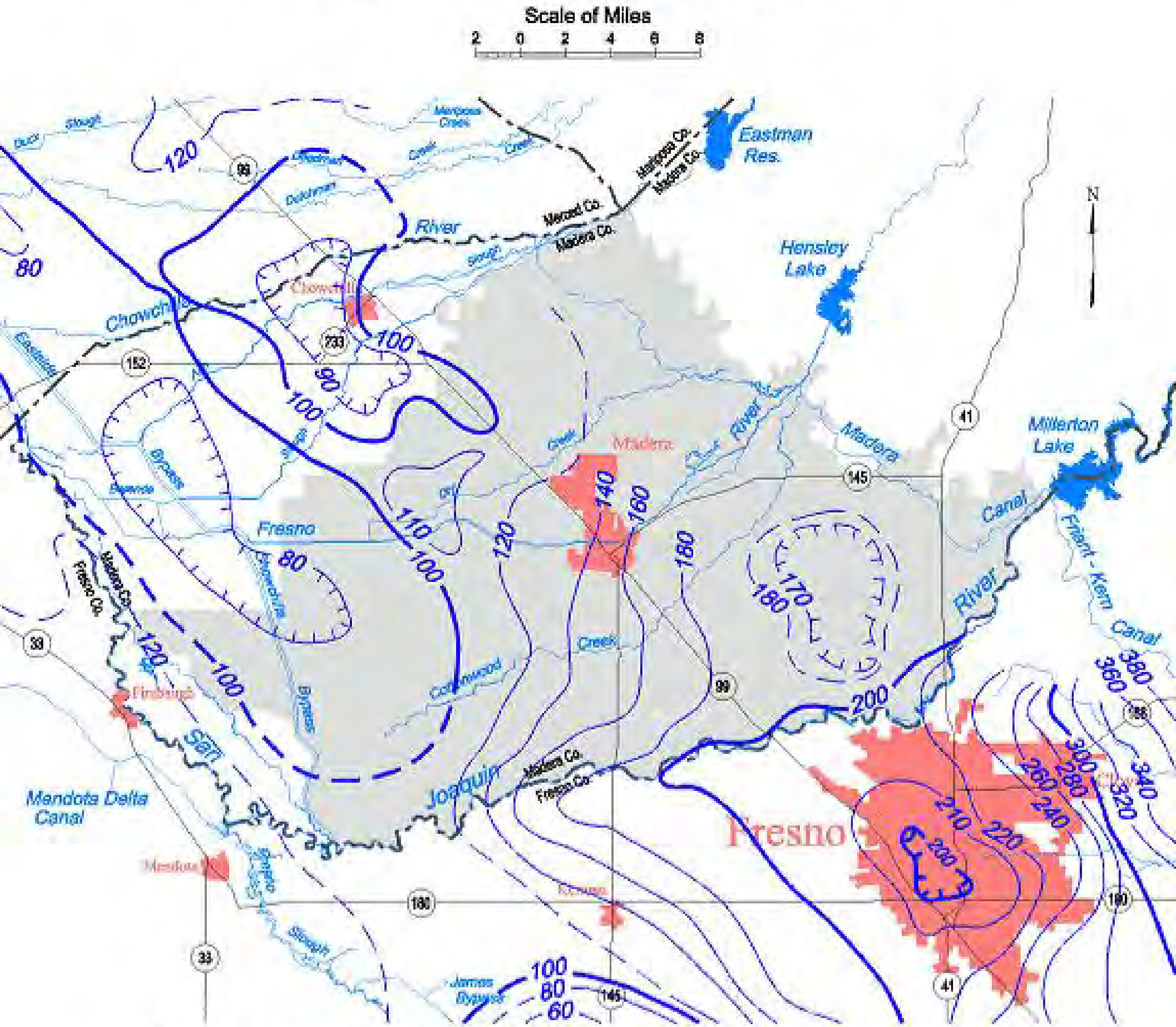
Spring 1990, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

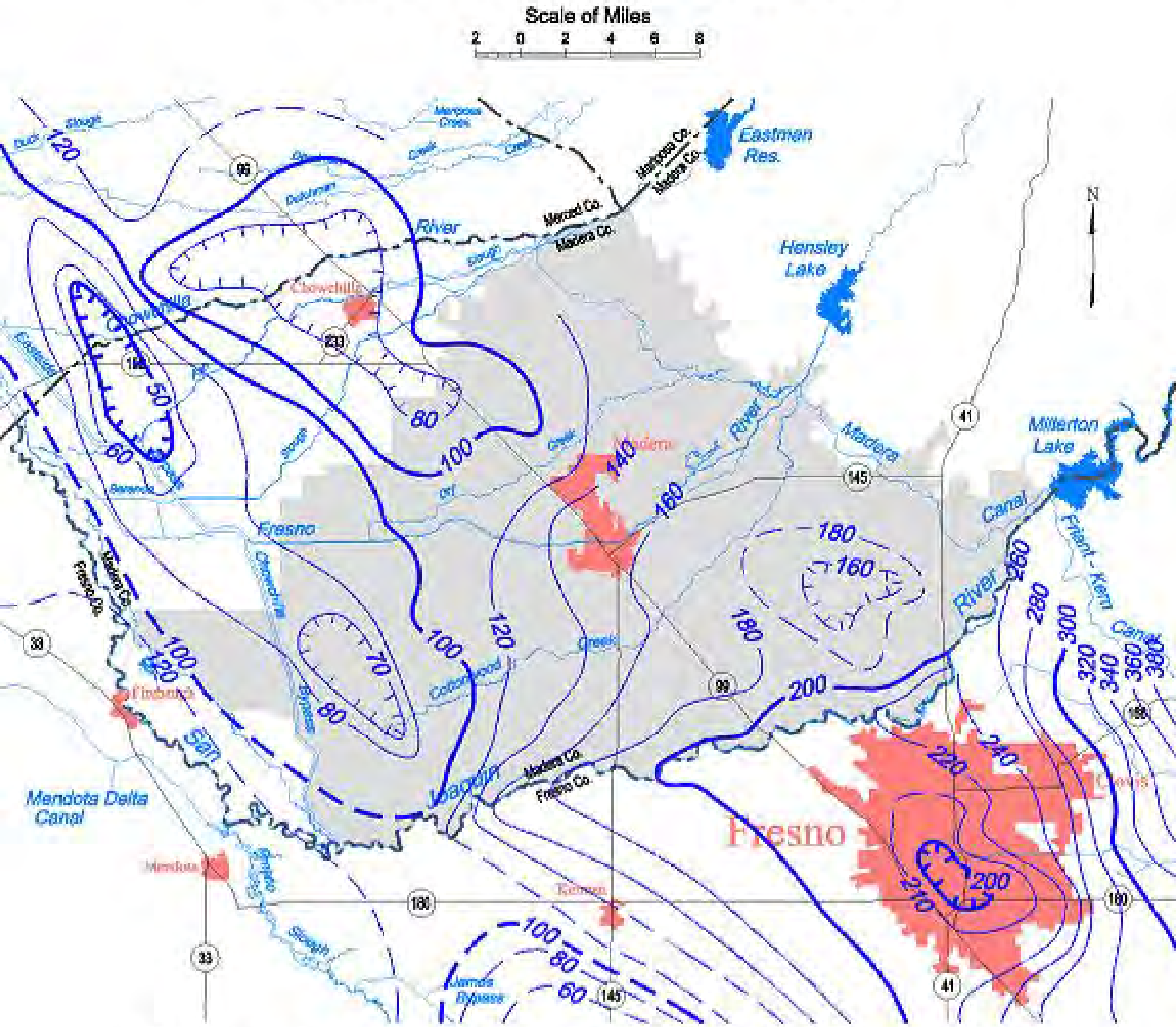
Spring 1991, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

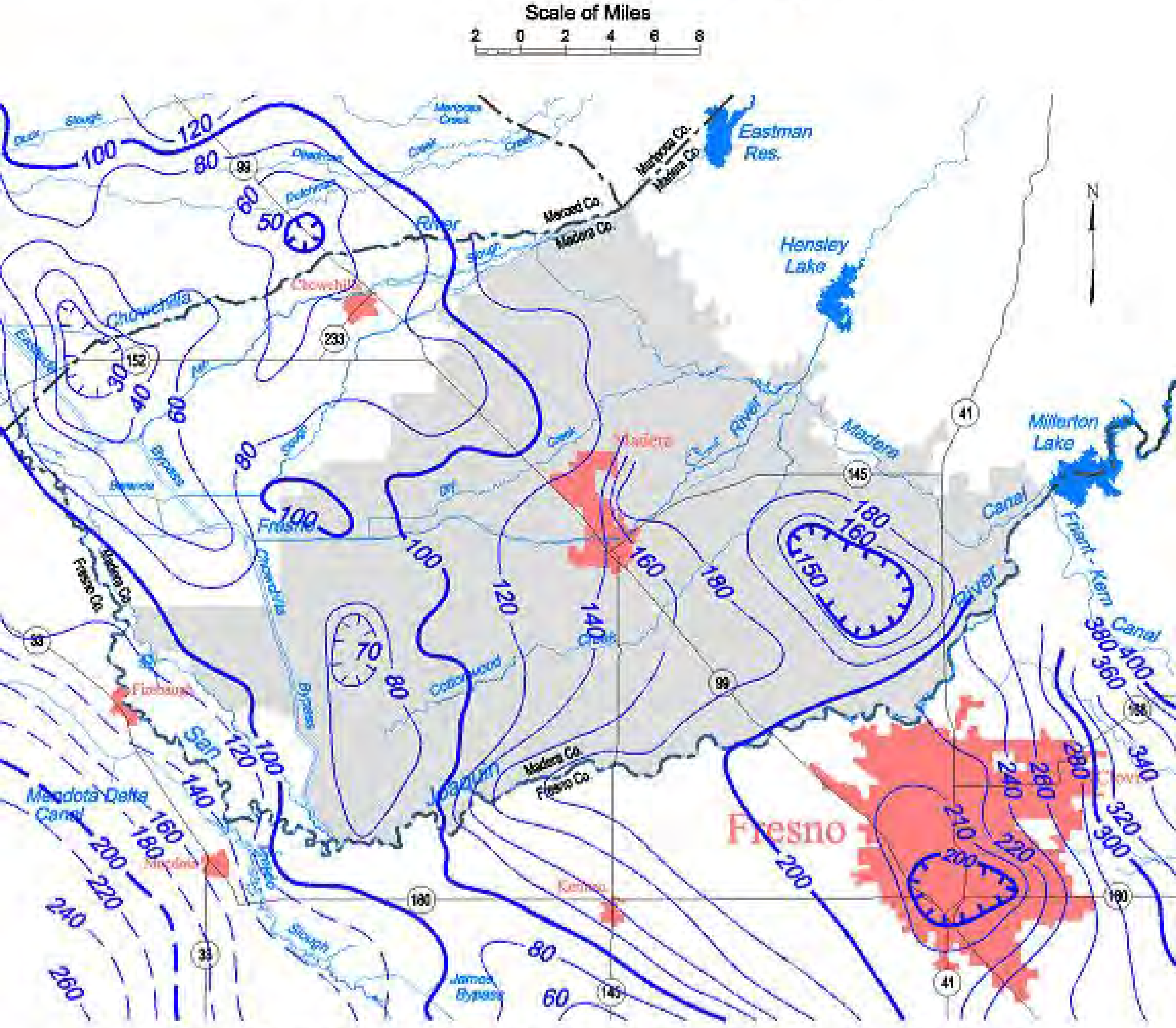
Spring 1992, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

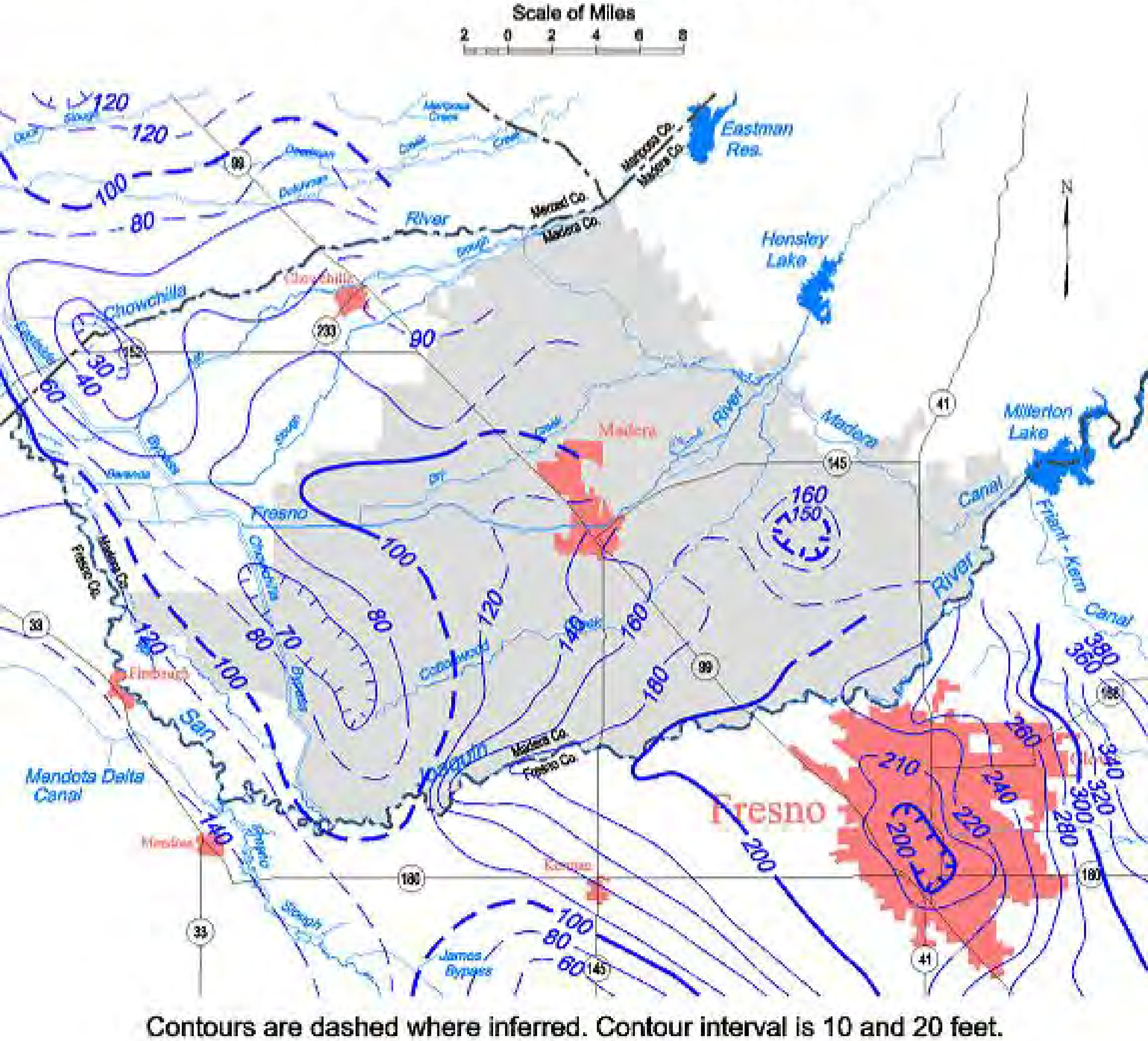
Spring 1993, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

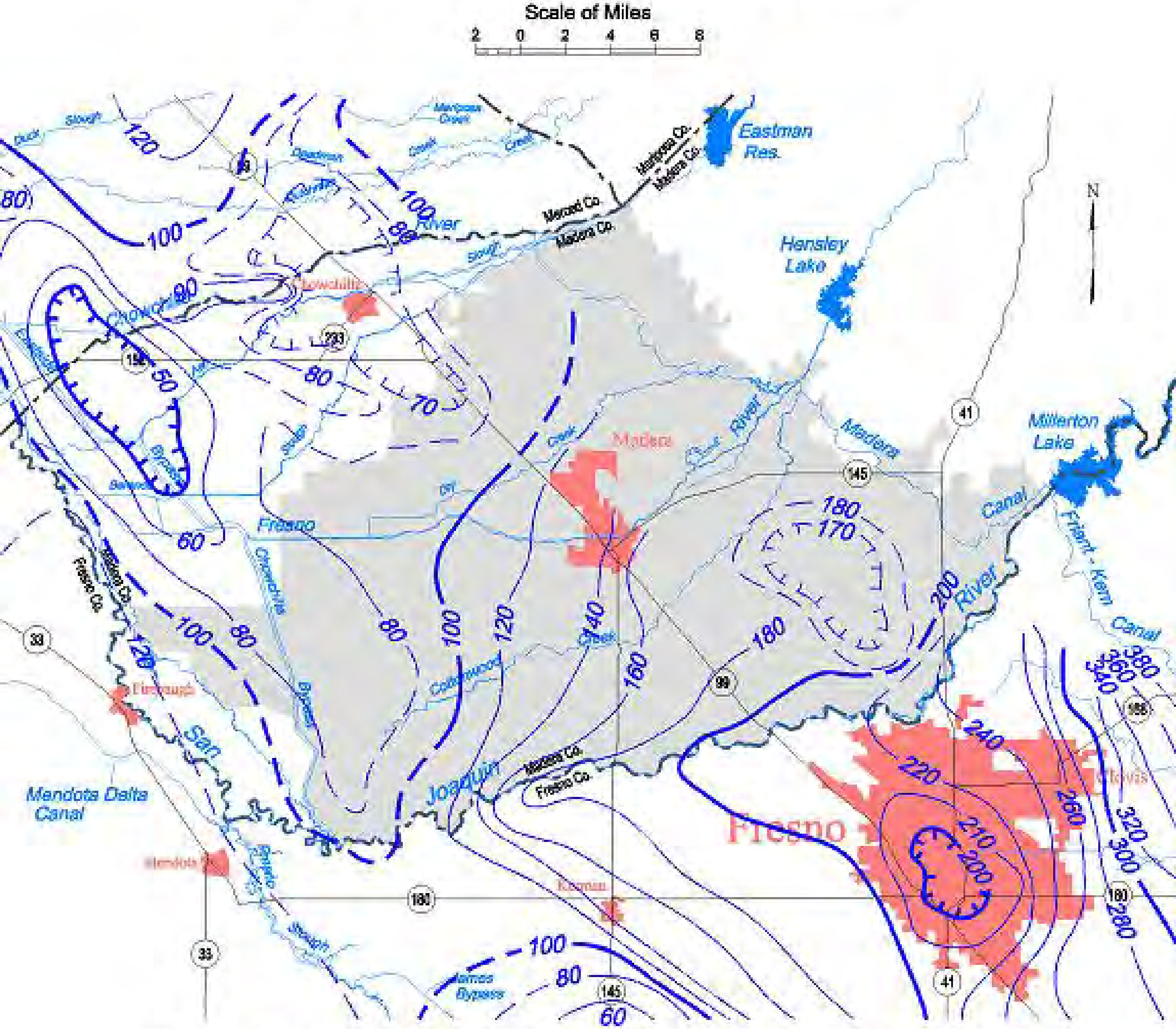
Madera Groundwater Basin

Spring 1994, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Madera Groundwater Basin

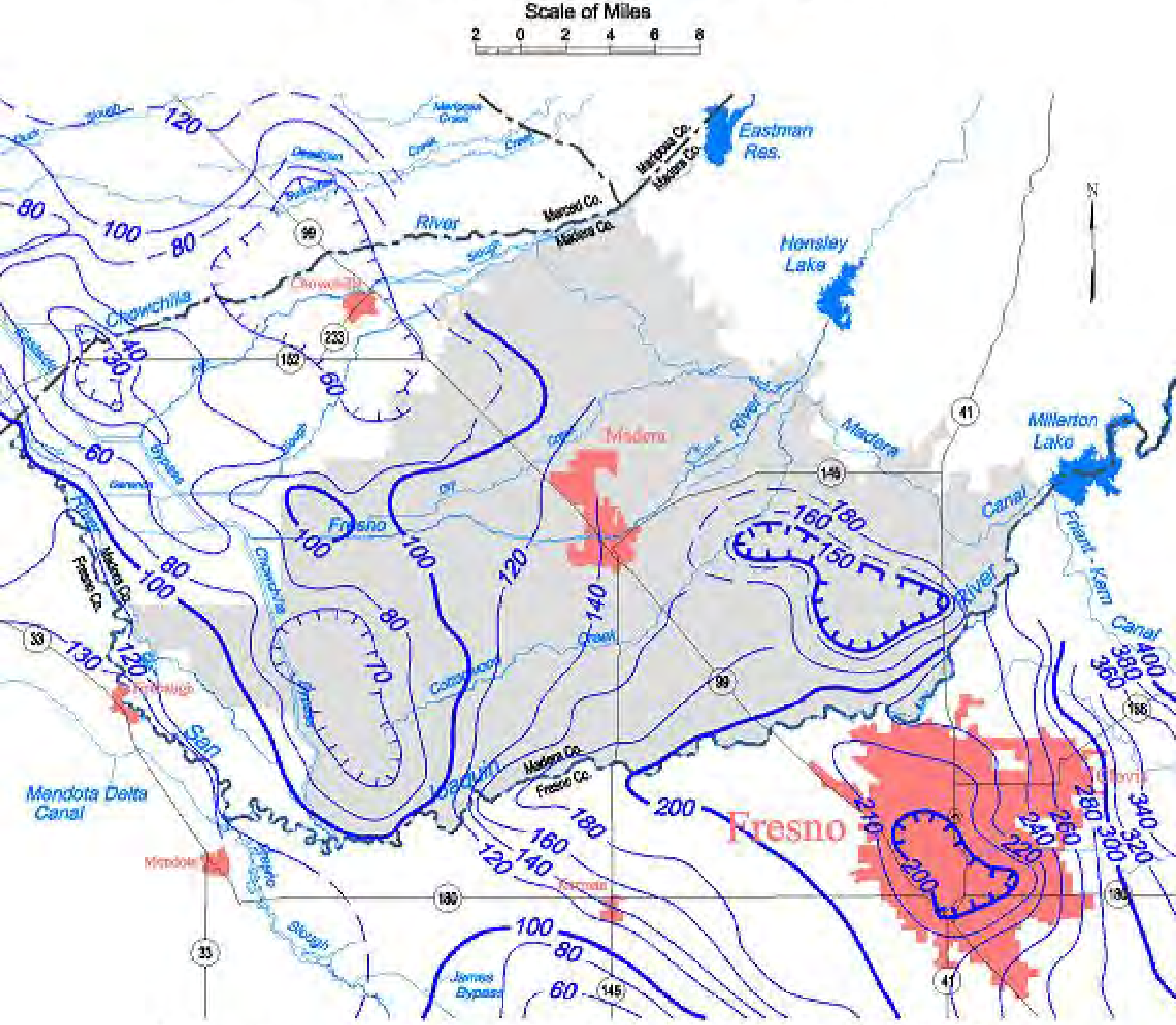
Spring 1995, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

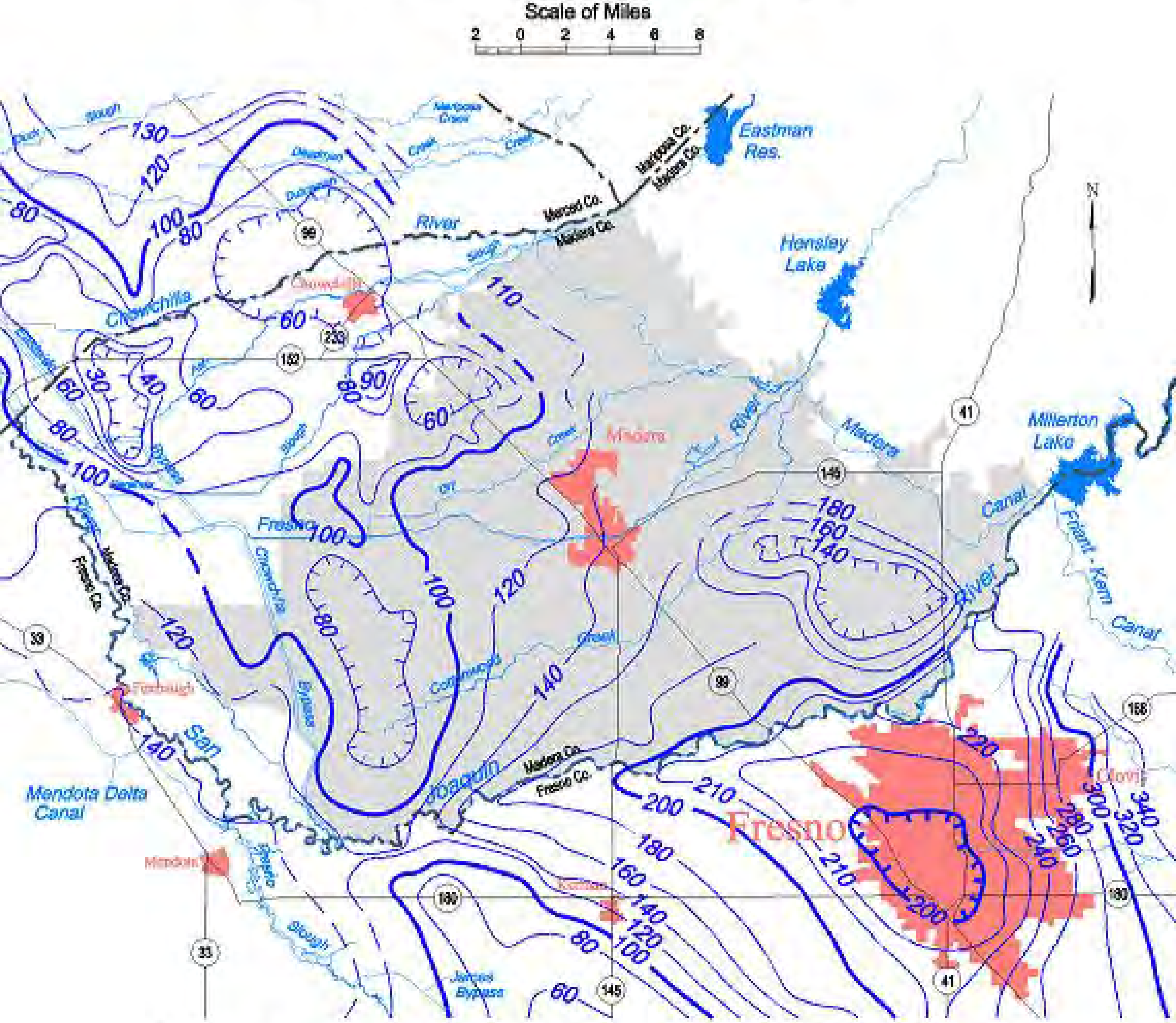
Spring 1996, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

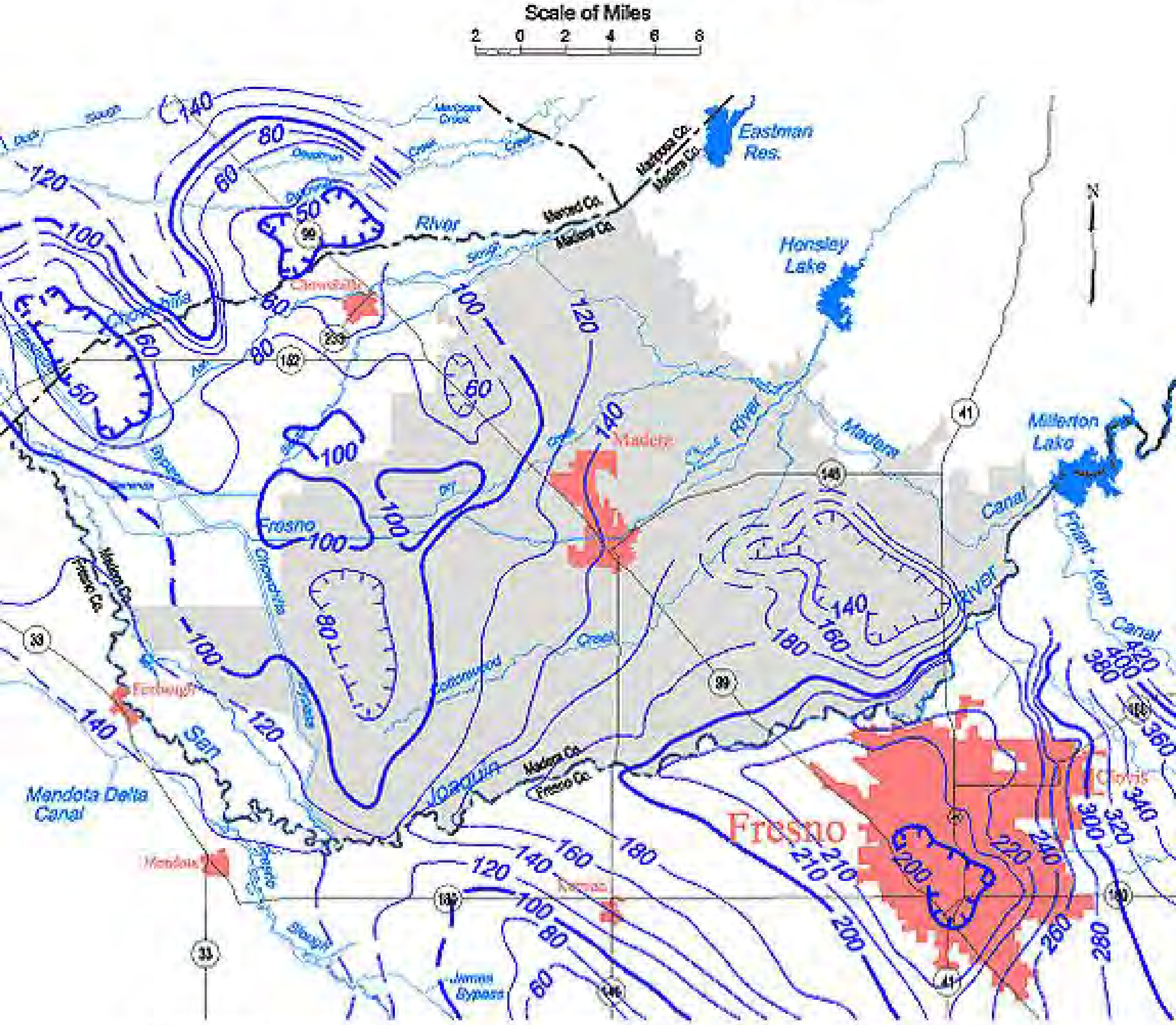
Spring 1997, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

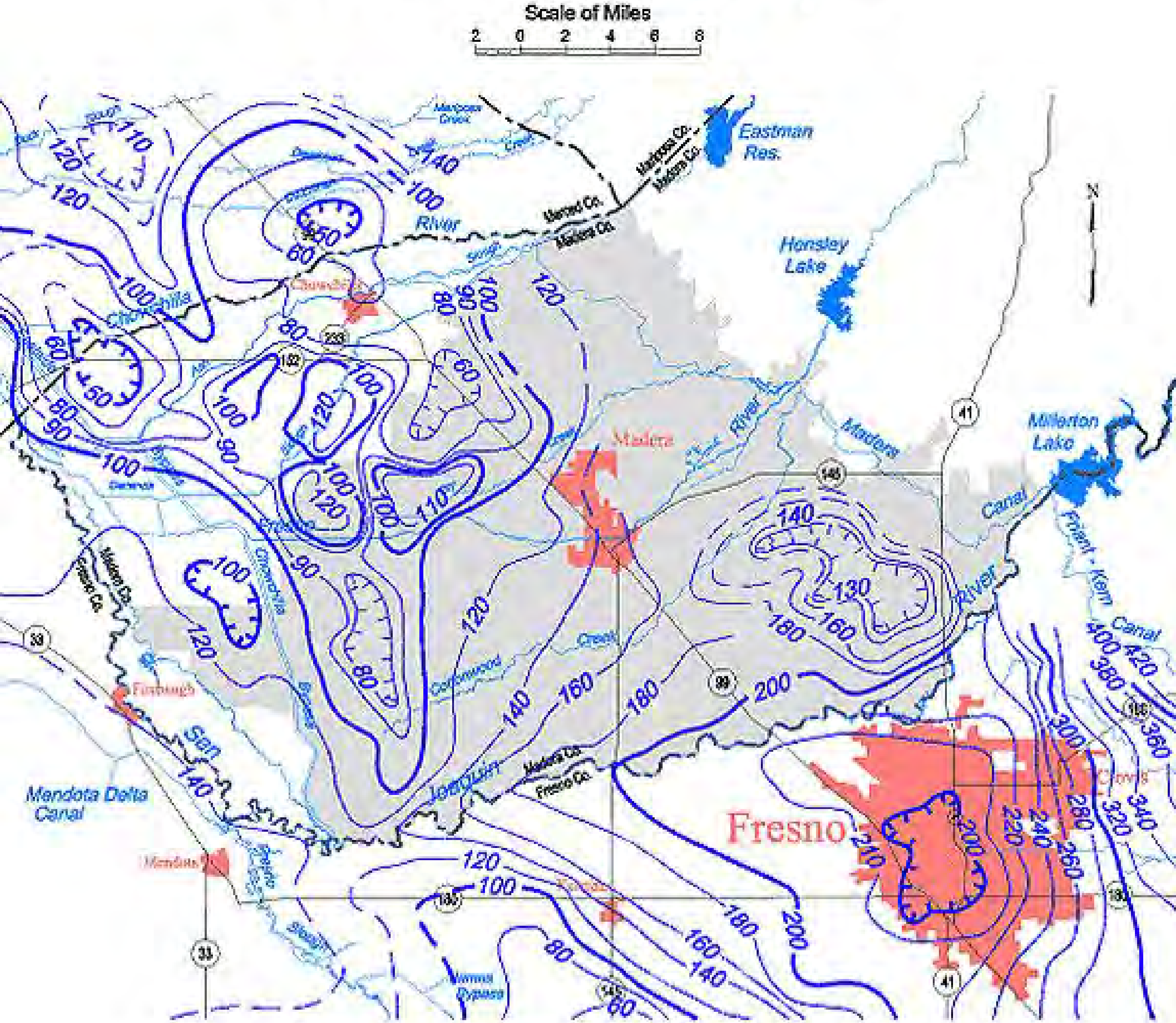
Spring 1998, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

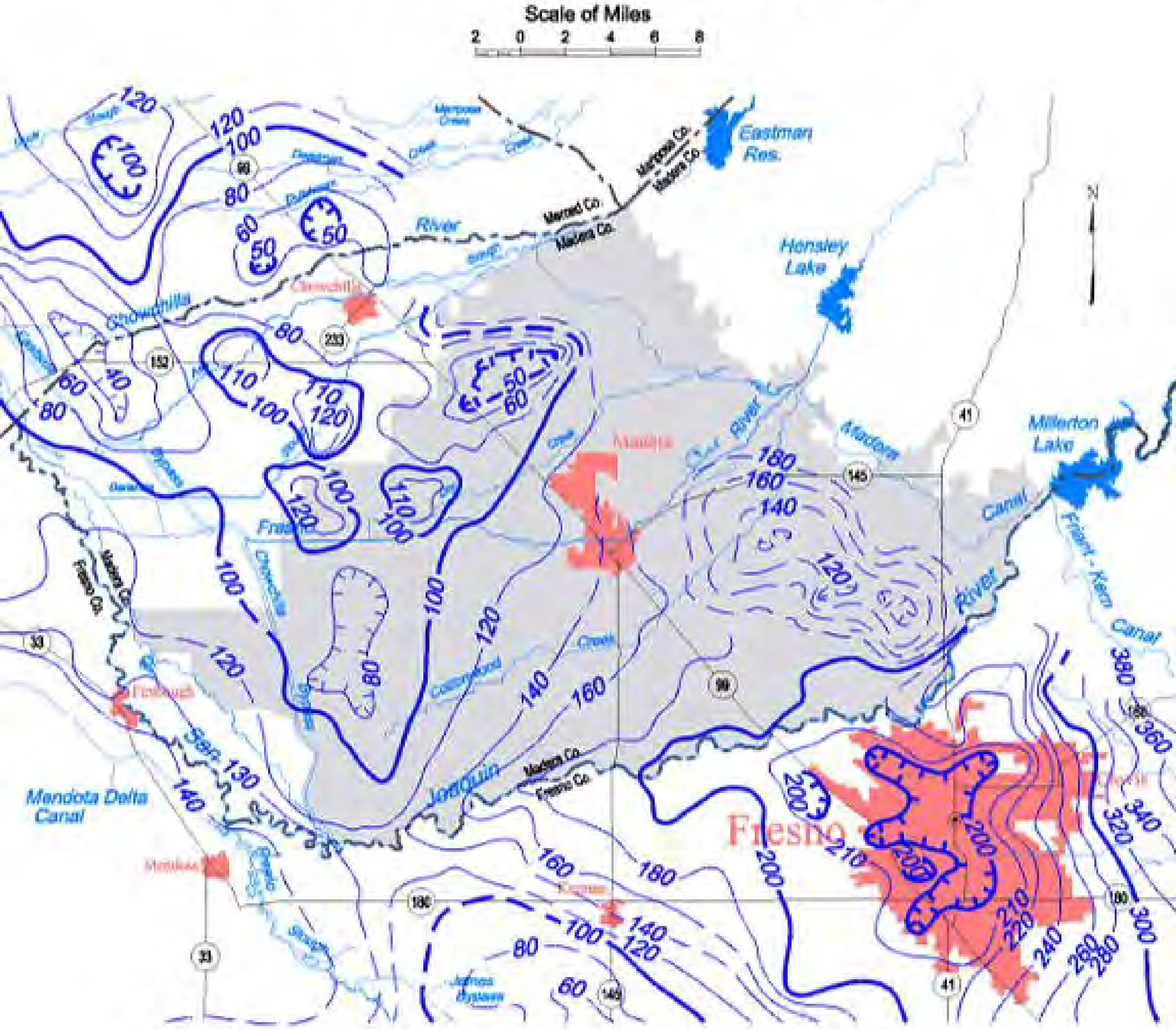
Spring 1999, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

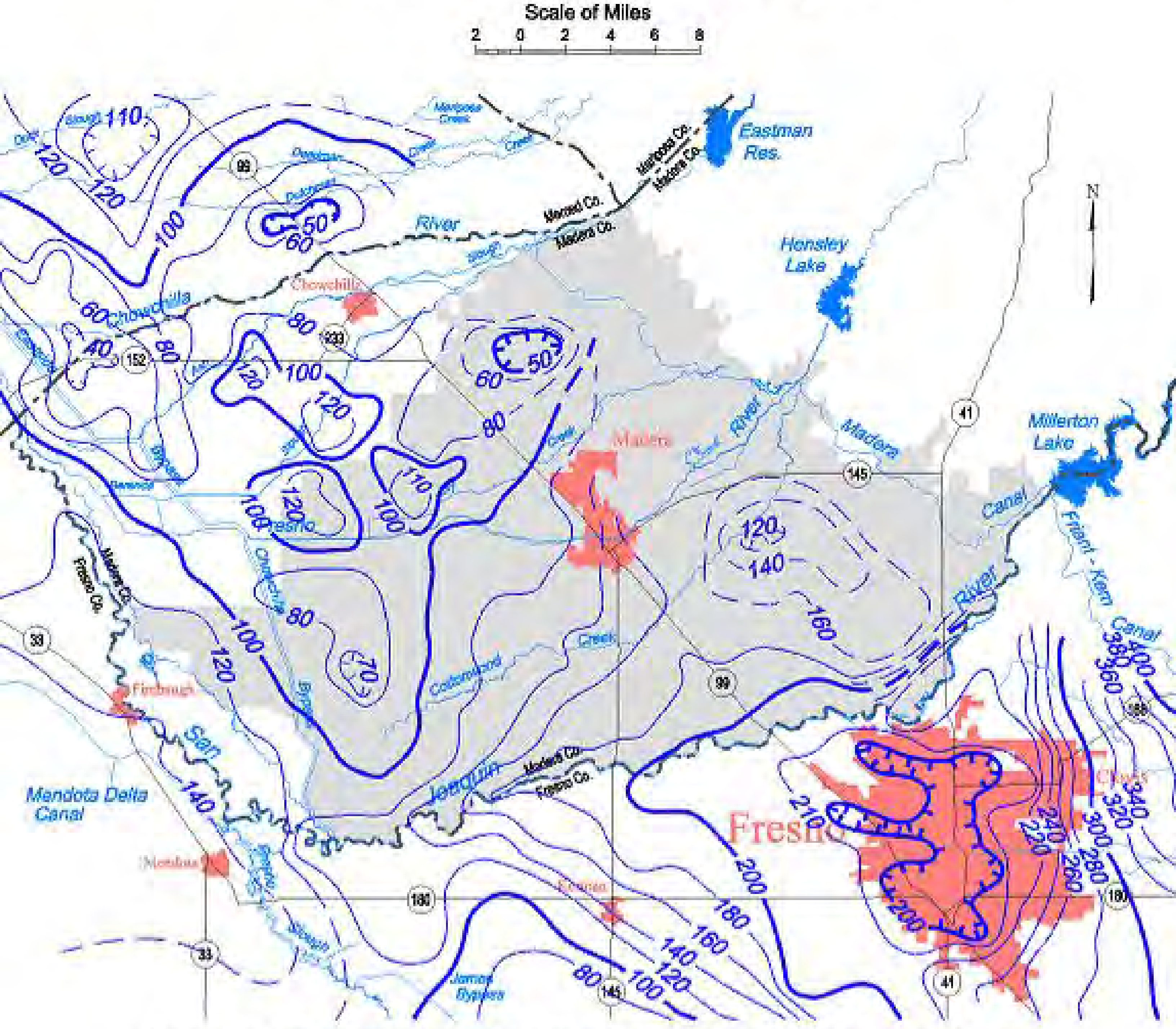
Spring 2000, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

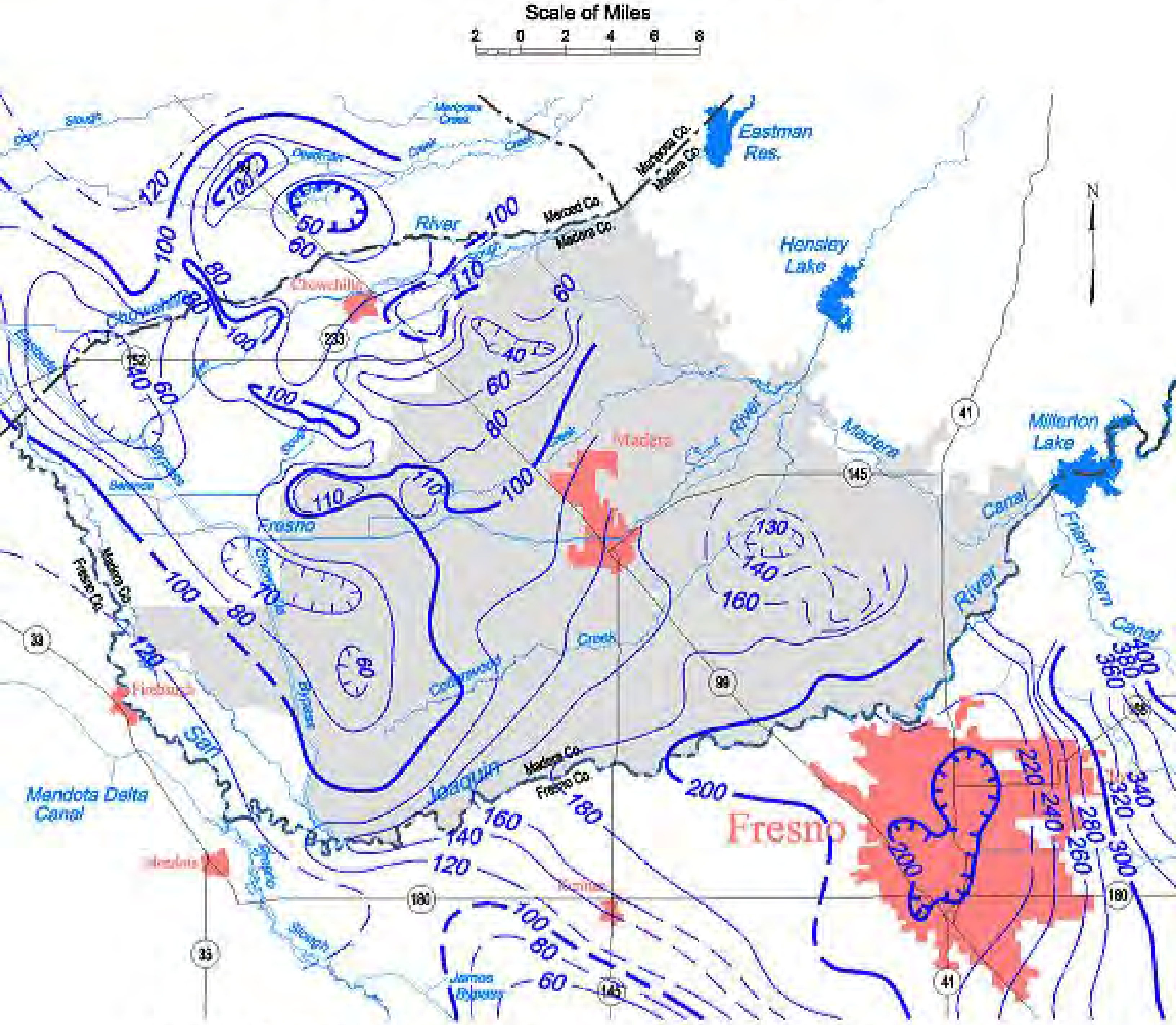
Spring 2001, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

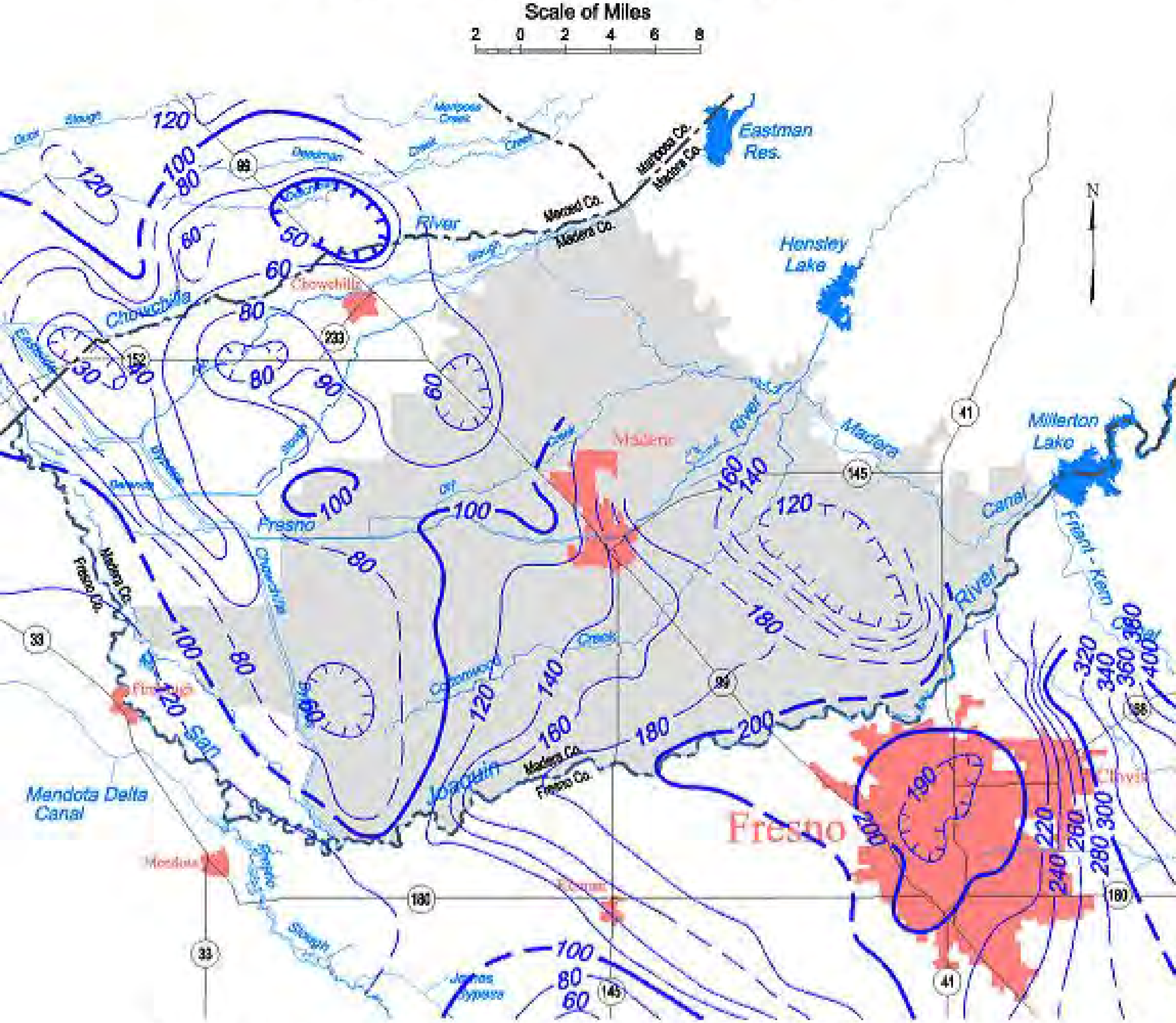
Spring 2002, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

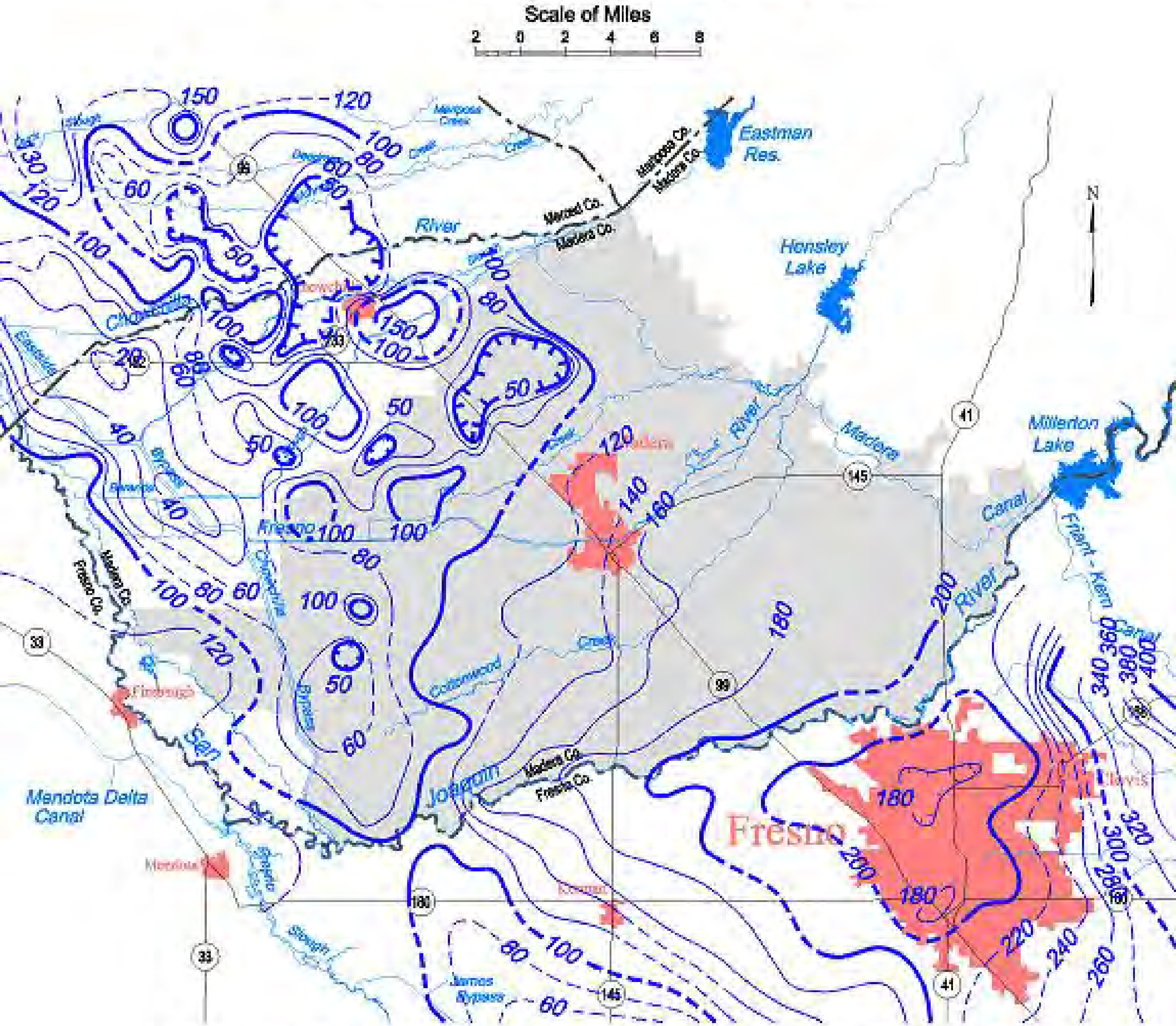
Spring 2003, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

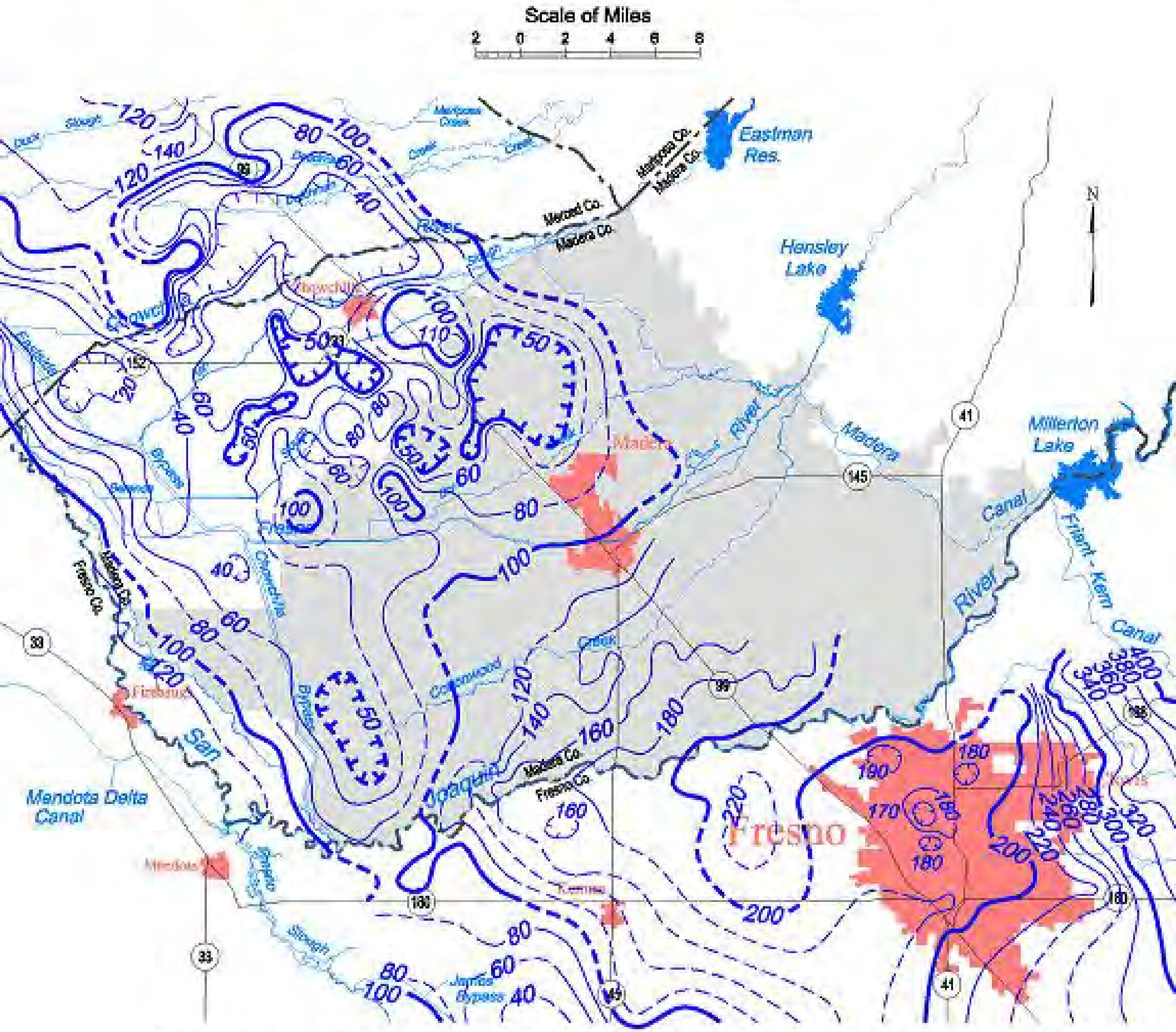
Spring 2004, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

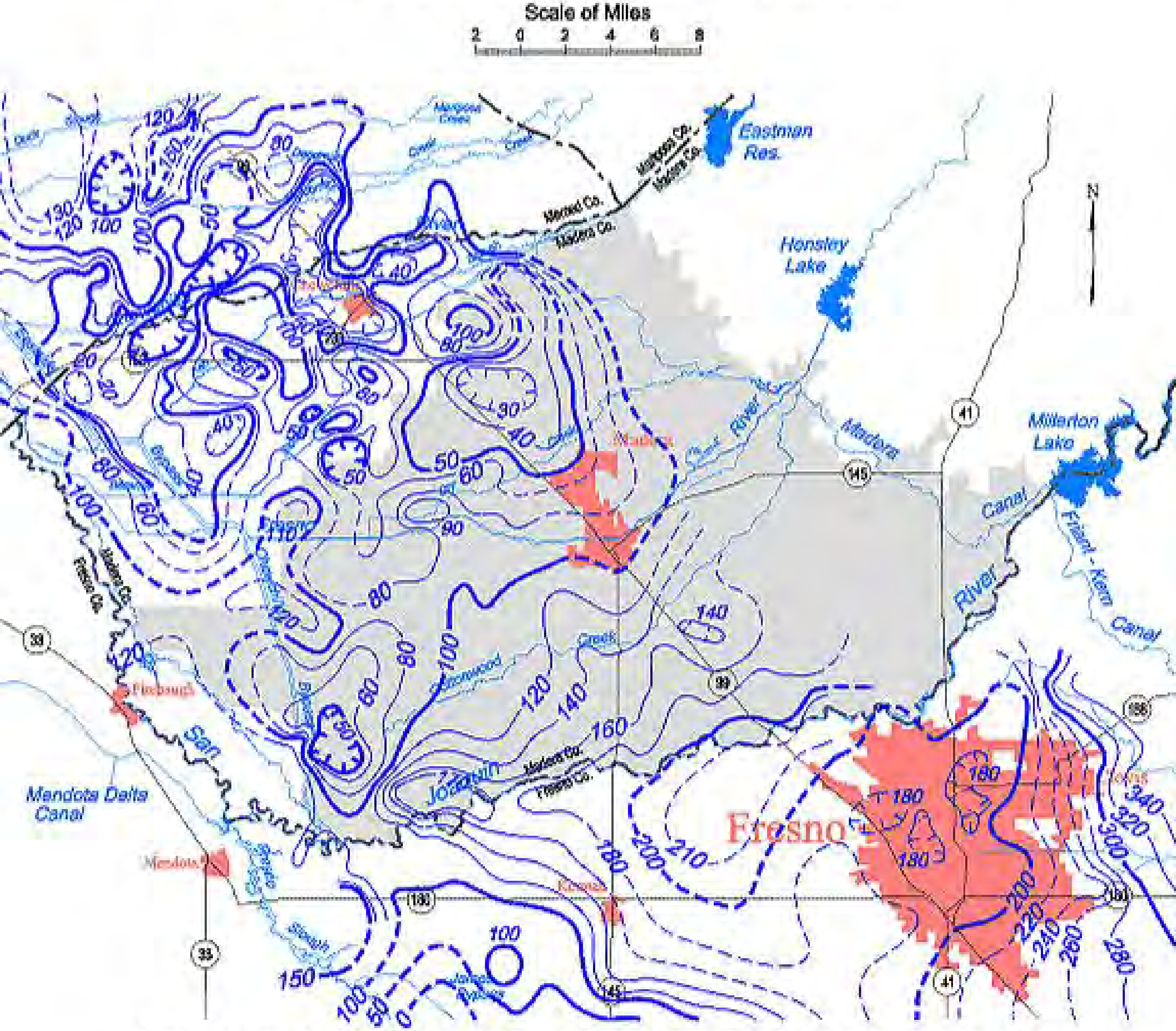
Spring 2005, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

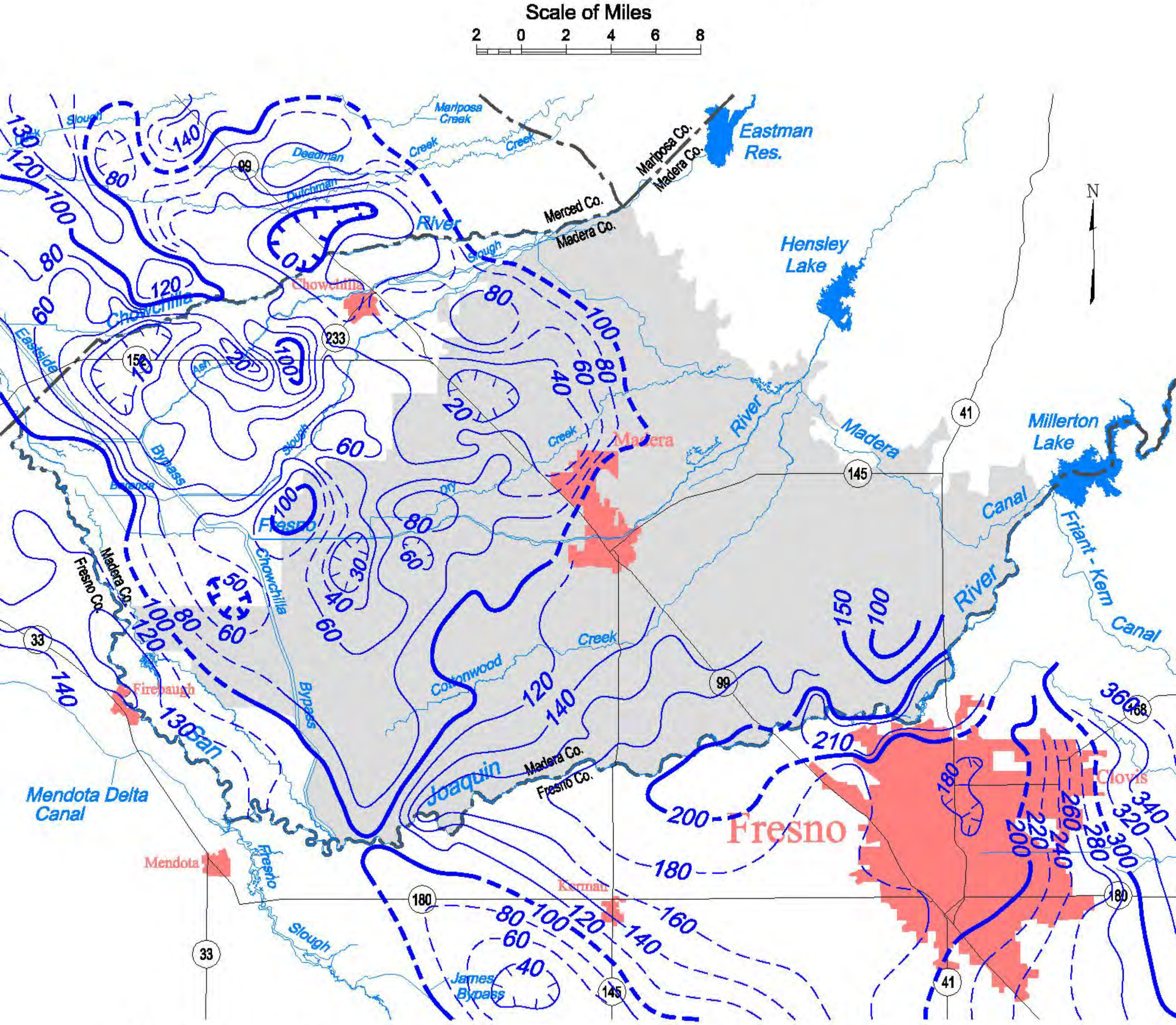
Spring 2006, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10, 20 and 50 feet.

Madera Groundwater Basin

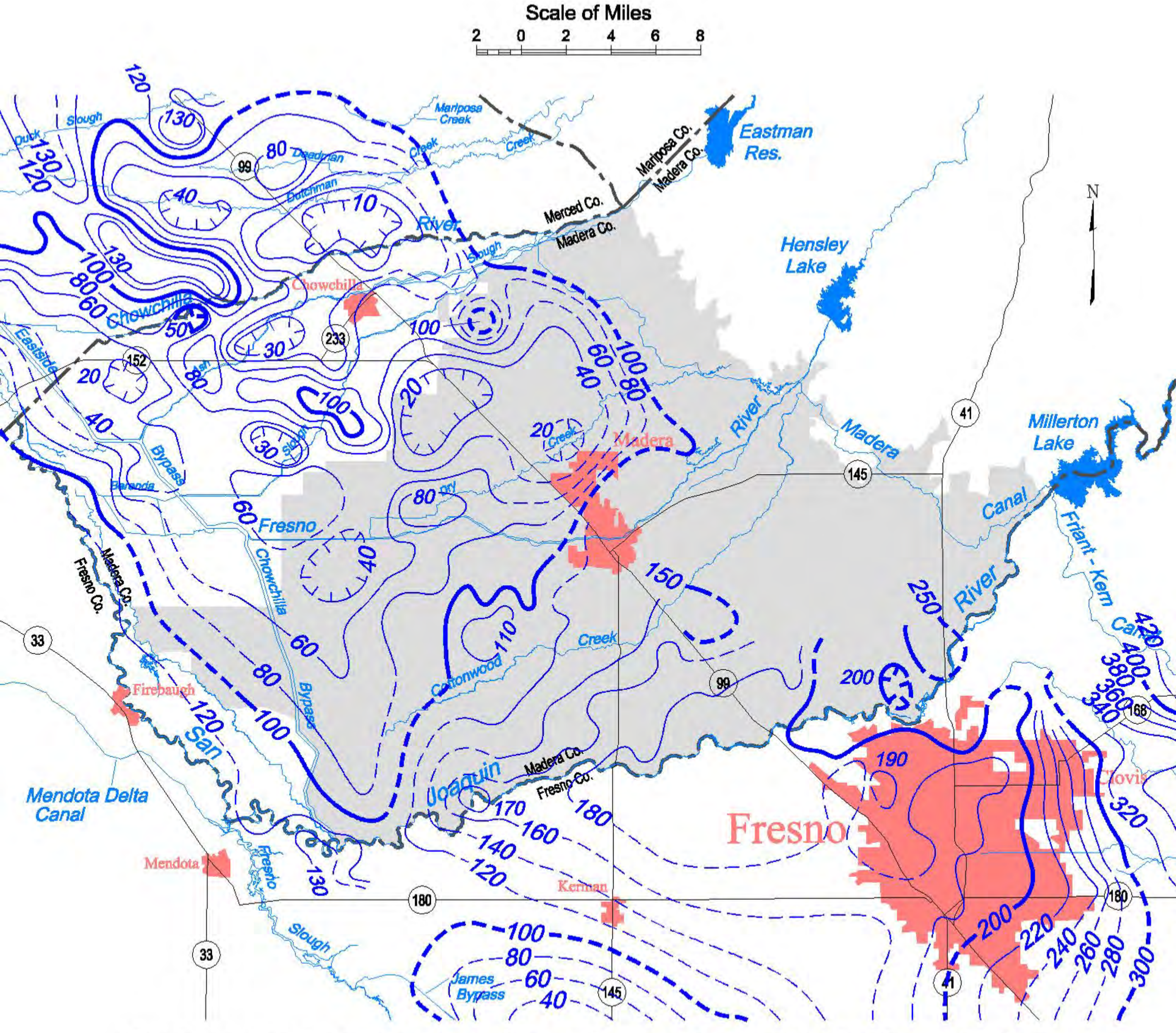
Spring 2007, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10, 20 and 50 feet.

Madera Groundwater Basin

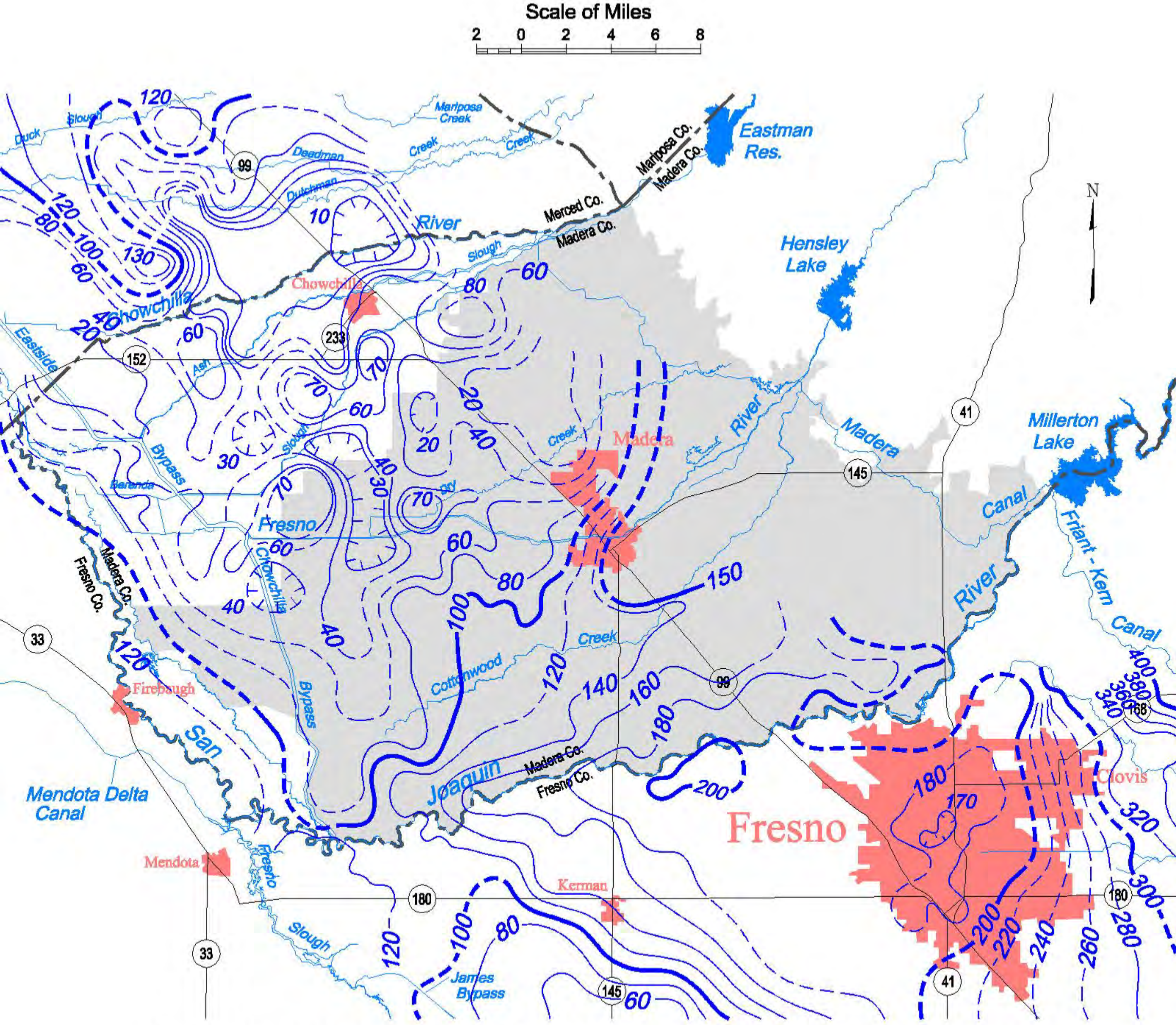
Spring 2008, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10, 20 and 50 feet.

Madera Groundwater Basin

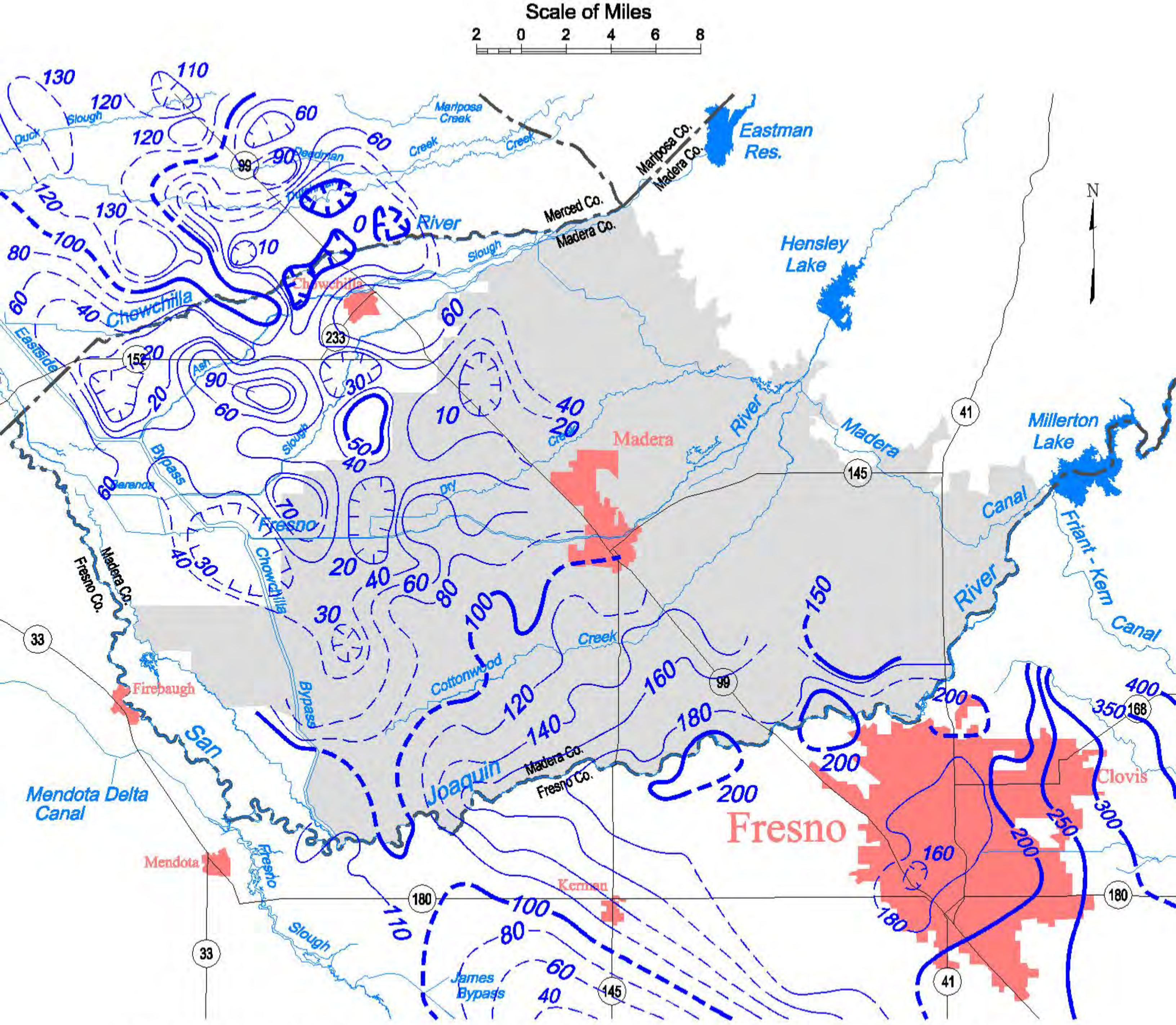
Spring 2009, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Madera Groundwater Basin

Spring 2010, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer

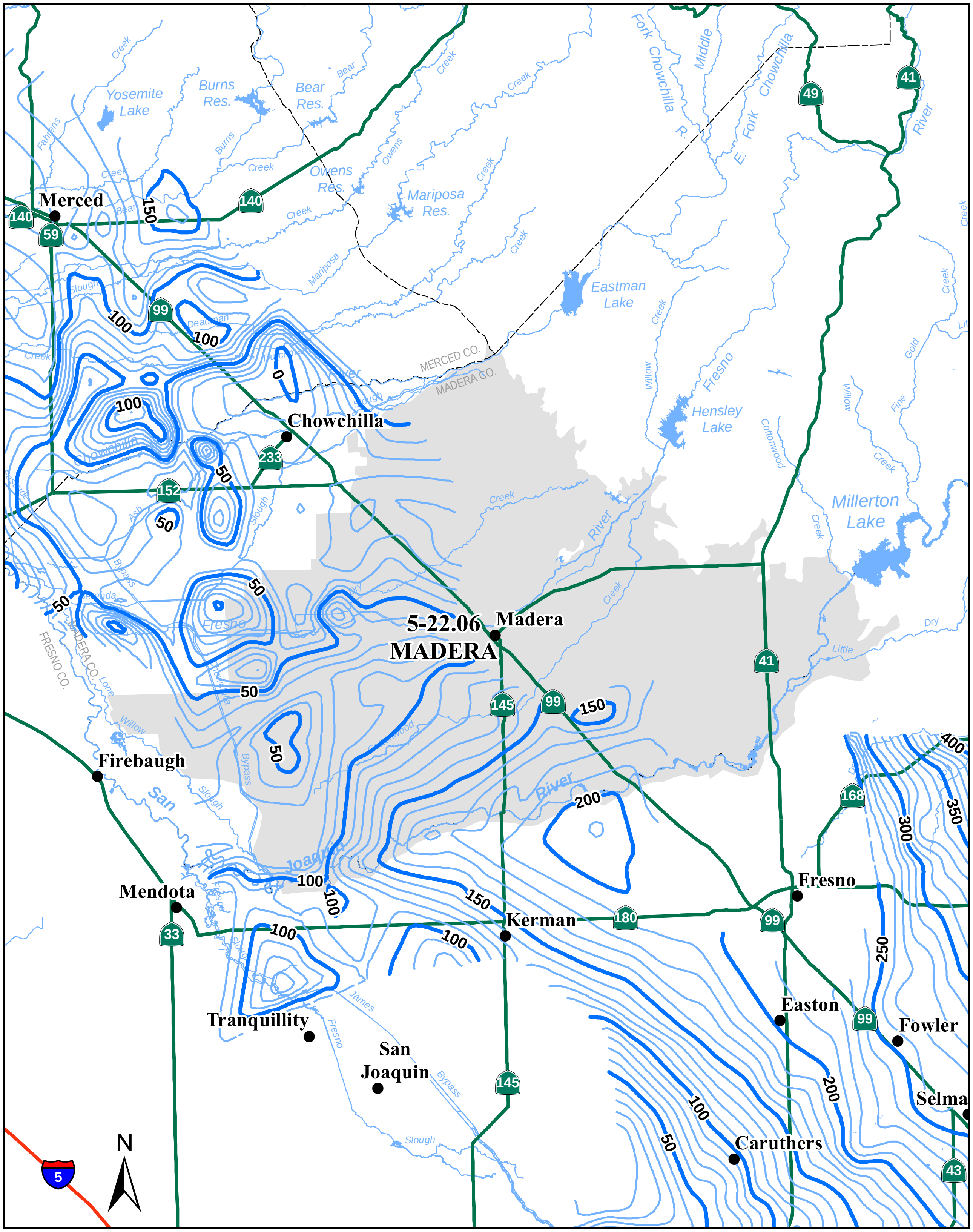


Contours are dashed where inferred. Contour interval is 10, 20 and 50 feet.

Madera Groundwater Basin 5-22.06

Groundwater Elevation Contours - Spring 2011

San Joaquin River Hydrologic Region



Lines of equal elevation of groundwater in feet above mean sea level.
Groundwater contours are a generalized representation of static water levels interpreted from wells measured in Spring 2011.
Water levels are interpreted to represent unconfined conditions.

0 5 10 Miles

South Central Region Office

A2.E.a-35

APPENDIX 2.E. CURRENT AND HISTORICAL GROUNDWATER CONDITIONS

2.E.b. Groundwater Elevation Hydrographs

Prepared as part of the

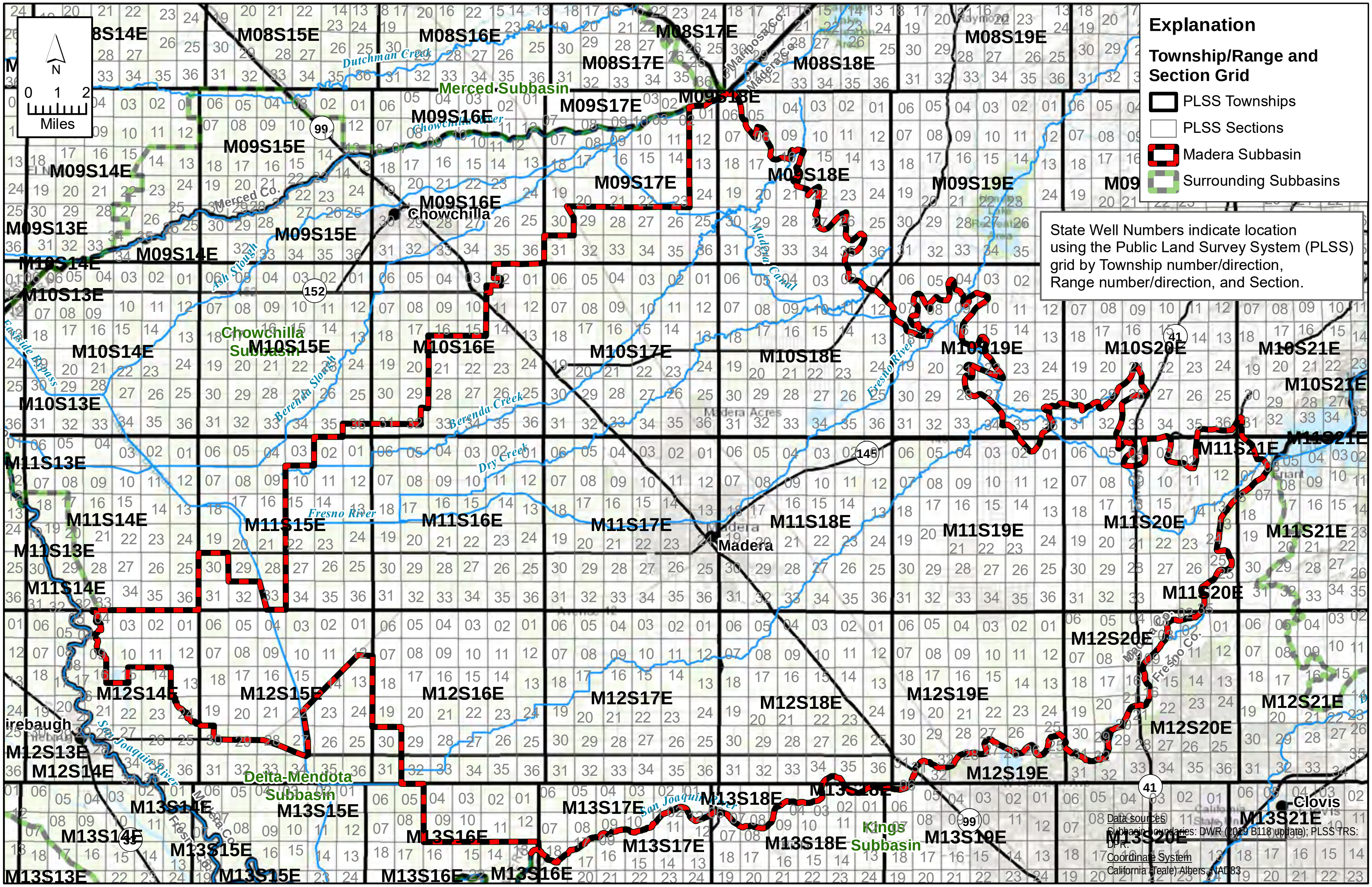
Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

GSP Team:

Davids Engineering, Inc
Luhdorff & Scalmanini
ERA Economics
Stillwater Sciences and
California State University, Sacramento

Groundwater Elevation Hydrographs



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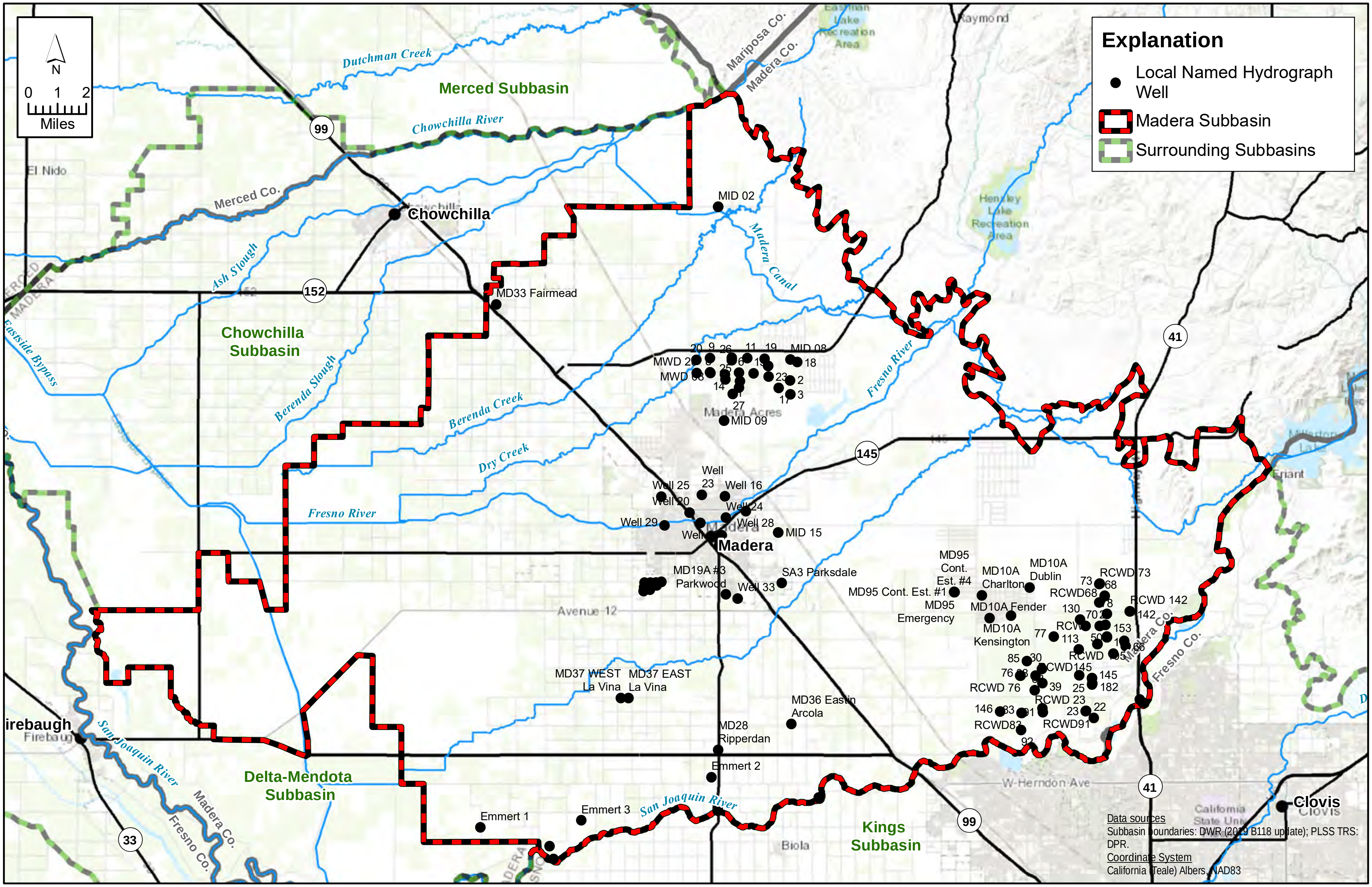
APPENDIX 2.E
Groundwater Elevation Hydrograph Location Map: State Well Number Locations

Madera Subbasin A2.E.b-2
Groundwater Sustainability Plan



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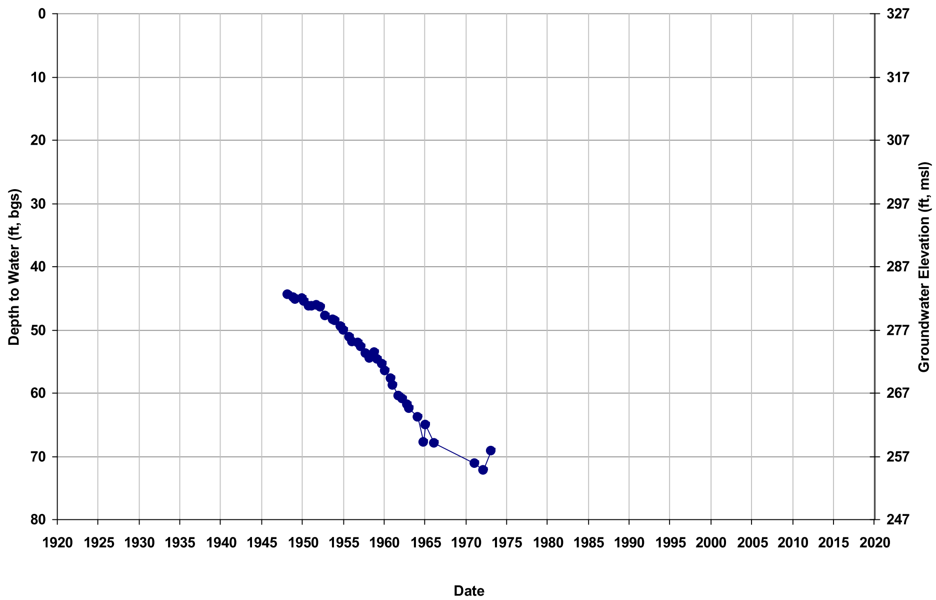
Luhdorff & Scalmanini Consulting Engineers

APPENDIX 2.E
Groundwater Elevation Hydrograph Location Map: Local Named Wells

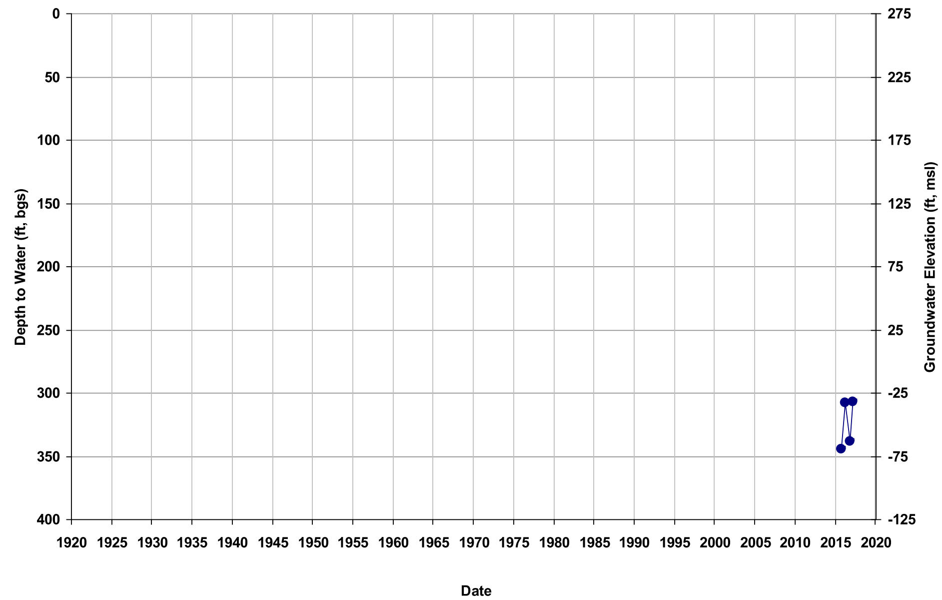
Well ID: 09S17E26J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 327
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



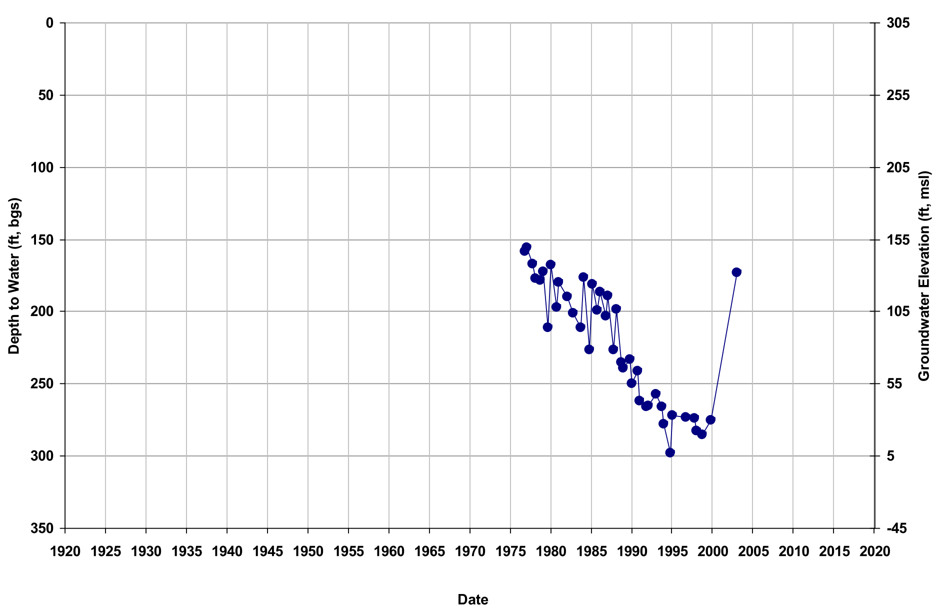
Well ID: 09S17E30A
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 275
Total Depth (ft): 820
Perf Top (ft): 257
Perf Bottom (ft): 726



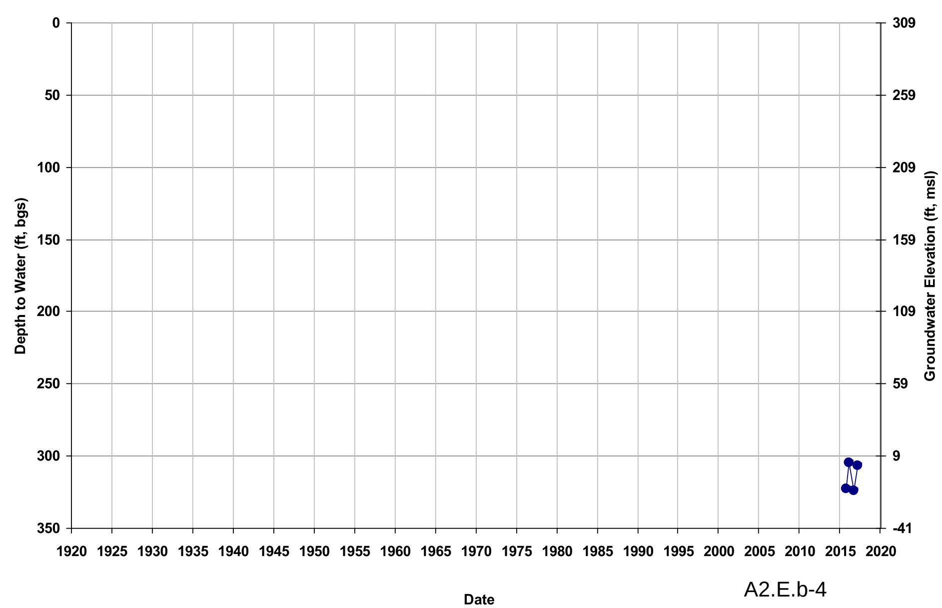
Well ID: 09S17E32A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

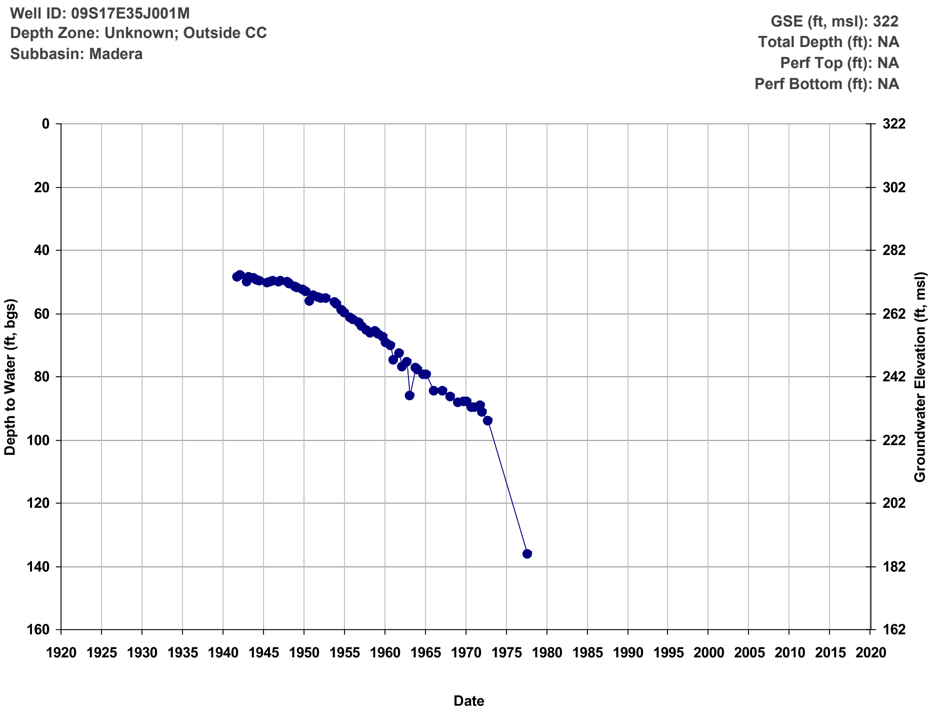
GSE (ft, msl): 304
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

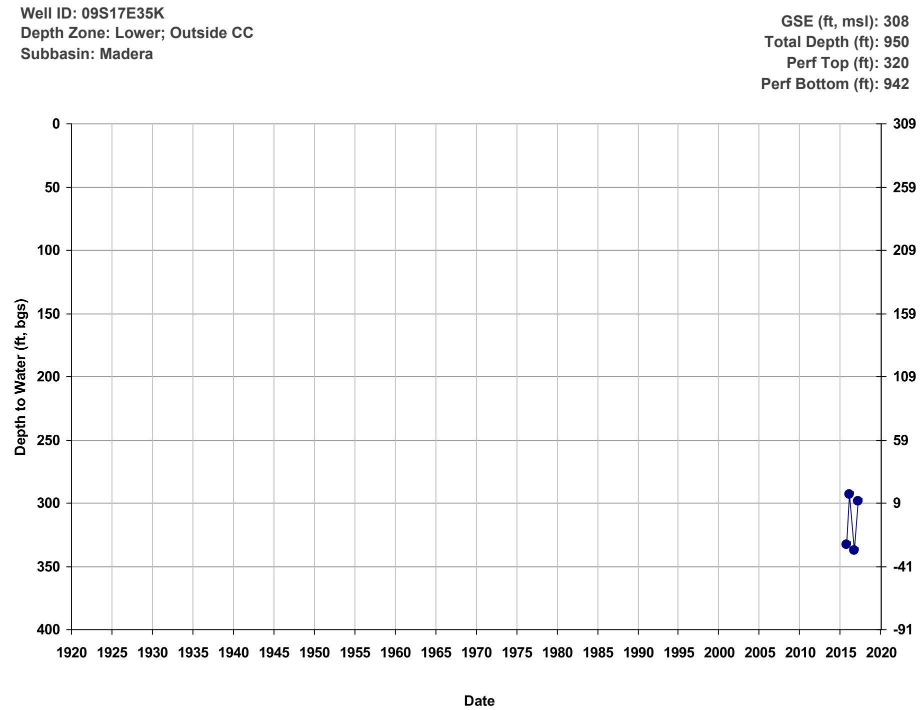


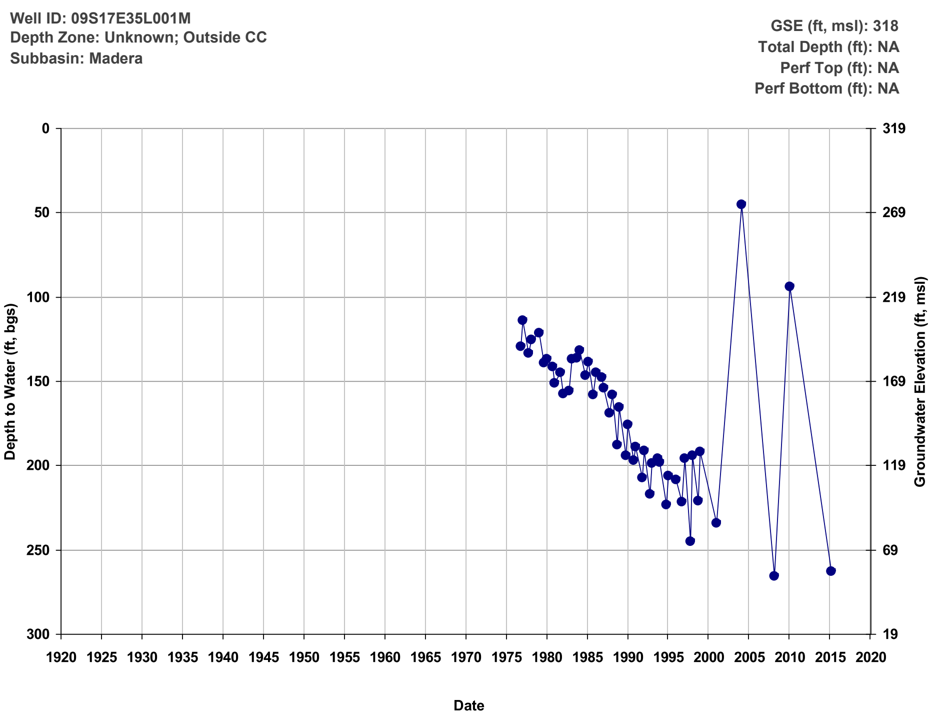
Well ID: 09S17E34R
Depth Zone: Lower; Outside CC
Subbasin: Madera

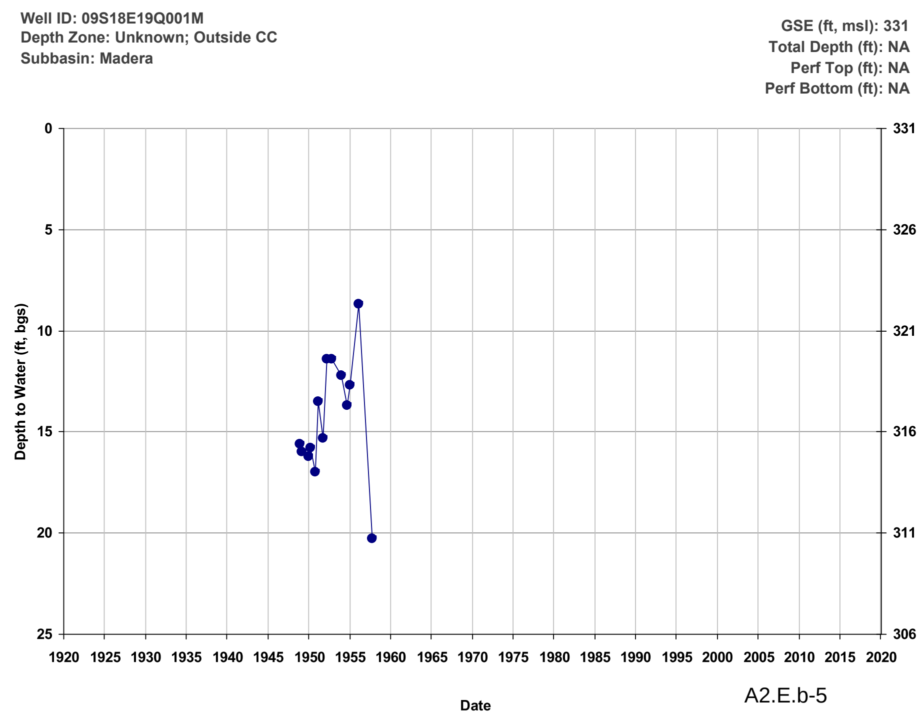
GSE (ft, msl): 309
Total Depth (ft): 840
Perf Top (ft): 240
Perf Bottom (ft): 840




Well ID: 09S17E35J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 322
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

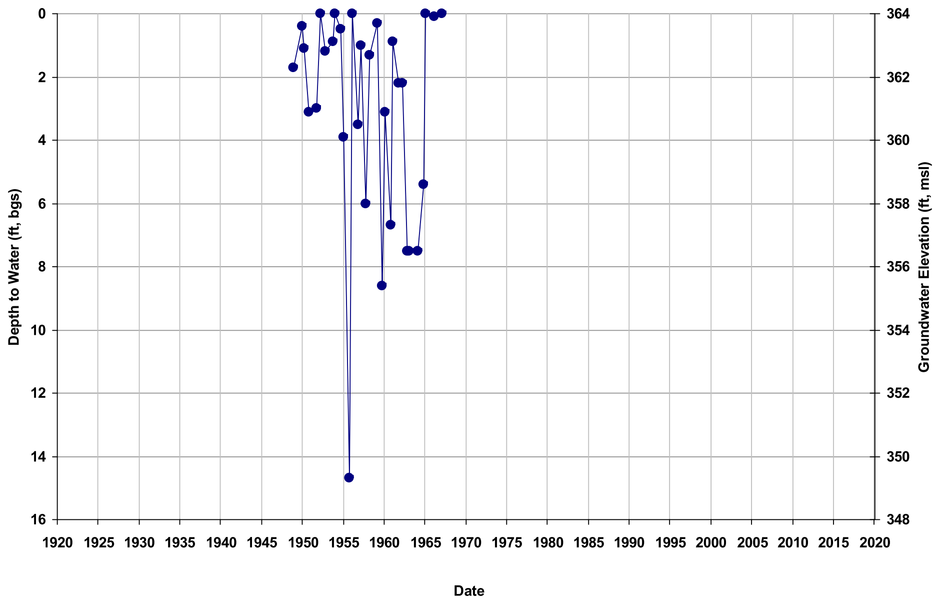

Well ID: 09S17E35K
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 308
Total Depth (ft): 950
Perf Top (ft): 320
Perf Bottom (ft): 942
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 09S17E35L001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 318
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 09S18E19Q001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 331
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

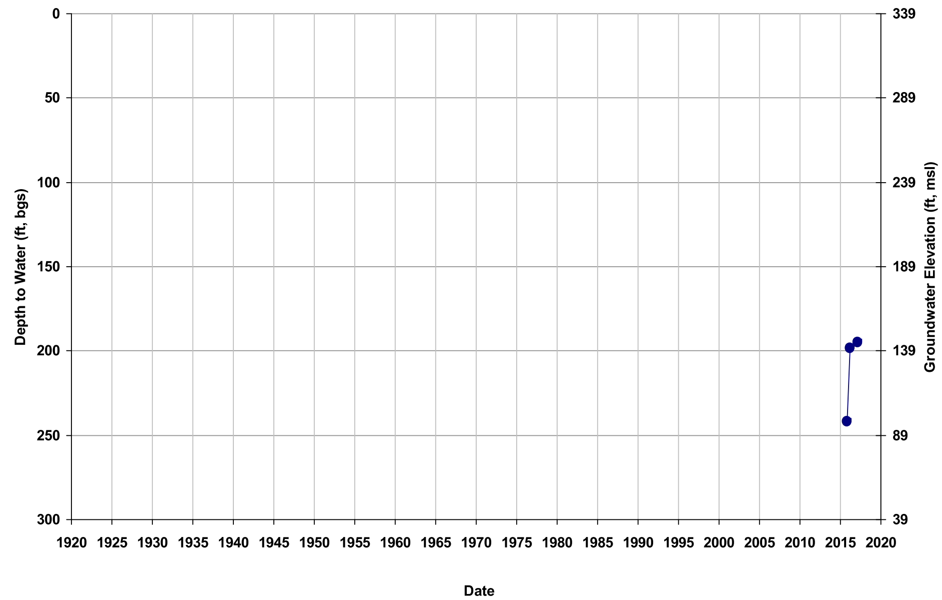
Well ID: 09S18E28D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 364
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



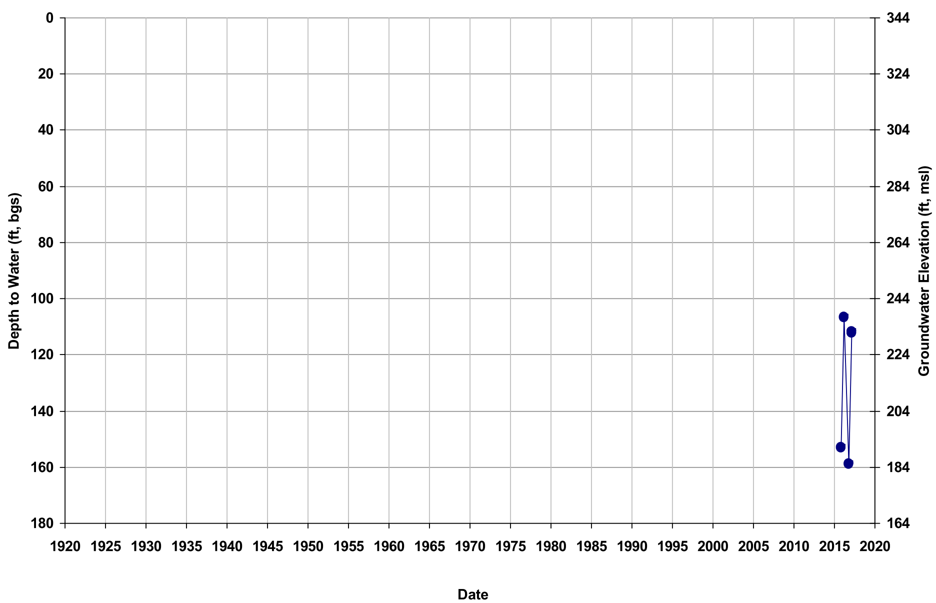
Well ID: 09S18E31G001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 339
Total Depth (ft): 408
Perf Top (ft): 240
Perf Bottom (ft): 367



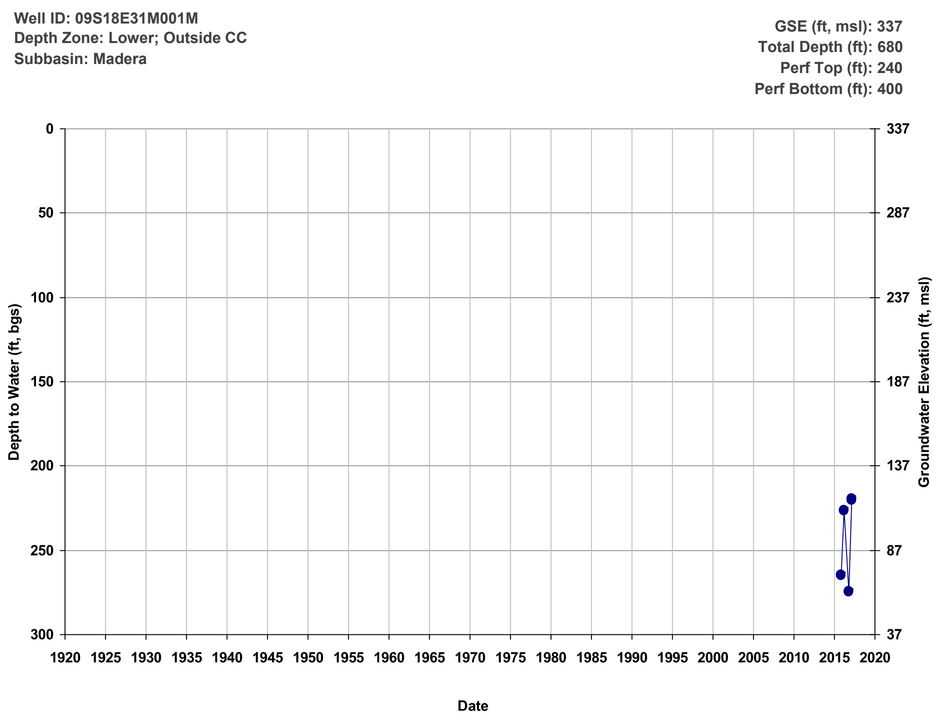
Well ID: 09S18E31H001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

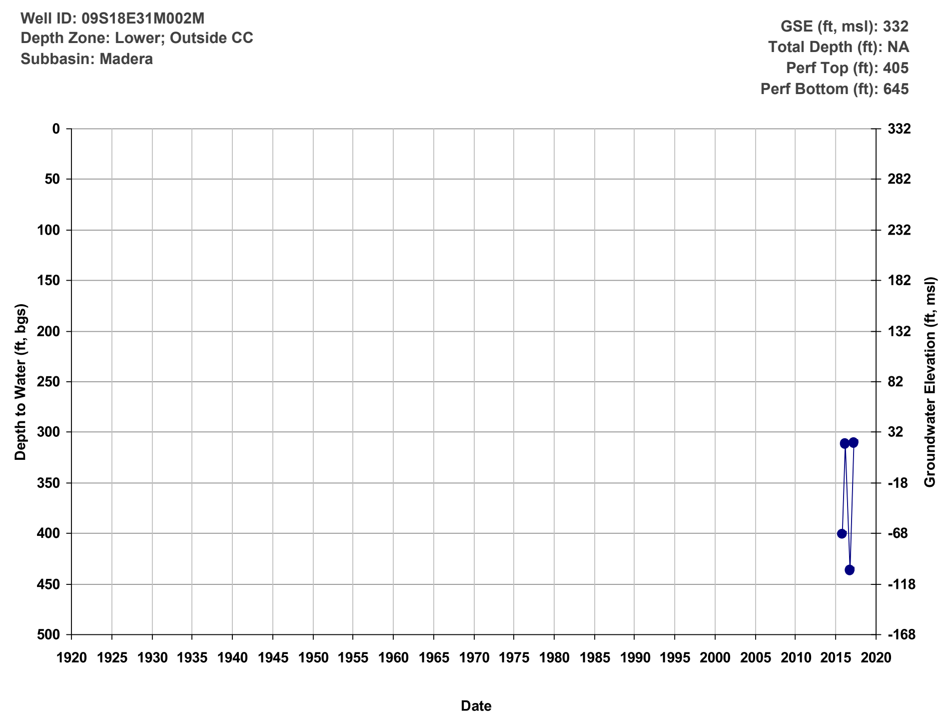
GSE (ft, msl): 343
Total Depth (ft): 724
Perf Top (ft): 105
Perf Bottom (ft): 350

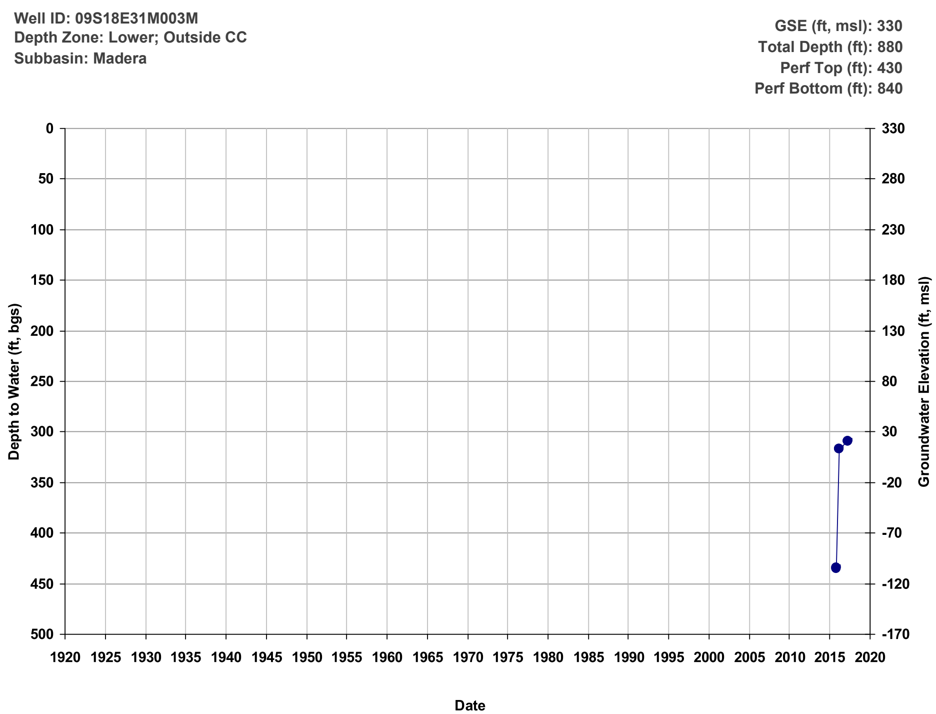


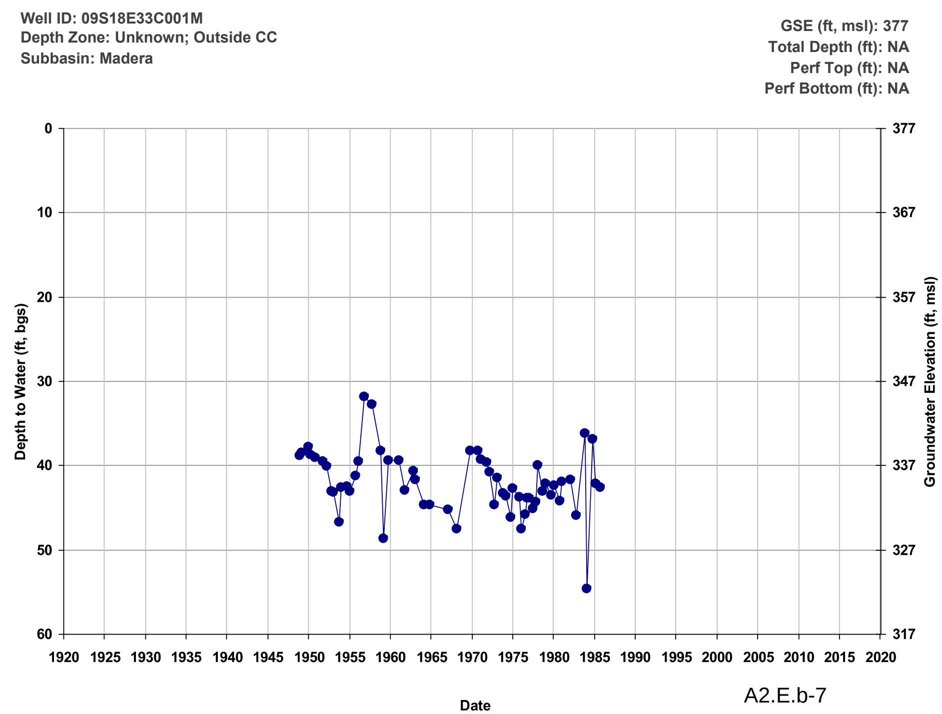
Well ID: 09S18E31L001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 336
Total Depth (ft): 906
Perf Top (ft): 298
Perf Bottom (ft): 470


Well ID: 09S18E31M001M
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 337
Total Depth (ft): 680
Perf Top (ft): 240
Perf Bottom (ft): 400
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

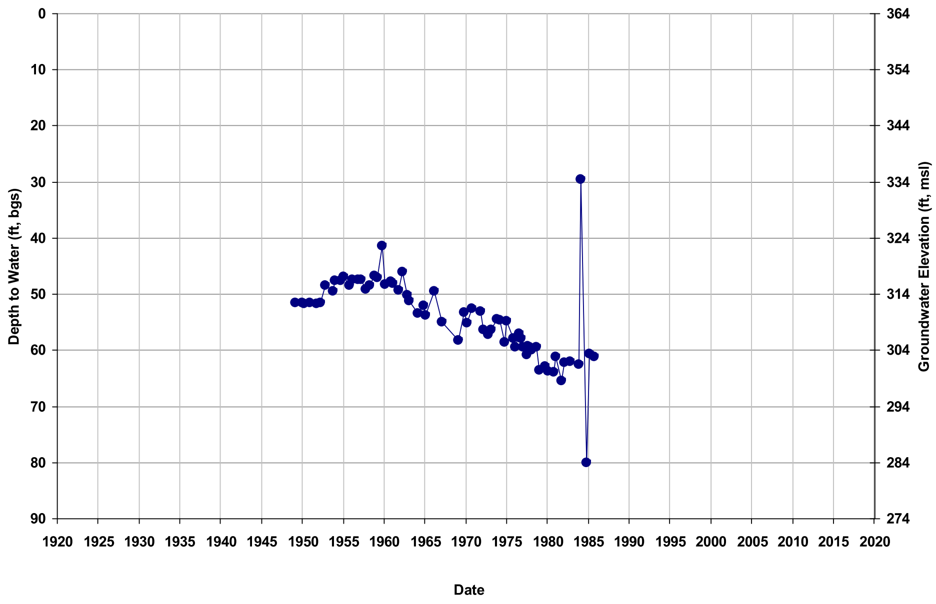

Well ID: 09S18E31M002M
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 332
Total Depth (ft): NA
Perf Top (ft): 405
Perf Bottom (ft): 645
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 09S18E31M003M
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 330
Total Depth (ft): 880
Perf Top (ft): 430
Perf Bottom (ft): 840
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 09S18E33C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 377
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

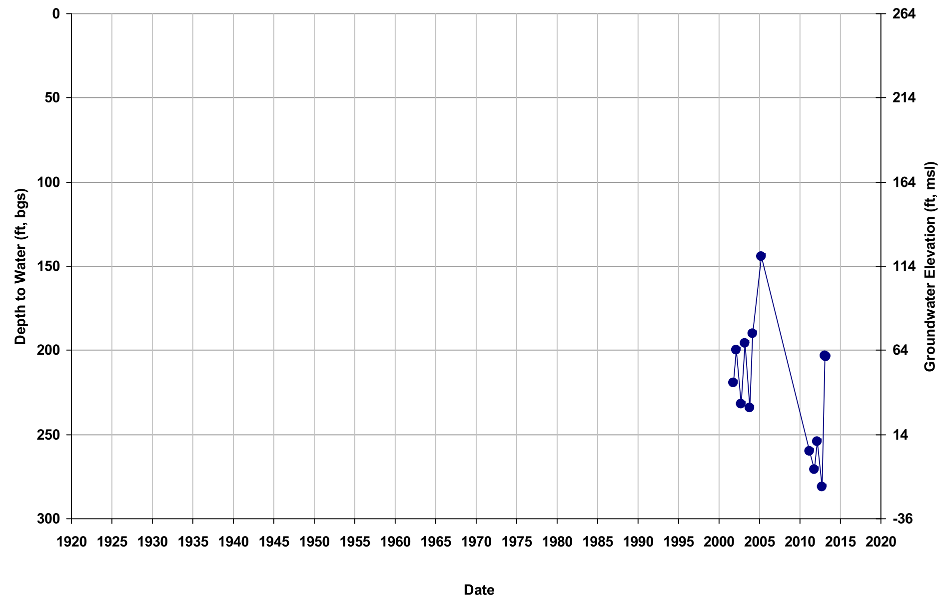
Well ID: 09S18E33Q001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 364
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



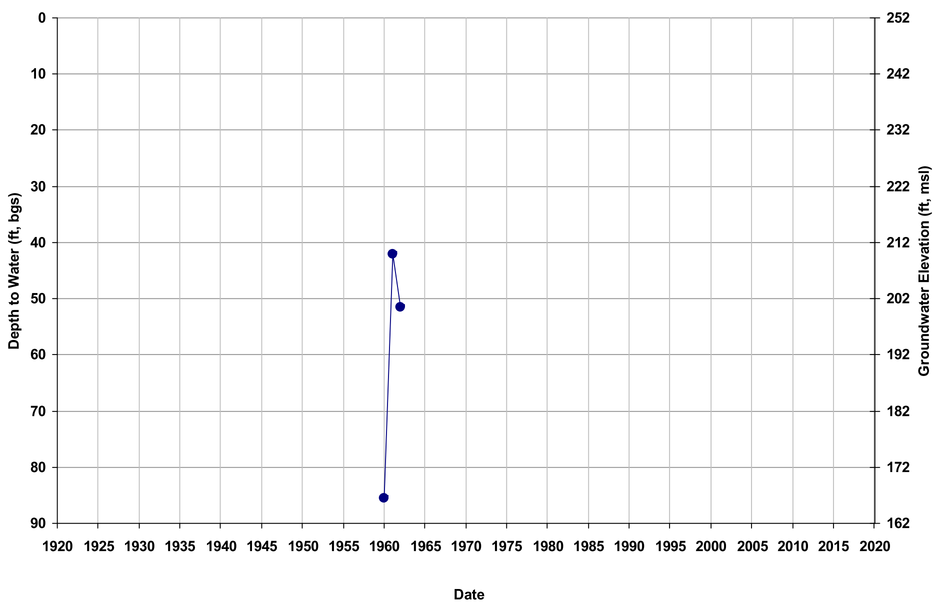
Well ID: 10S16E01E001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 264
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



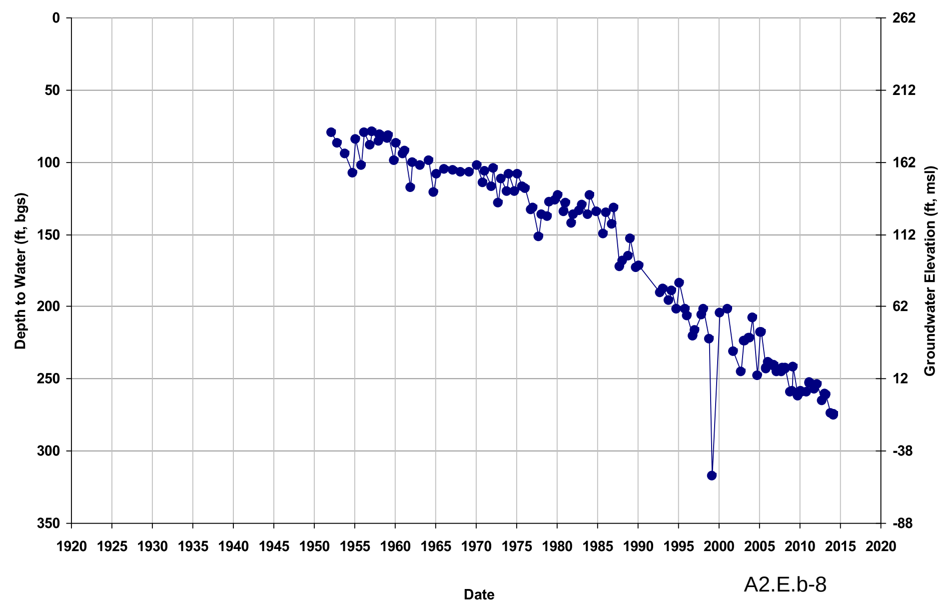
Well ID: 10S16E11G001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

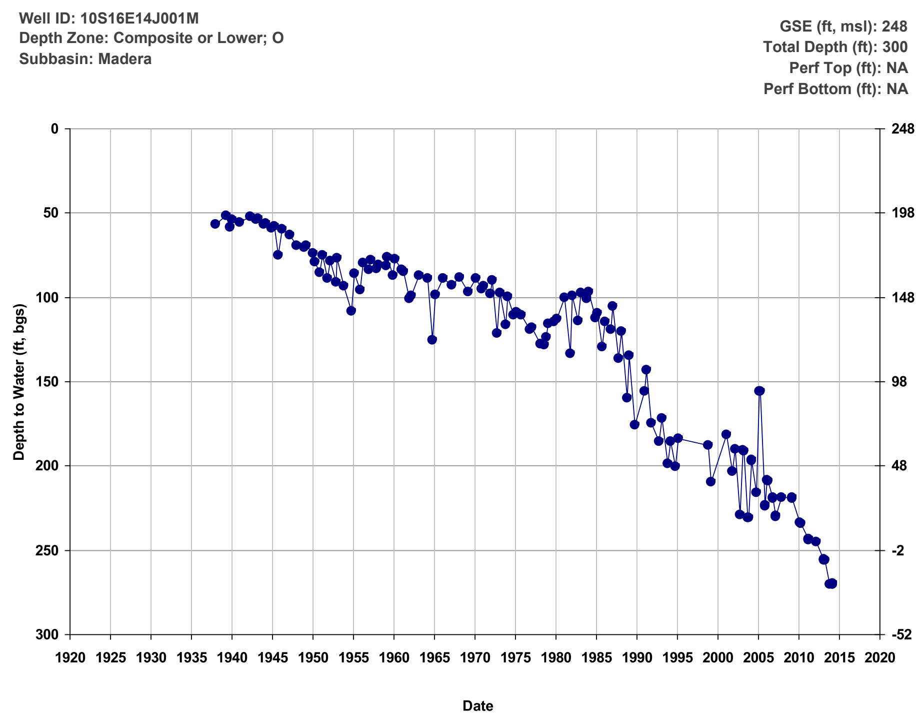
GSE (ft, msl): 252
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

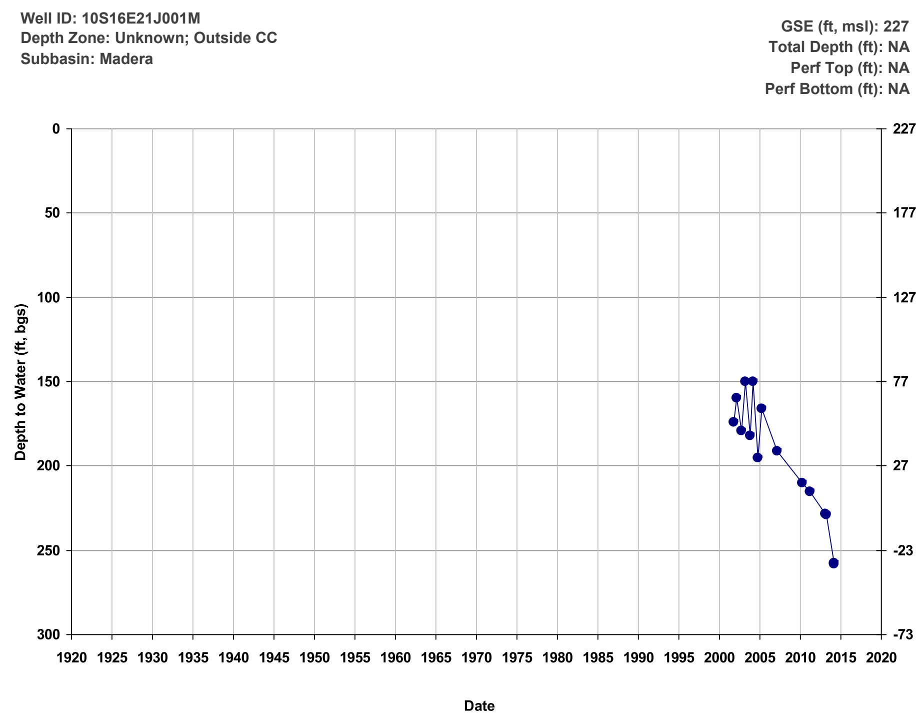


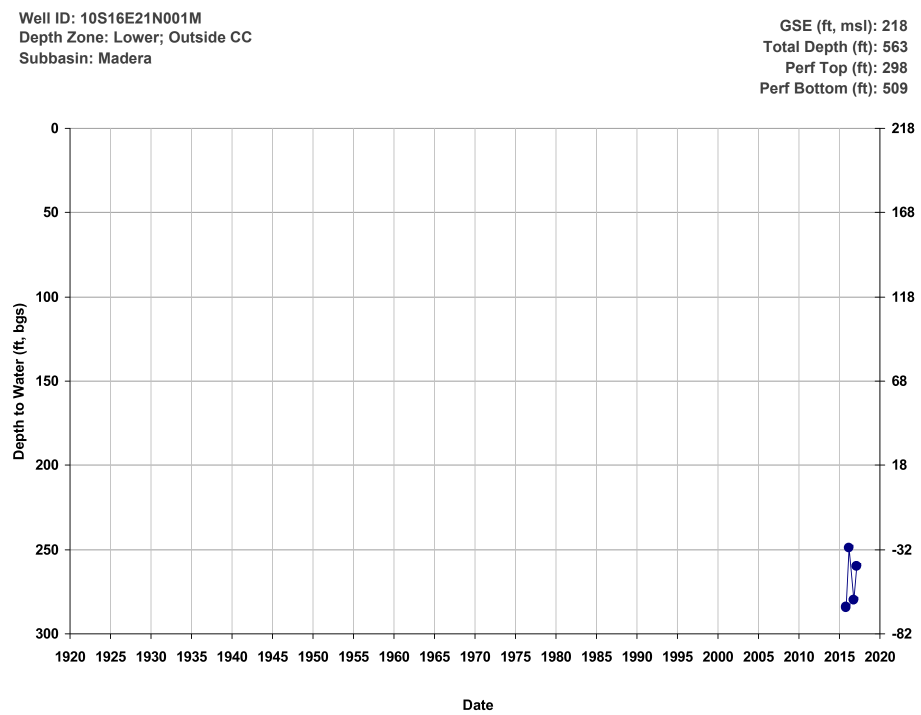
Well ID: 10S16E12K001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

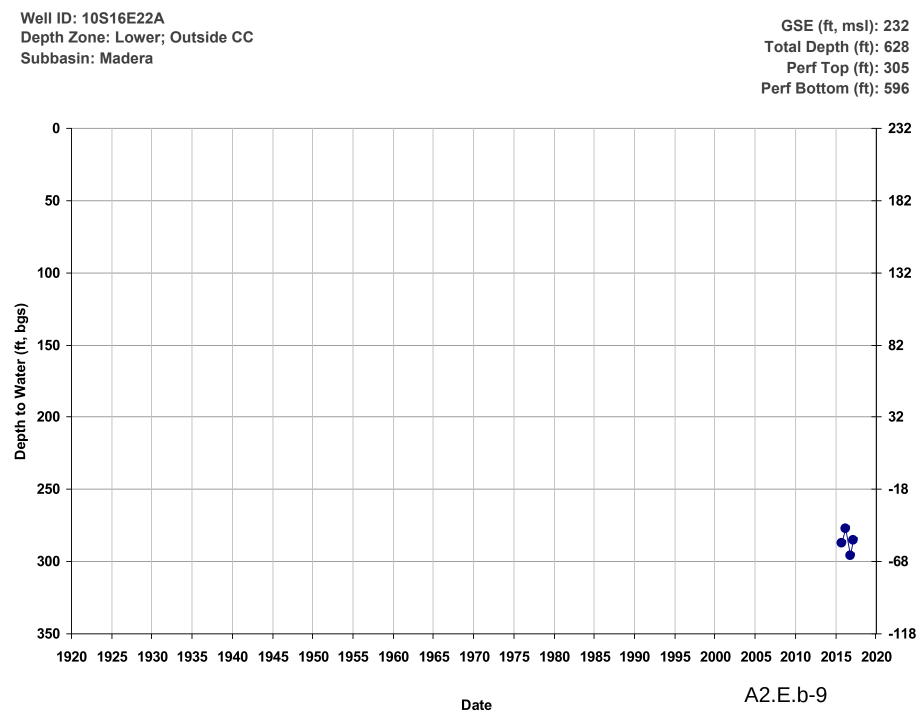
GSE (ft, msl): 262
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA




Well ID: 10S16E14J001M
Depth Zone: Composite or Lower; O
Subbasin: Madera
GSE (ft, msl): 248
Total Depth (ft): 300
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

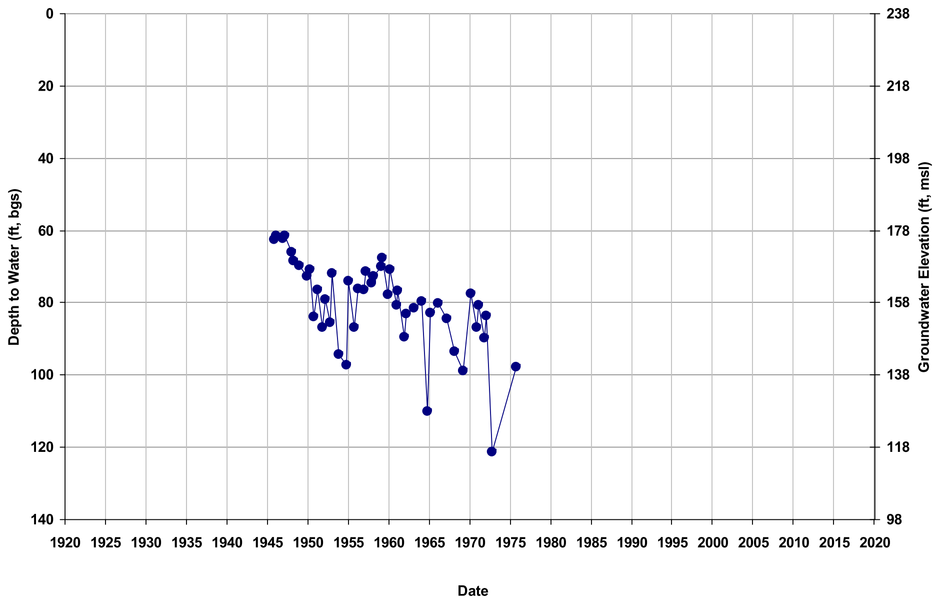

Well ID: 10S16E21J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 227
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 10S16E21N001M
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 218
Total Depth (ft): 563
Perf Top (ft): 298
Perf Bottom (ft): 509
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 10S16E22A
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 232
Total Depth (ft): 628
Perf Top (ft): 305
Perf Bottom (ft): 596
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

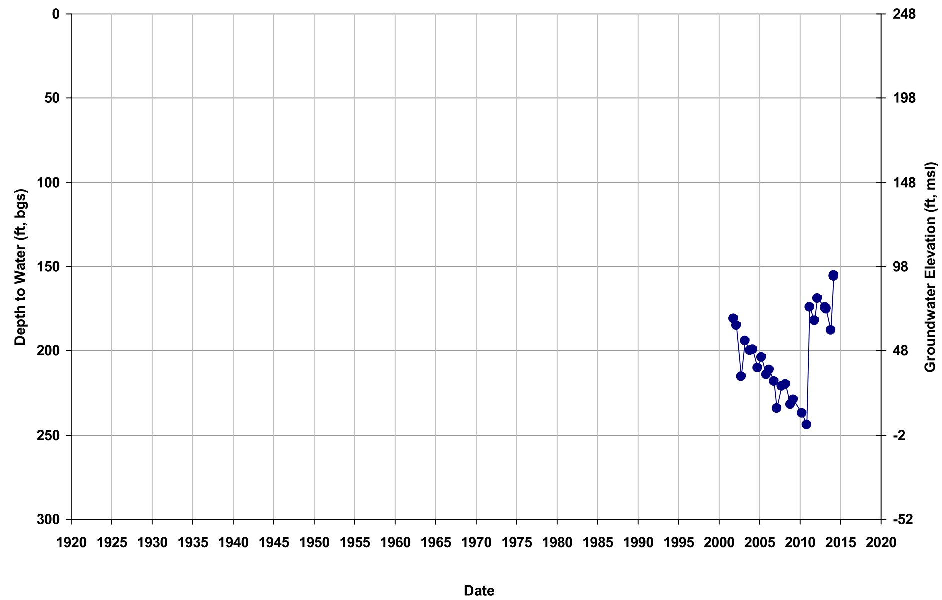
Well ID: 10S16E22A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 238
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



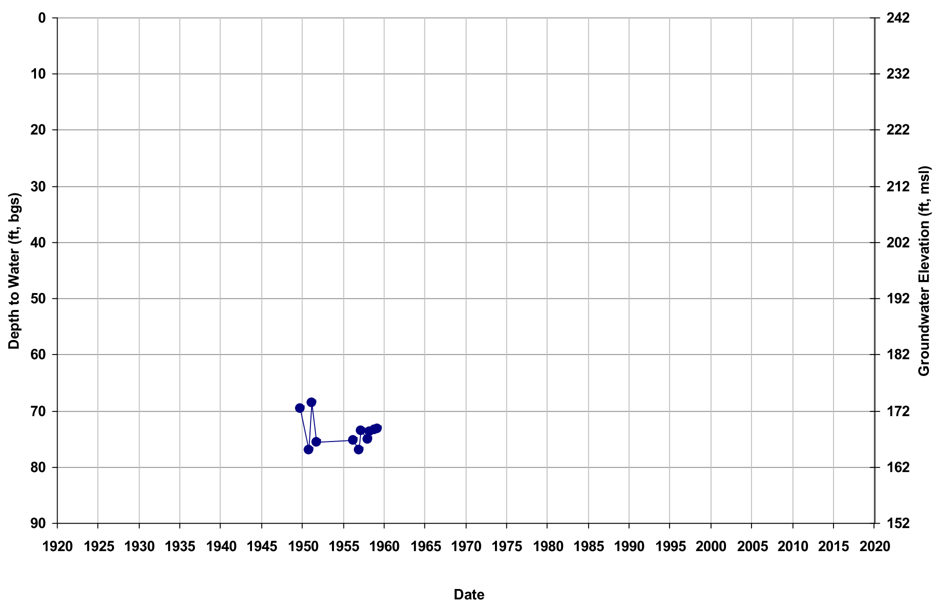
Well ID: 10S16E24J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 248
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



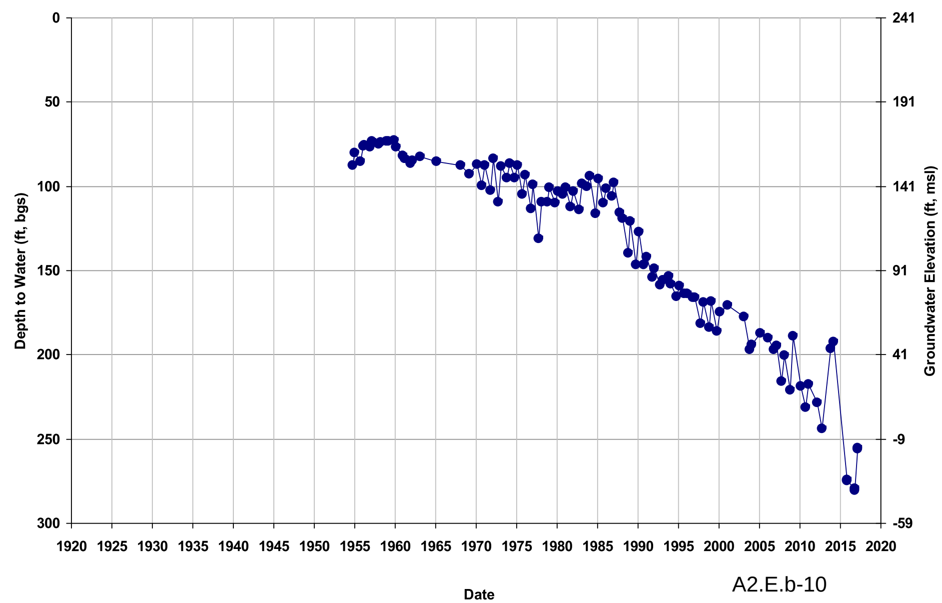
Well ID: 10S16E25F001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 242
Total Depth (ft): 544
Perf Top (ft): 350
Perf Bottom (ft): 537



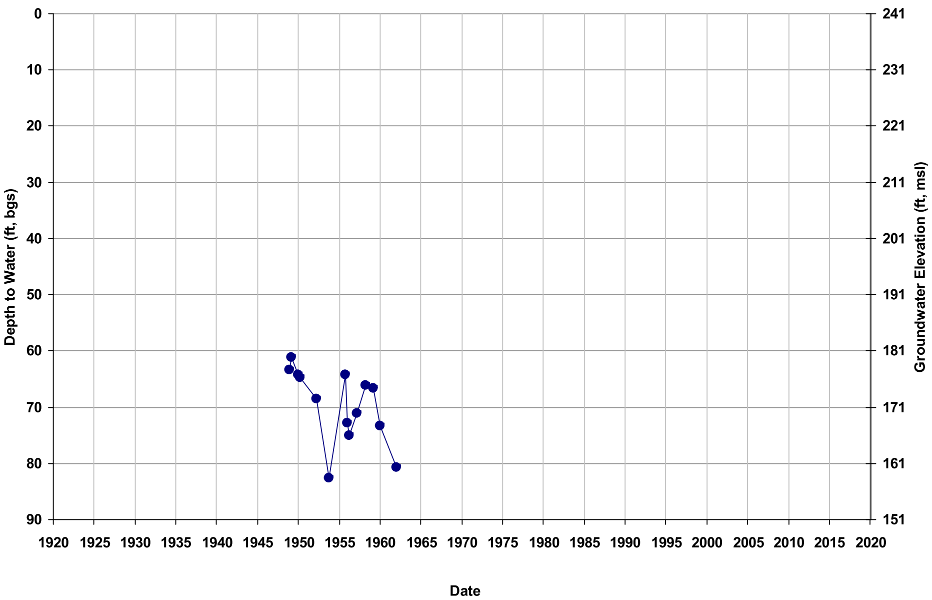
Well ID: 10S16E25F002M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 241
Total Depth (ft): 516
Perf Top (ft): 260
Perf Bottom (ft): 507



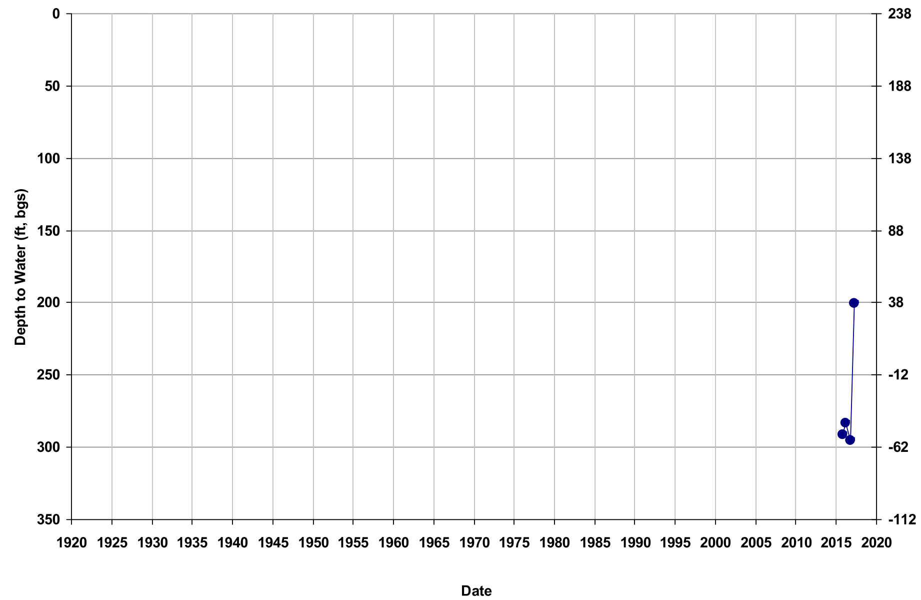
Well ID: 10S16E25J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 240
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



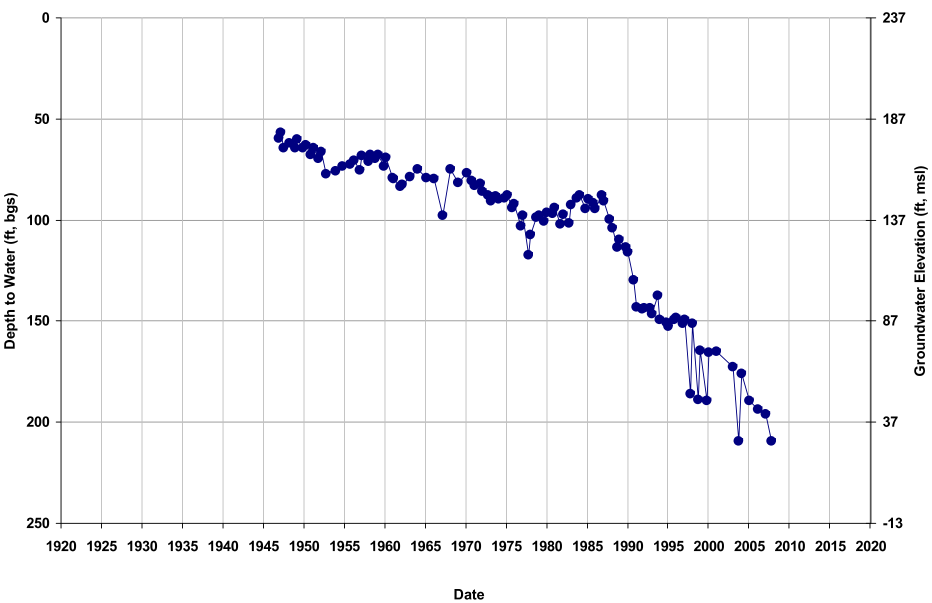
Well ID: 10S16E25L001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 238
Total Depth (ft): 800
Perf Top (ft): 400
Perf Bottom (ft): 800



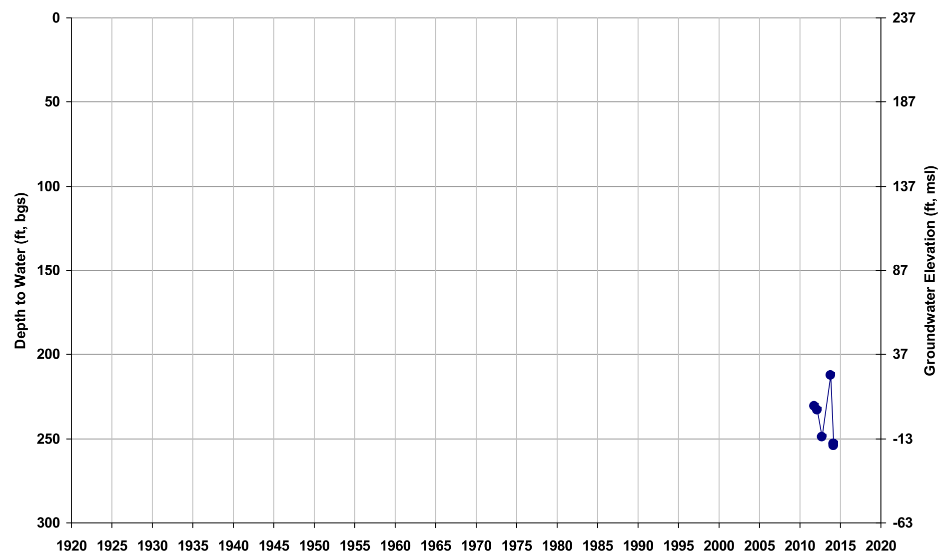
Well ID: 10S16E25Q001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 237
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



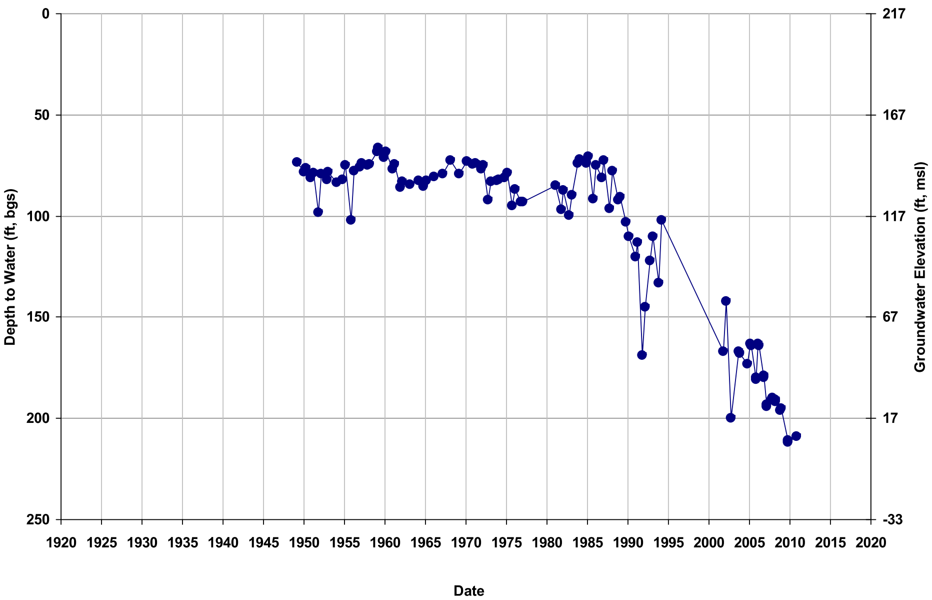
Well ID: 10S16E26B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 237
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



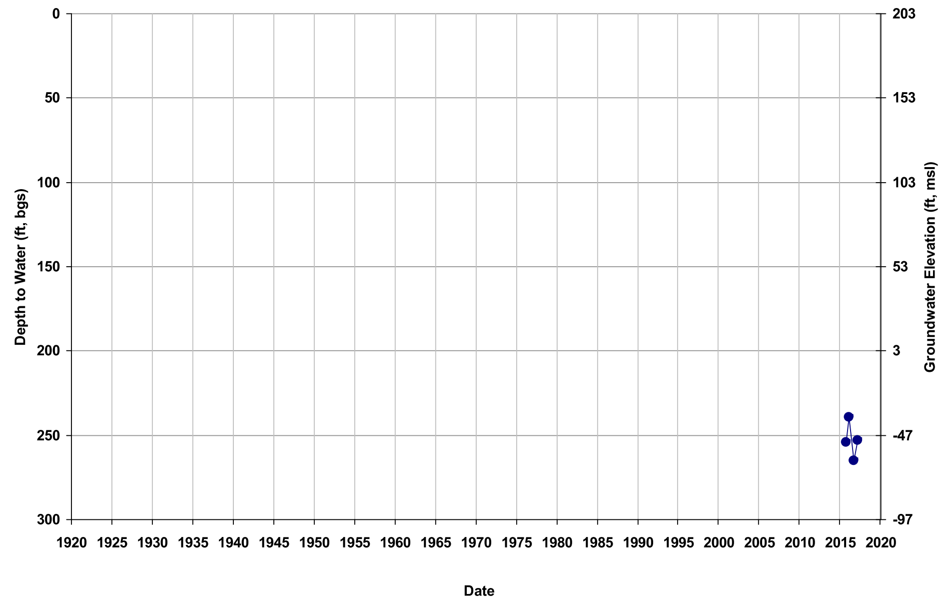
Well ID: 10S16E28D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 217
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



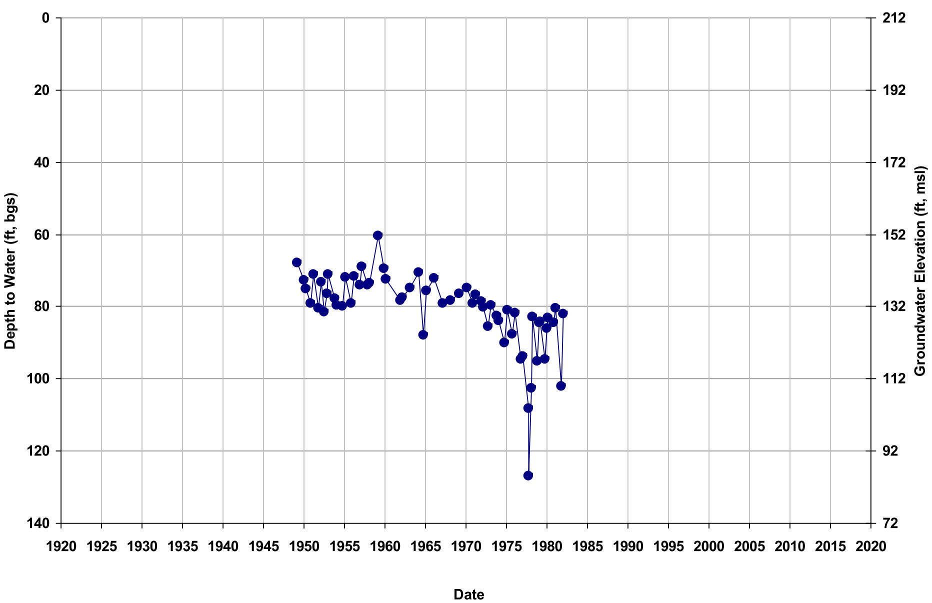
Well ID: 10S16E32K
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 203
Total Depth (ft): 624
Perf Top (ft): 278
Perf Bottom (ft): 588



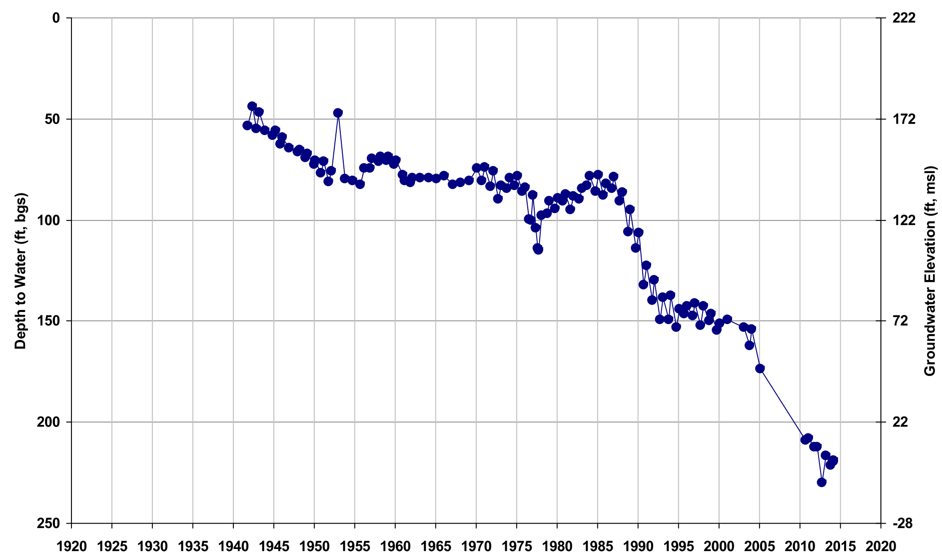
Well ID: 10S16E33P001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 212
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

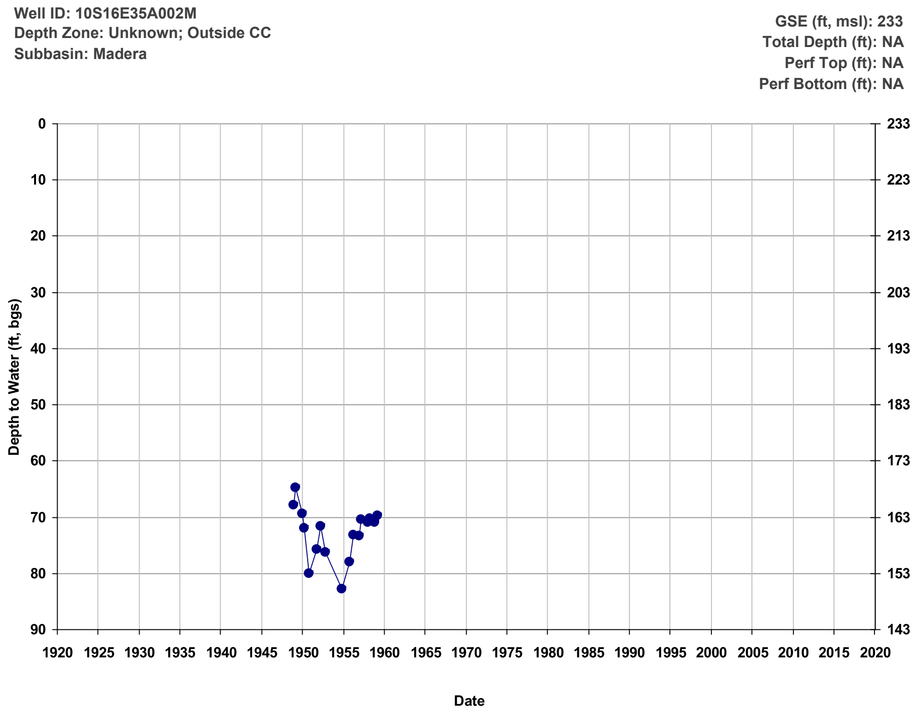


Well ID: 10S16E34H001M
Depth Zone: Upper; Outside CC
Subbasin: Madera

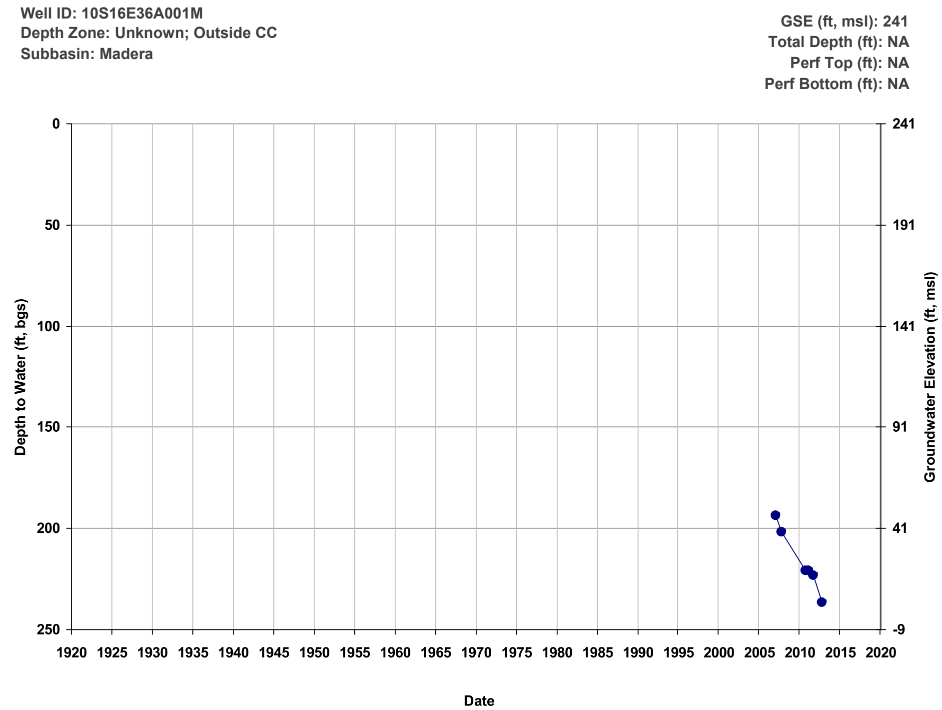
GSE (ft, msl): 222
Total Depth (ft): 120
Perf Top (ft): NA
Perf Bottom (ft): NA



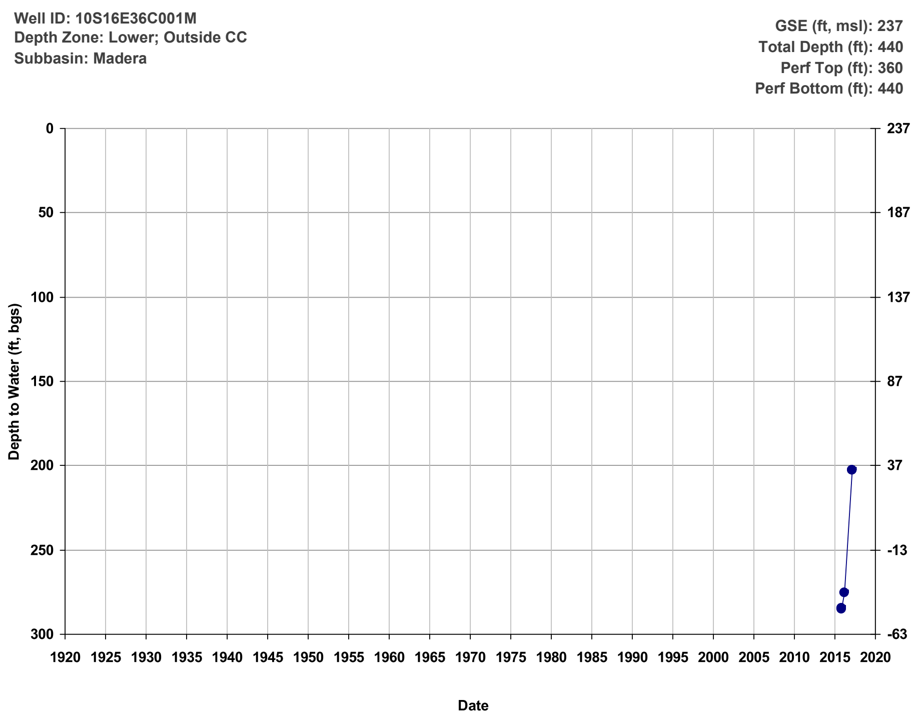
Date



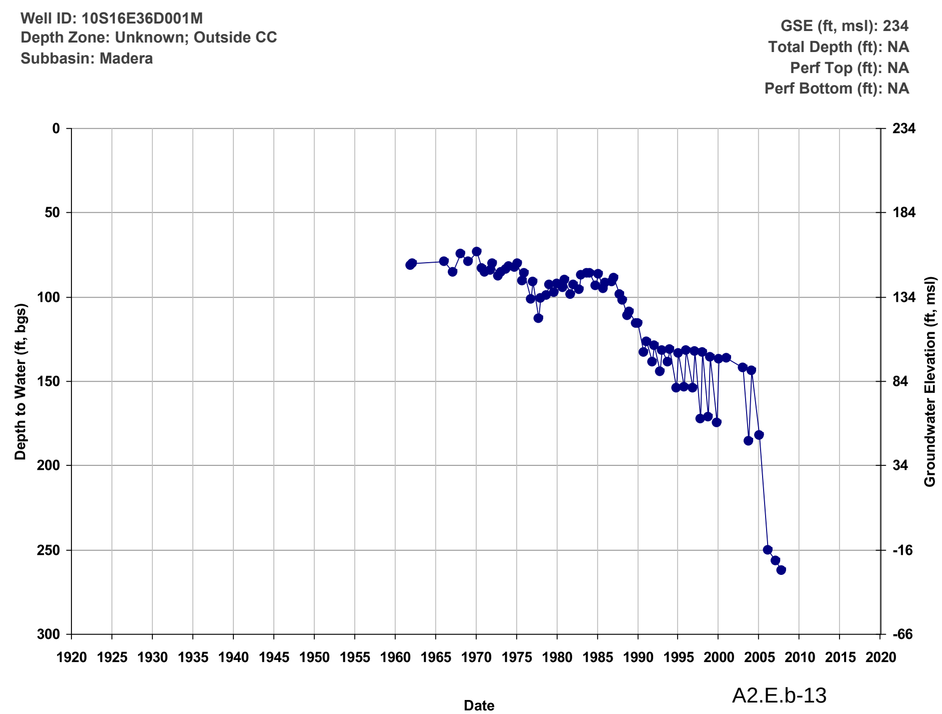
Well ID: 10S16E35A002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 233
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



Well ID: 10S16E36A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 241
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



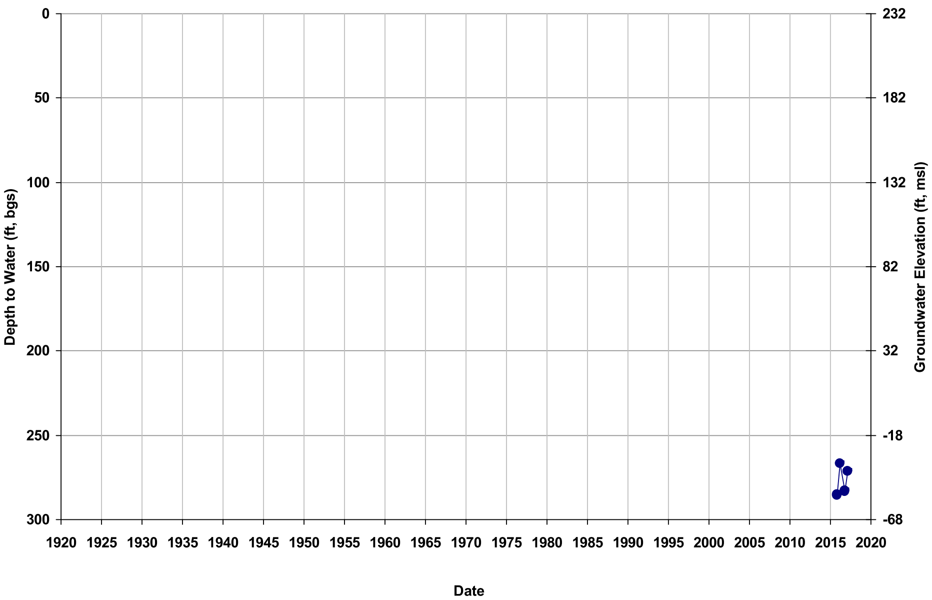
Well ID: 10S16E36C001M
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 237
Total Depth (ft): 440
Perf Top (ft): 360
Perf Bottom (ft): 440
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



Well ID: 10S16E36D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 234
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

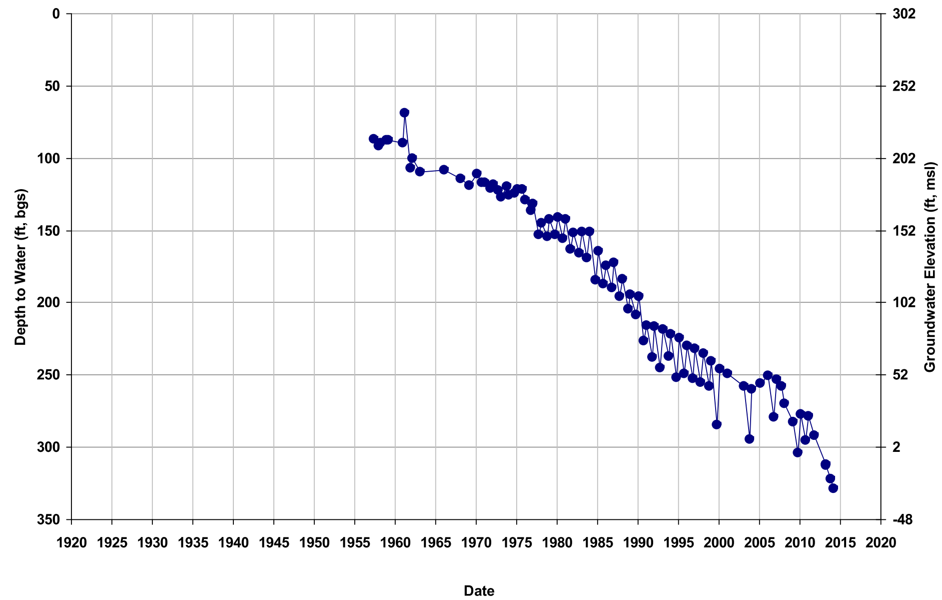
Well ID: 10S16E36E001M
Depth Zone: Composite or Lower; O
Subbasin: Madera

GSE (ft, msl): 232
Total Depth (ft): 500
Perf Top (ft): NA
Perf Bottom (ft): NA



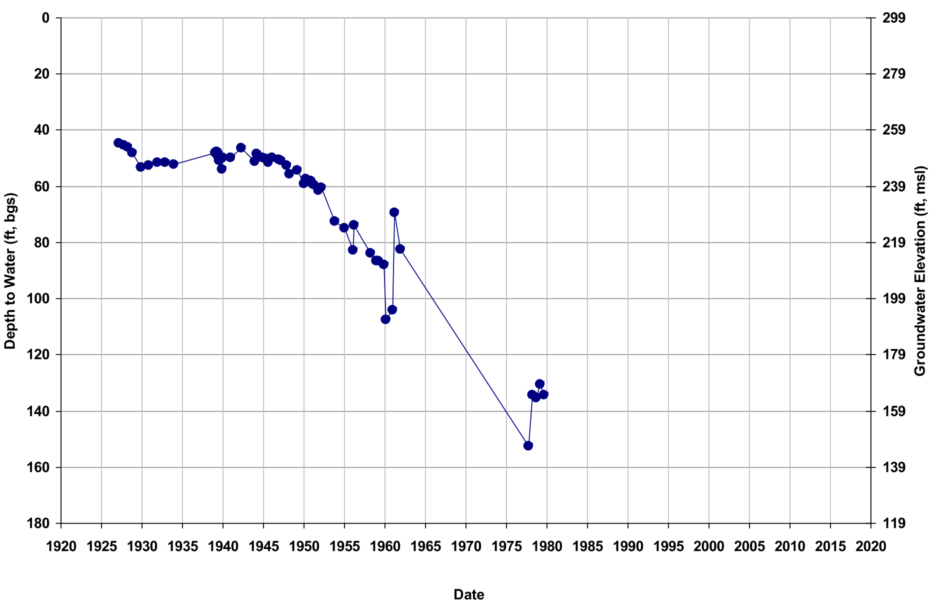
Well ID: 10S17E03F001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 302
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



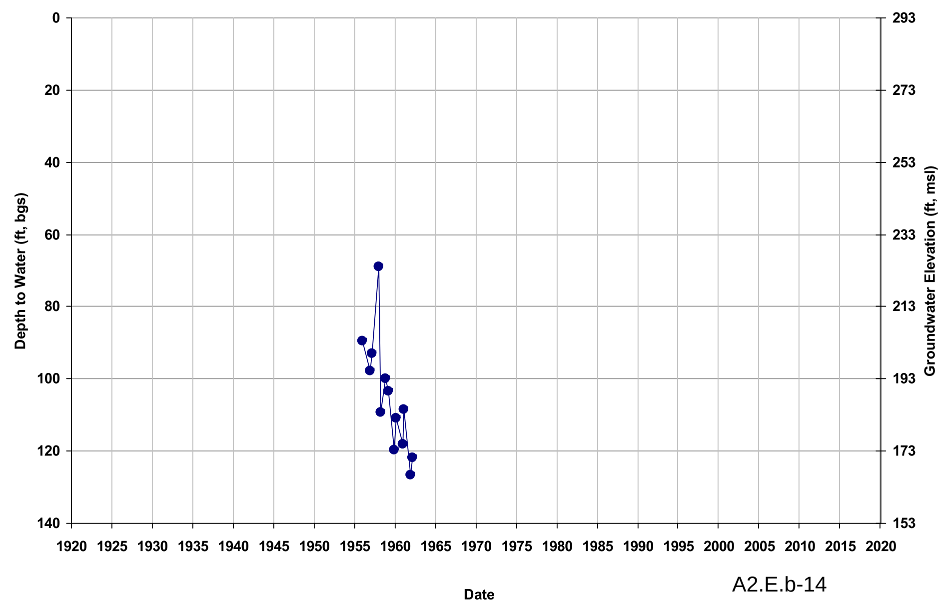
Well ID: 10S17E04J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 298
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



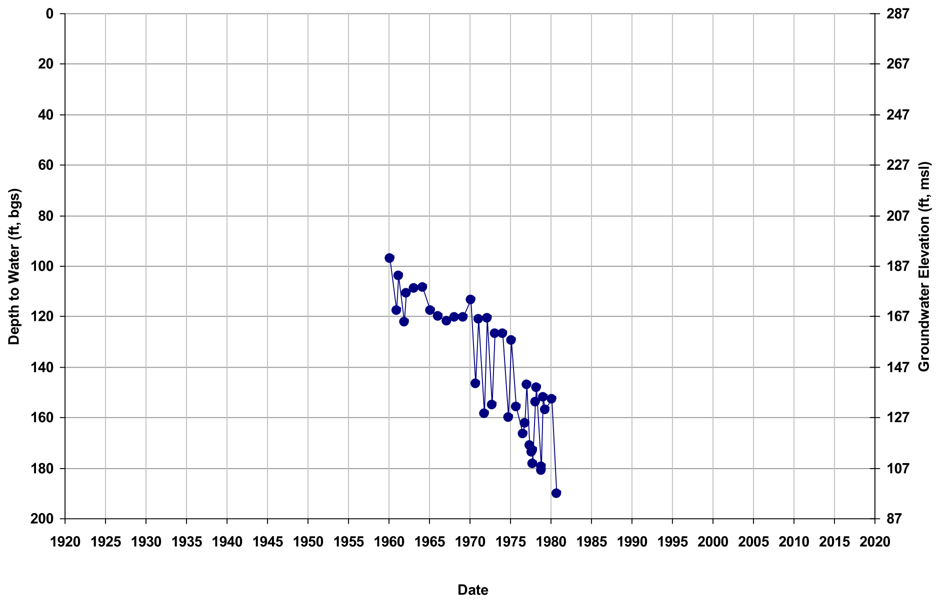
Well ID: 10S17E05H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 293
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



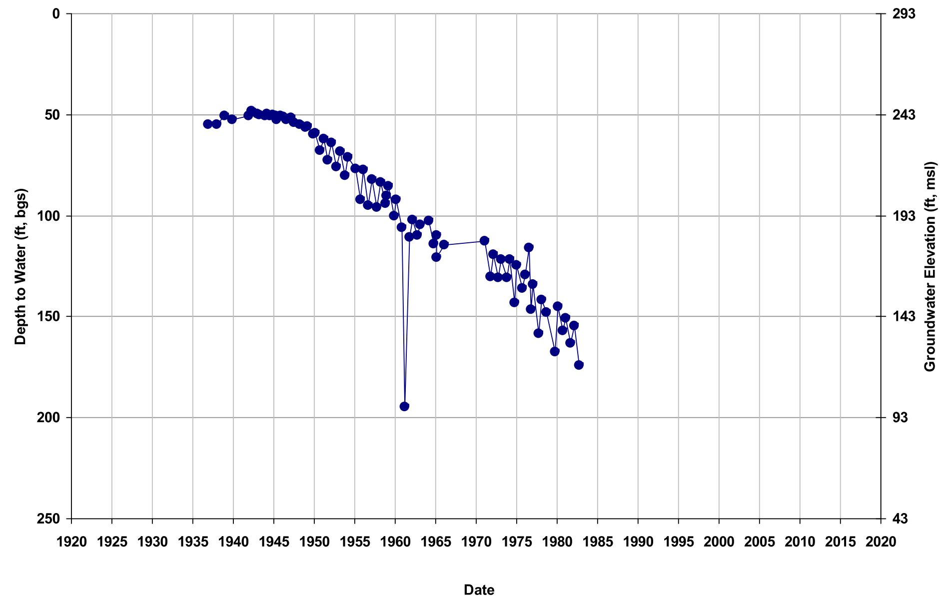
Well ID: 10S17E06A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 287
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



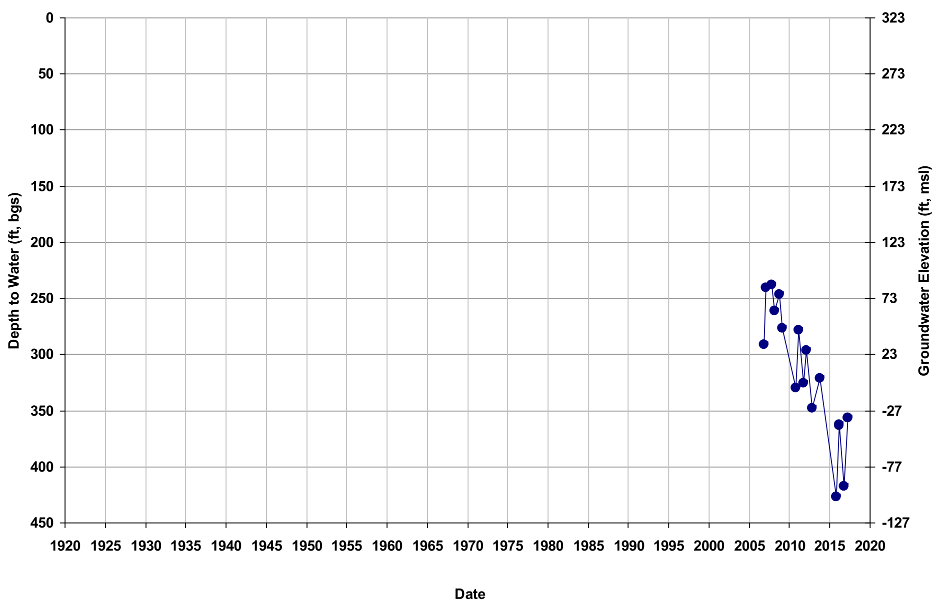
Well ID: 10S17E09A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 293
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



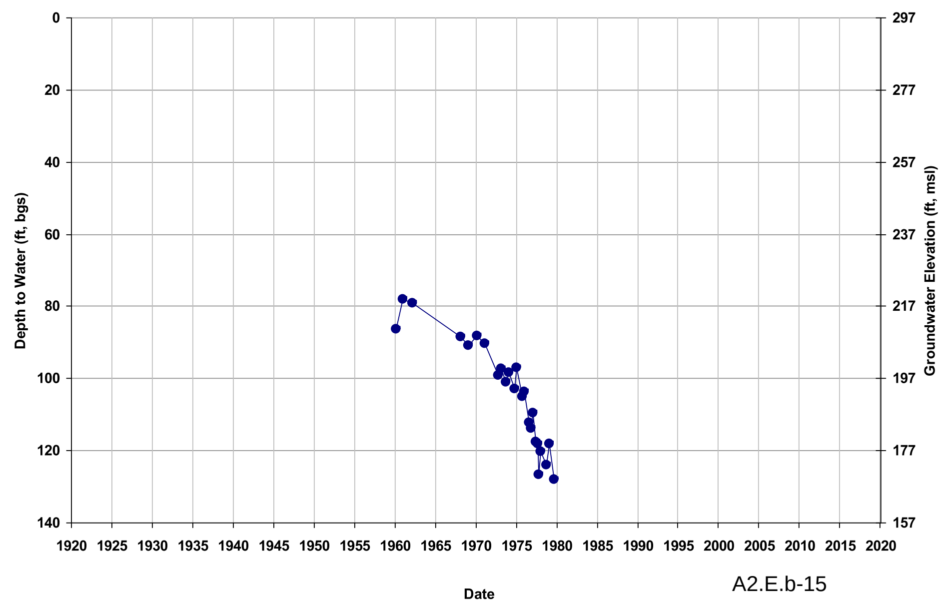
Well ID: 10S17E12C001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 323
Total Depth (ft): 640
Perf Top (ft): 140
Perf Bottom (ft): 502



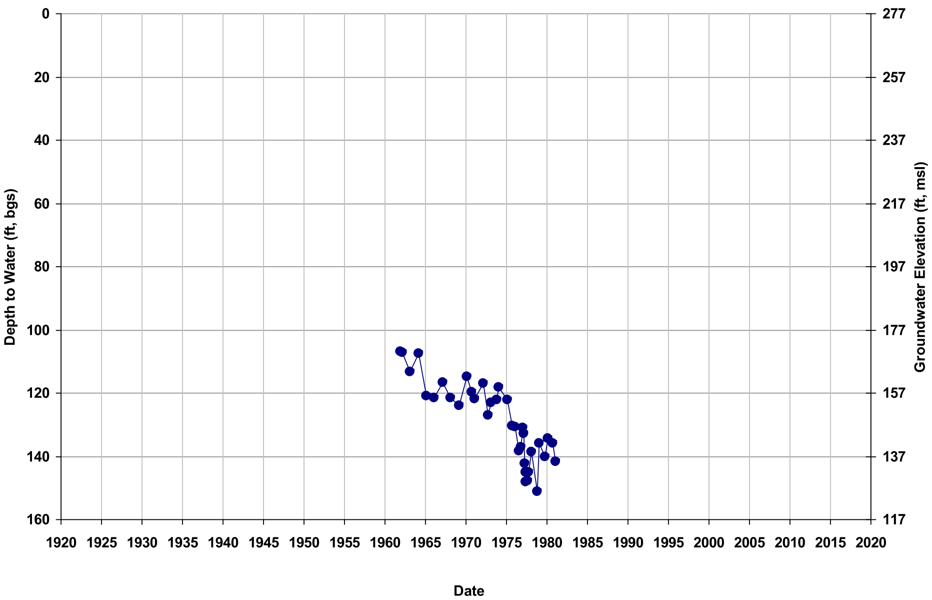
Well ID: 10S17E14C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 297
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



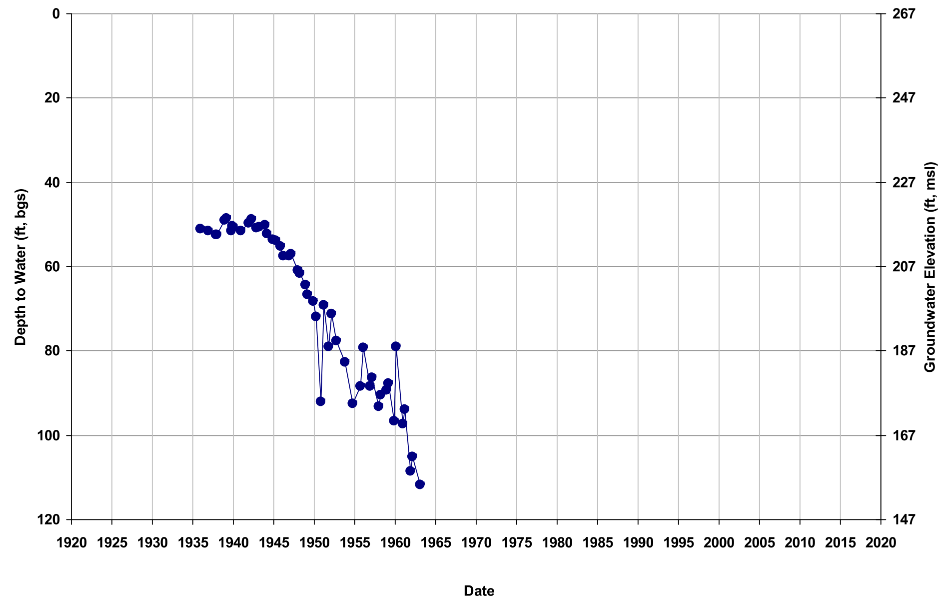
Well ID: 10S17E17A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 277
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



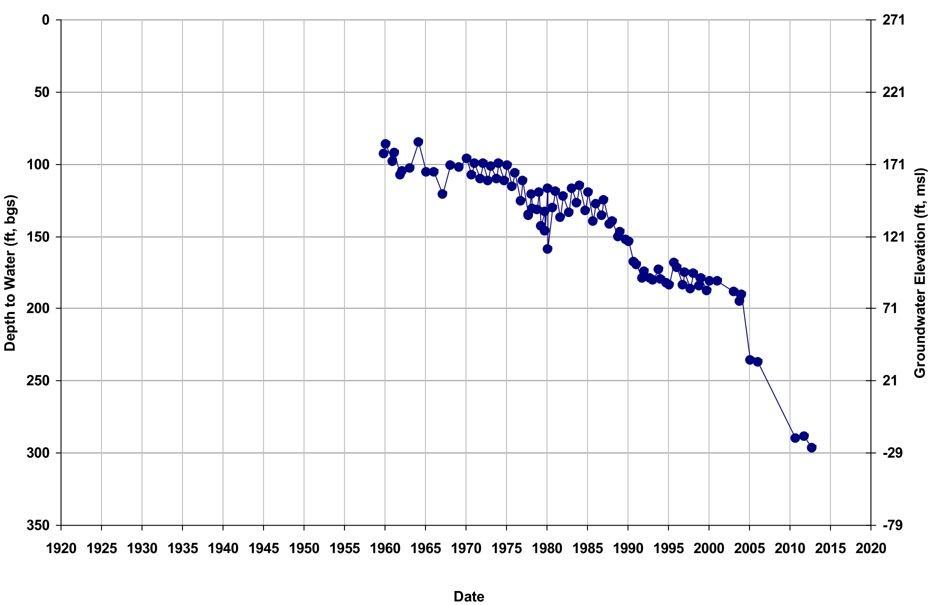
Well ID: 10S17E18H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 267
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



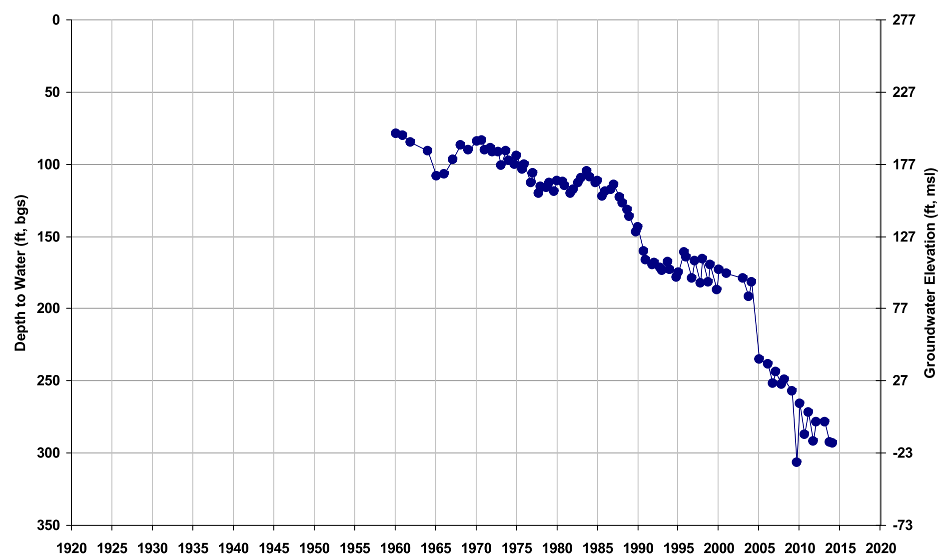
Well ID: 10S17E21M001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 271
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



Well ID: 10S17E22D001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 277
Total Depth (ft): 250
Perf Top (ft): 140
Perf Bottom (ft): 250



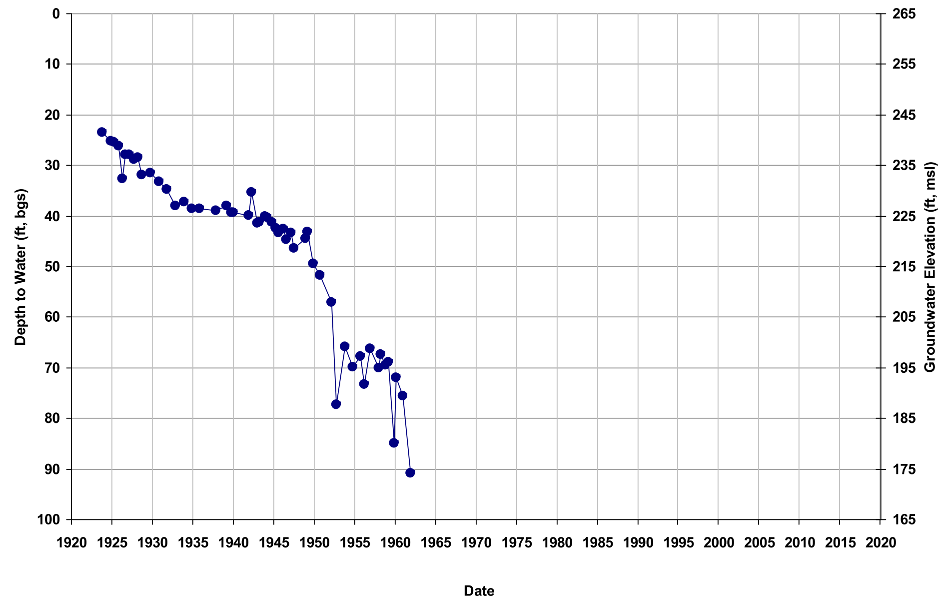
Date

Well ID: 10S17E23A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 296
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

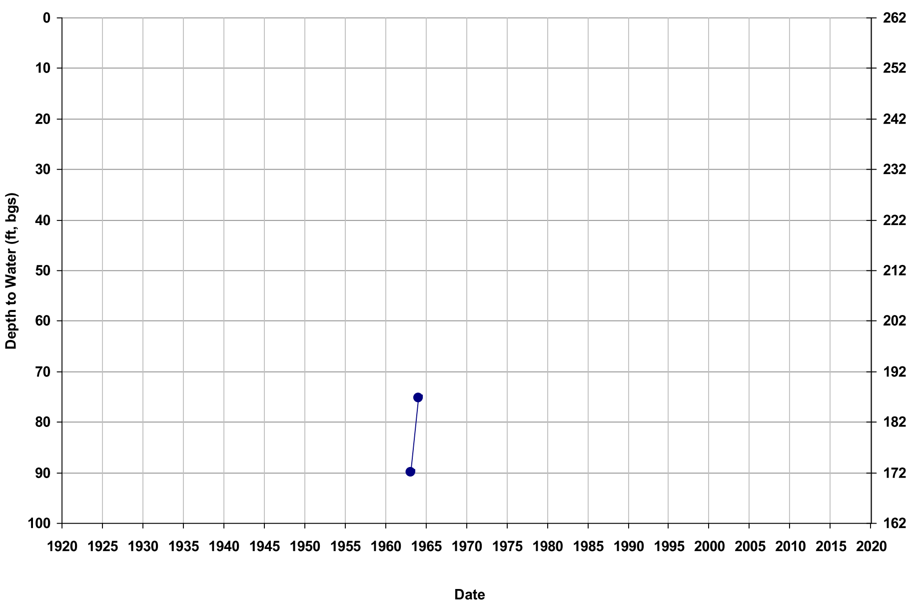
Well ID: 10S17E27E001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 265
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



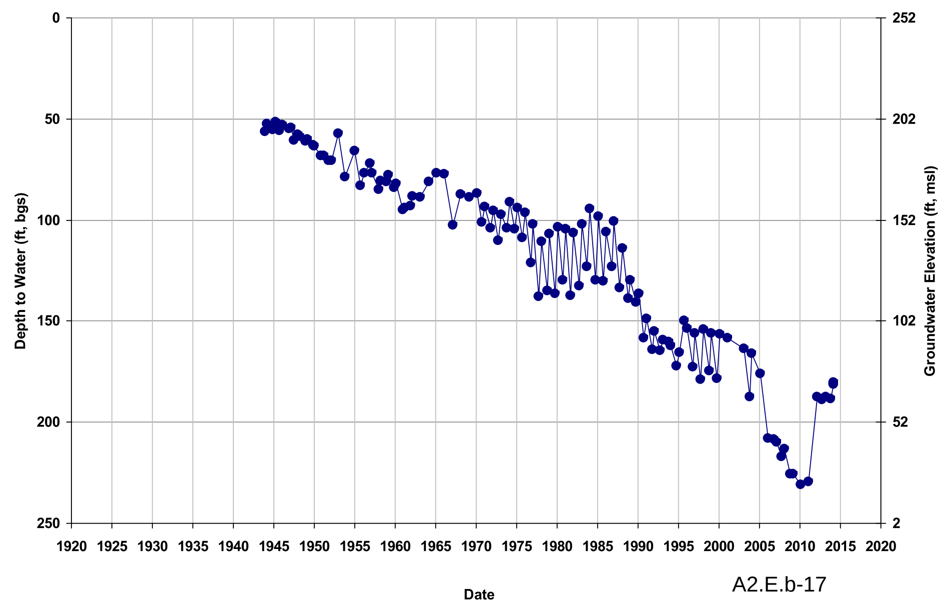
Well ID: 10S17E28R001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 262
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



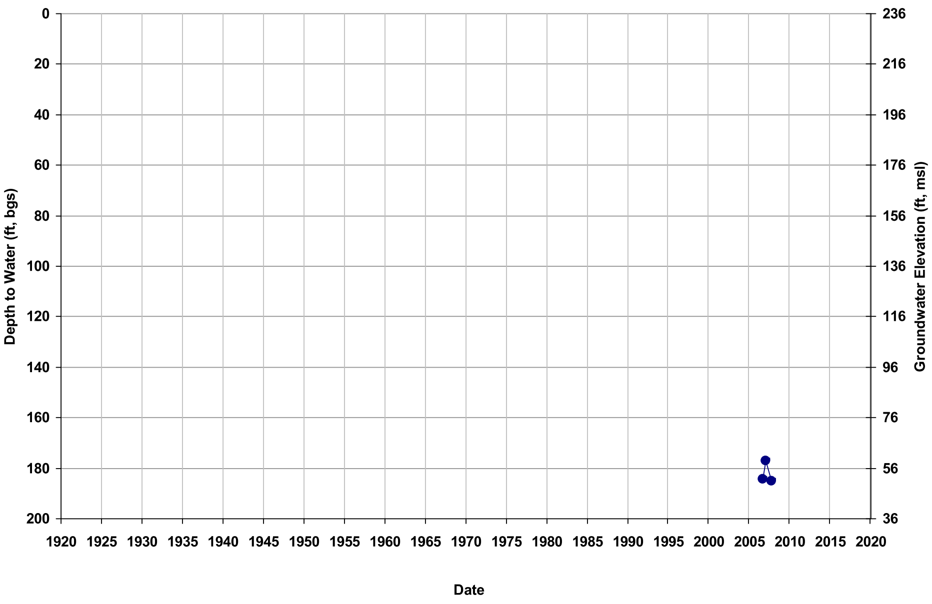
Well ID: 10S17E30B002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 252
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



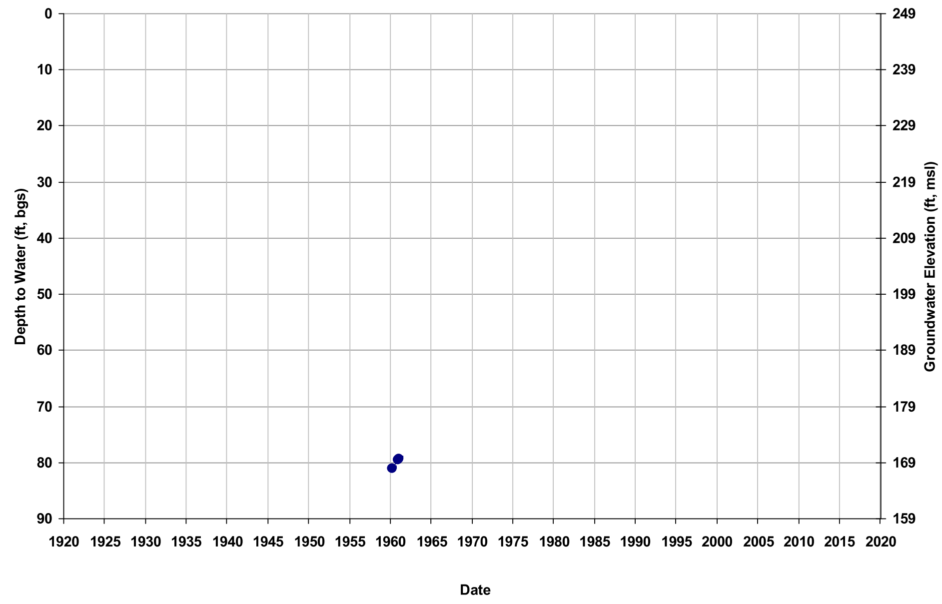
Well ID: 10S17E31N001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 236
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



Well ID: 10S17E32J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 249
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

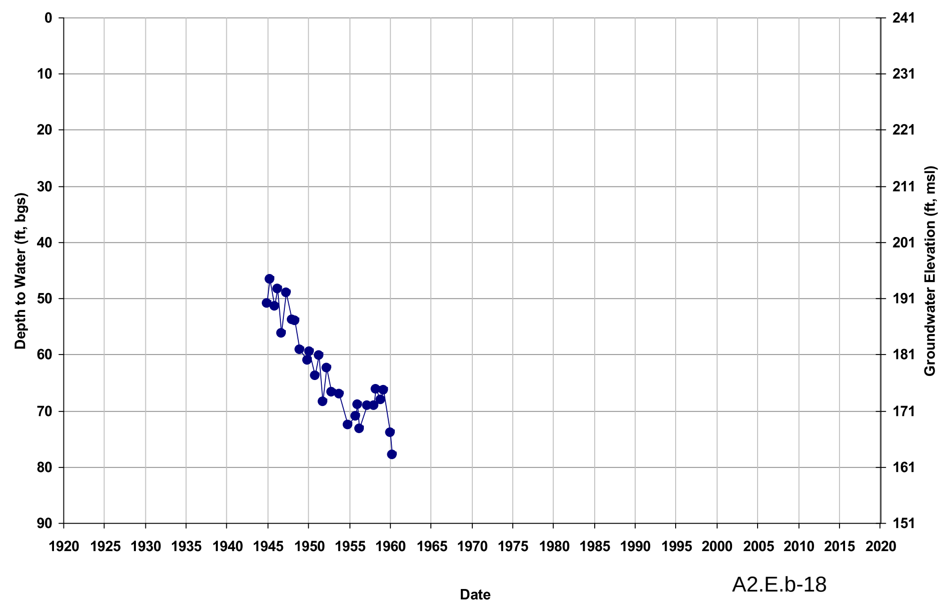


Well ID: 10S17E32K001M
Depth Zone: Composite or Lower; O
Subbasin: Madera

GSE (ft, msl): 248
Total Depth (ft): 288
Perf Top (ft): NA
Perf Bottom (ft): NA

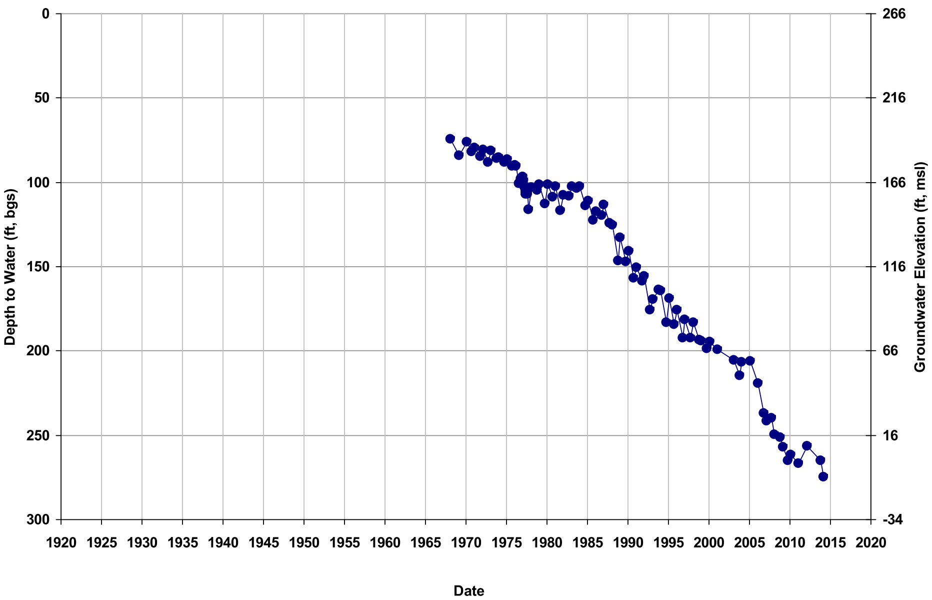
Well ID: 10S17E32N001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 241
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



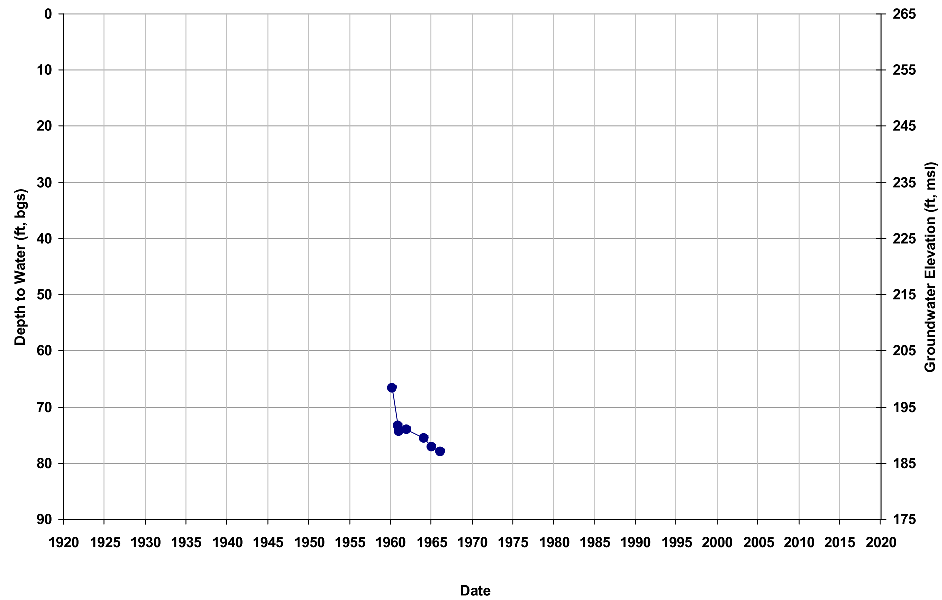
Well ID: 10S17E34A002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 266
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



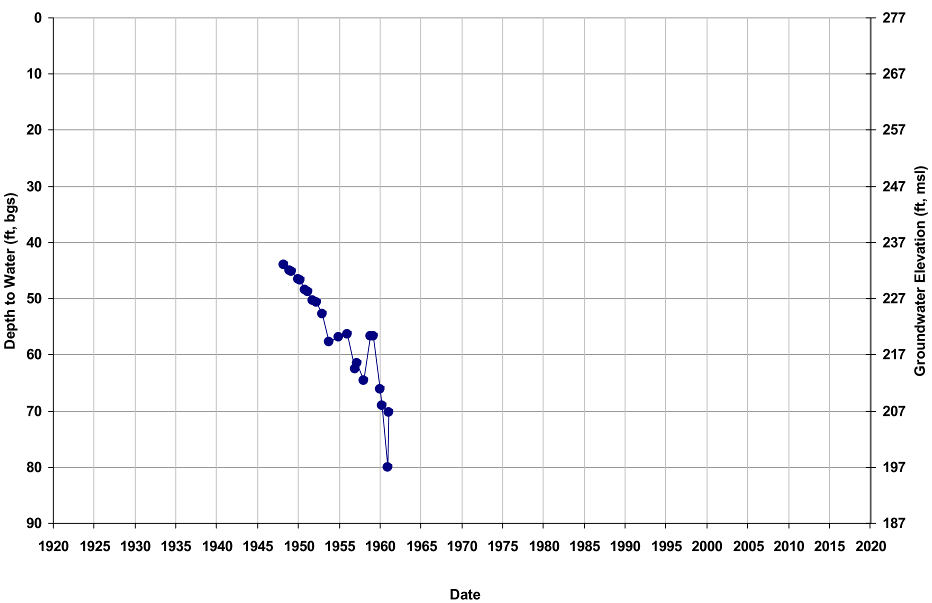
Well ID: 10S17E34R001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 265
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



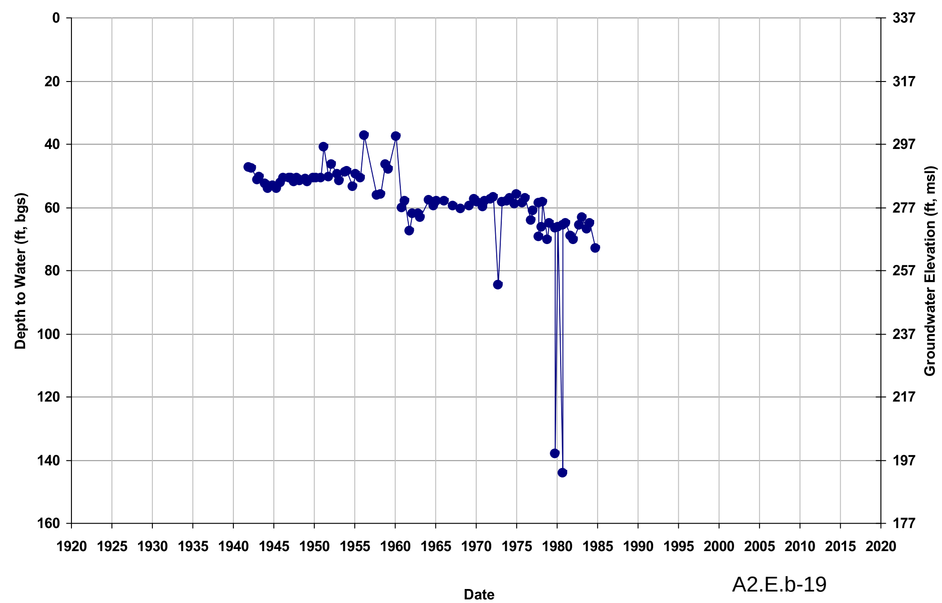
Well ID: 10S17E36E001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 277
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



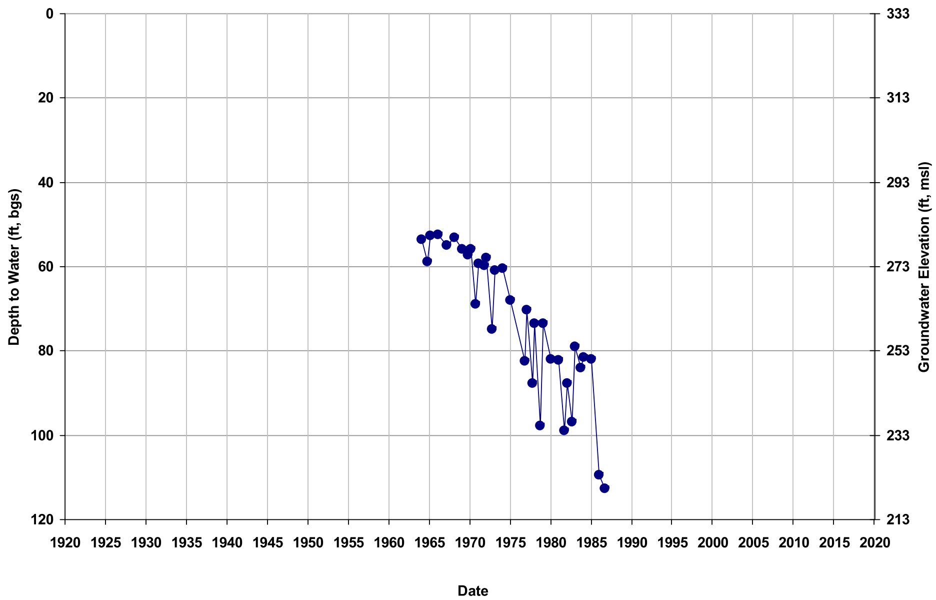
Well ID: 10S18E08L001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 337
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



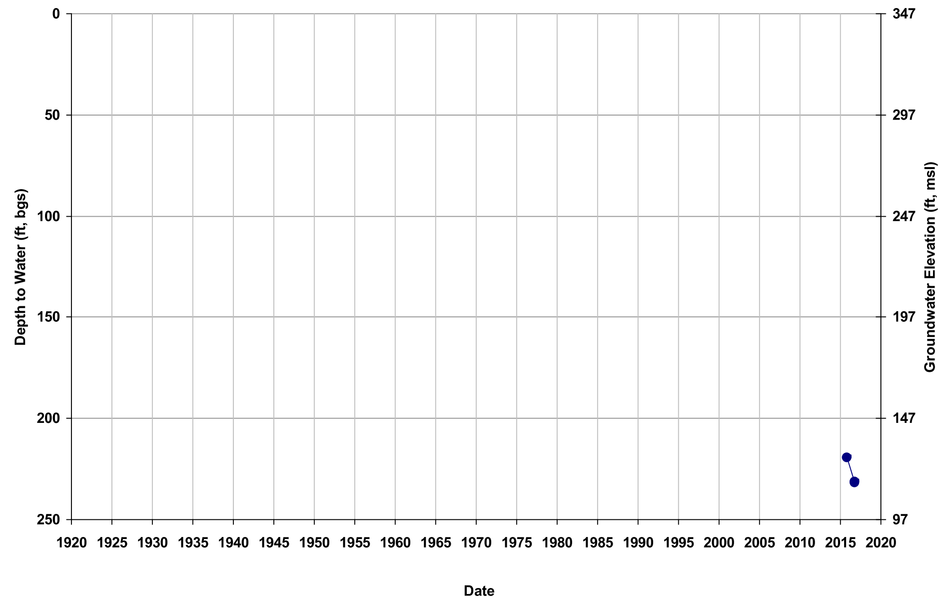
Well ID: 10S18E08L002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 333
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



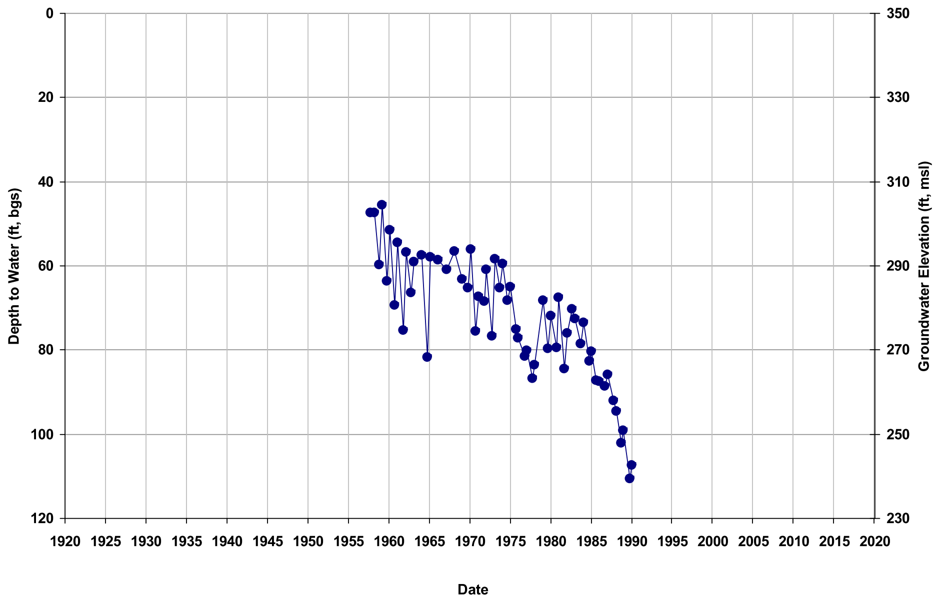
Well ID: 10S18E09A001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 346
Total Depth (ft): 890
Perf Top (ft): 400
Perf Bottom (ft): 716



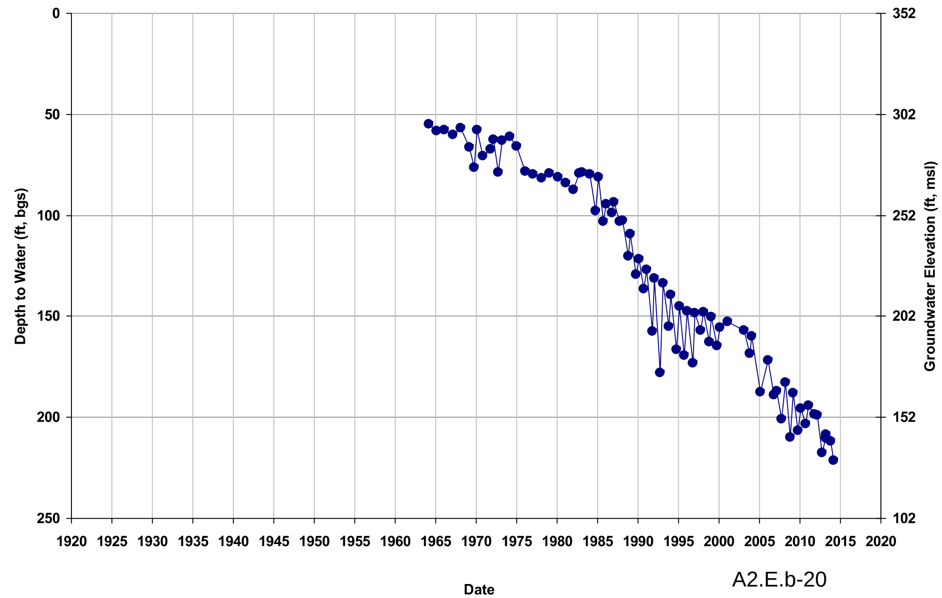
Well ID: 10S18E09B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

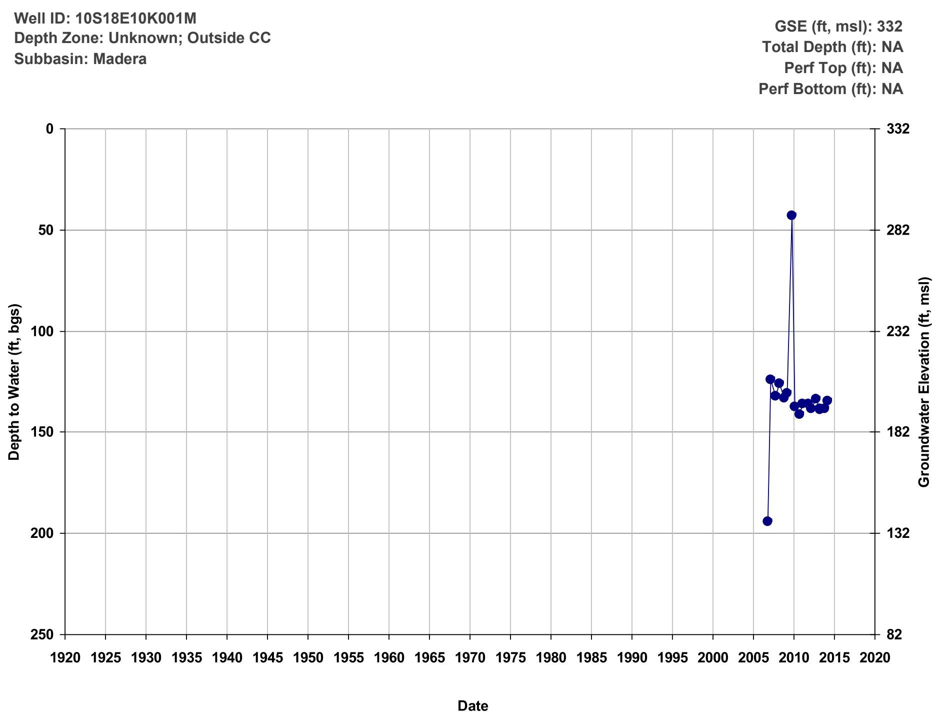
GSE (ft, msl): 350
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



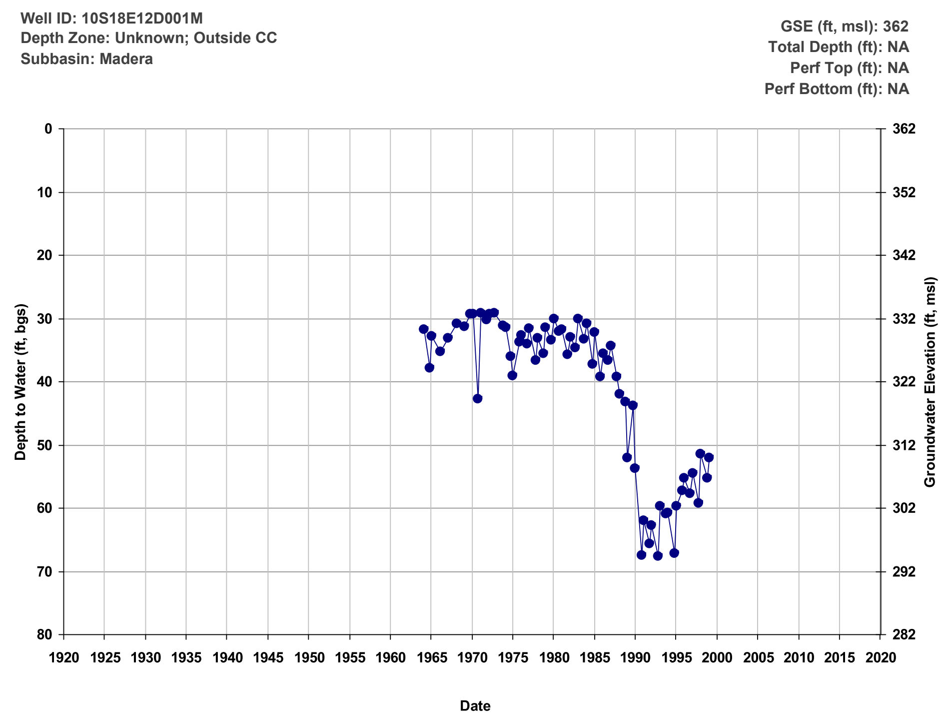
Well ID: 10S18E09C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 351
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

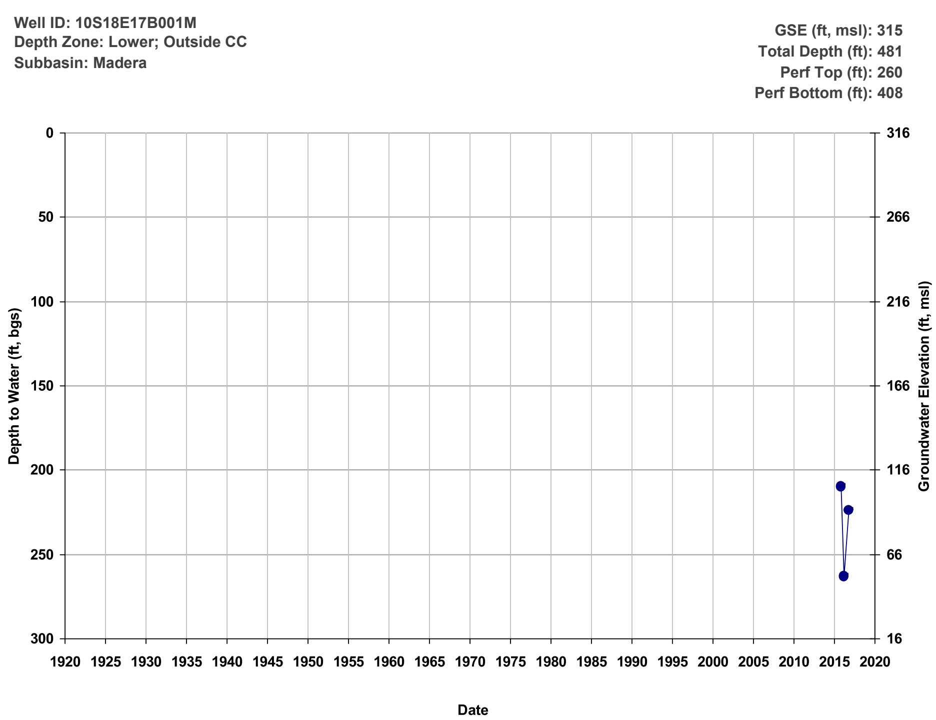




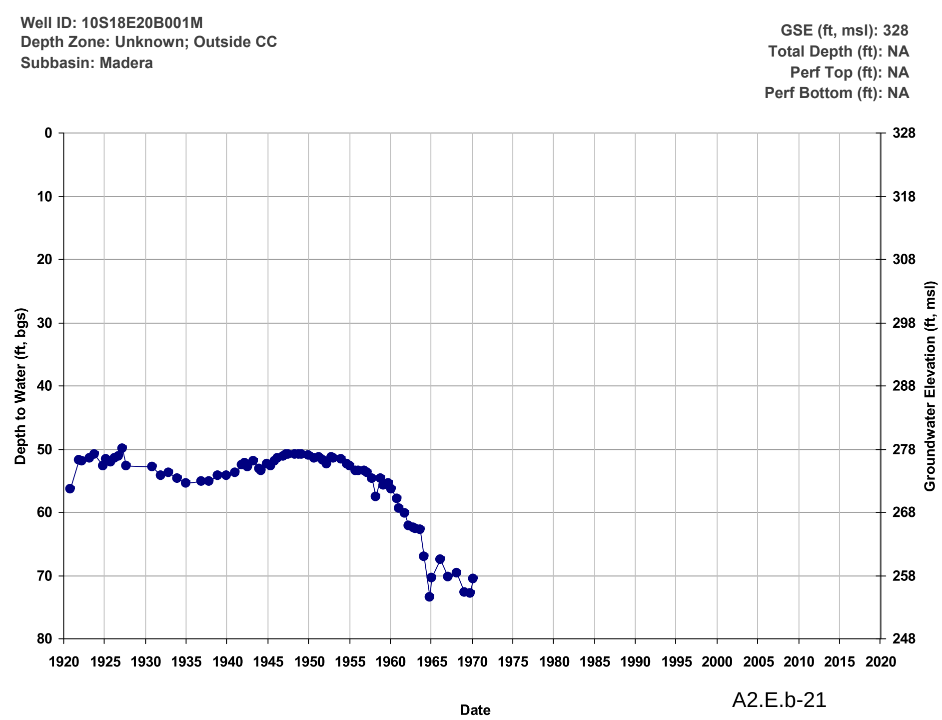
Well ID: 10S18E10K001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 332
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



Well ID: 10S18E12D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 362
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



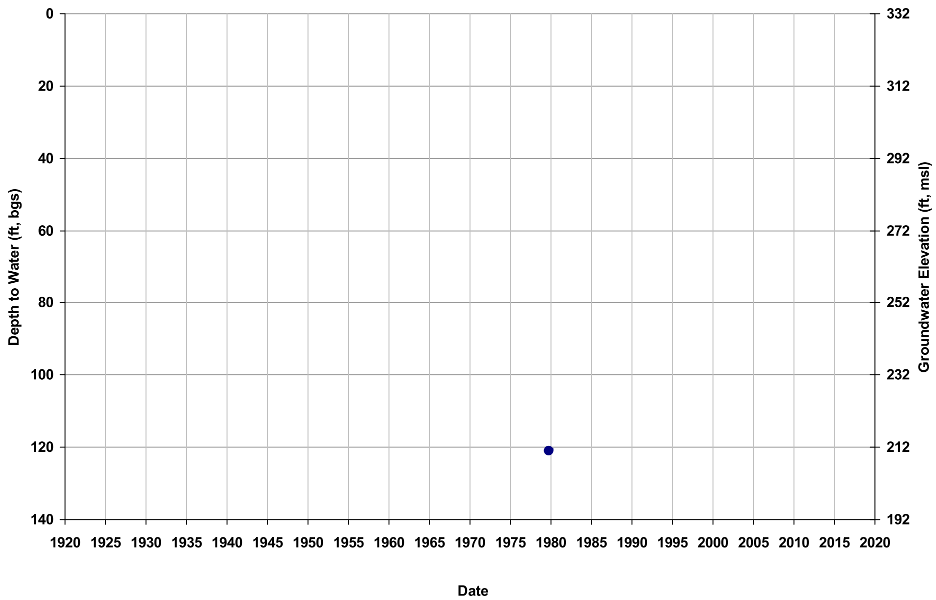
Well ID: 10S18E17B001M
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 315
Total Depth (ft): 481
Perf Top (ft): 260
Perf Bottom (ft): 408
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



Well ID: 10S18E20B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 328
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

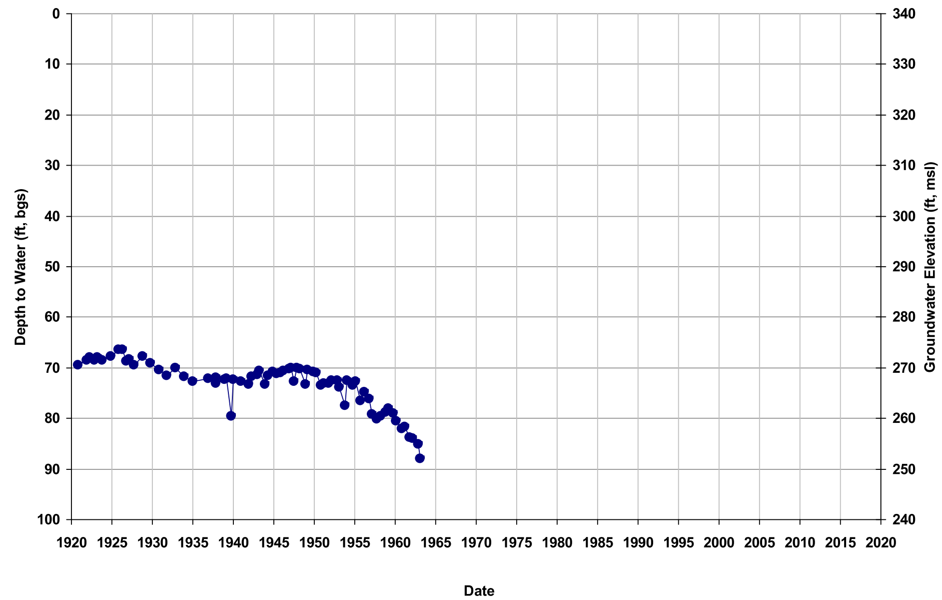
Well ID: 10S18E20G001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 332
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



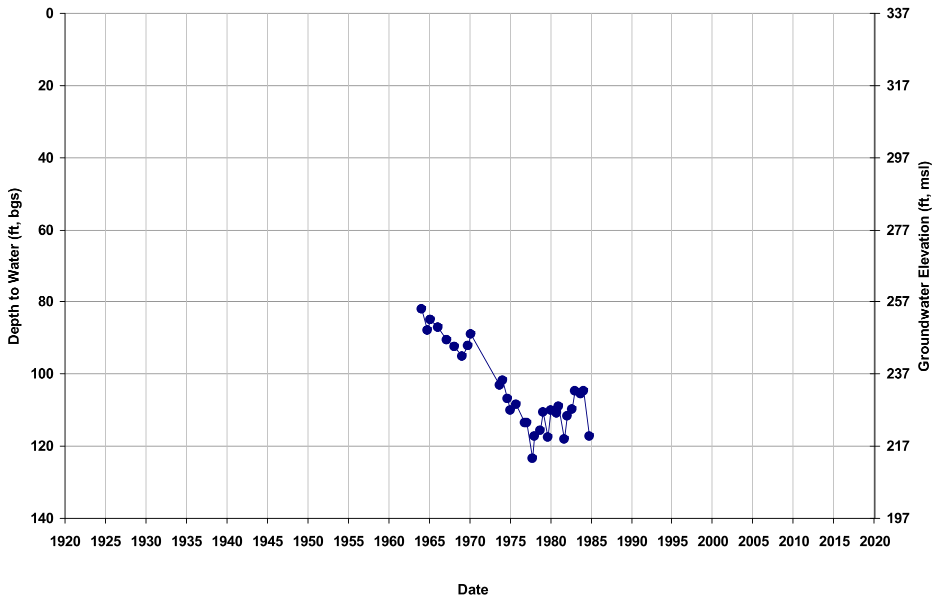
Well ID: 10S18E20M001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 339
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



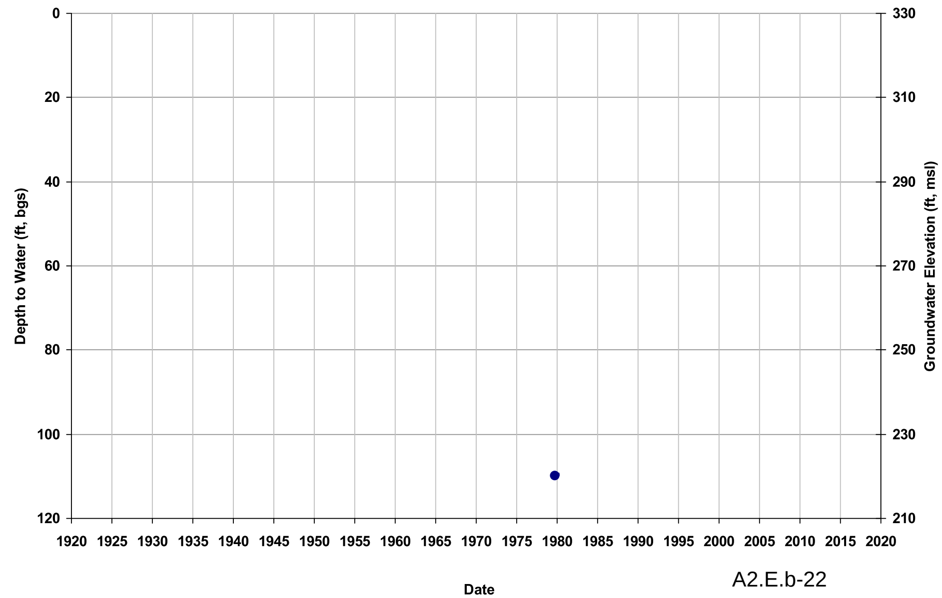
Well ID: 10S18E20M002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 337
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



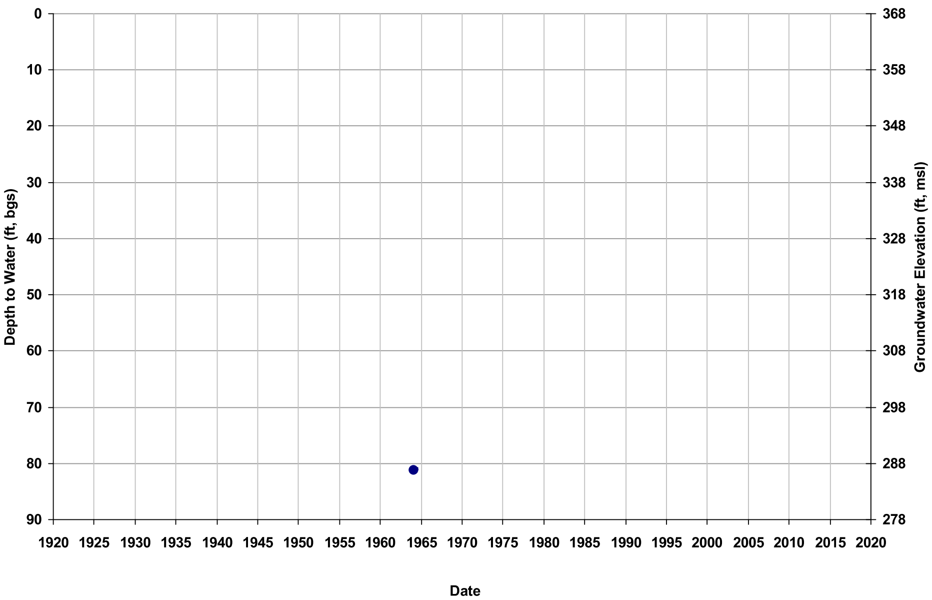
Well ID: 10S18E21F001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 330
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



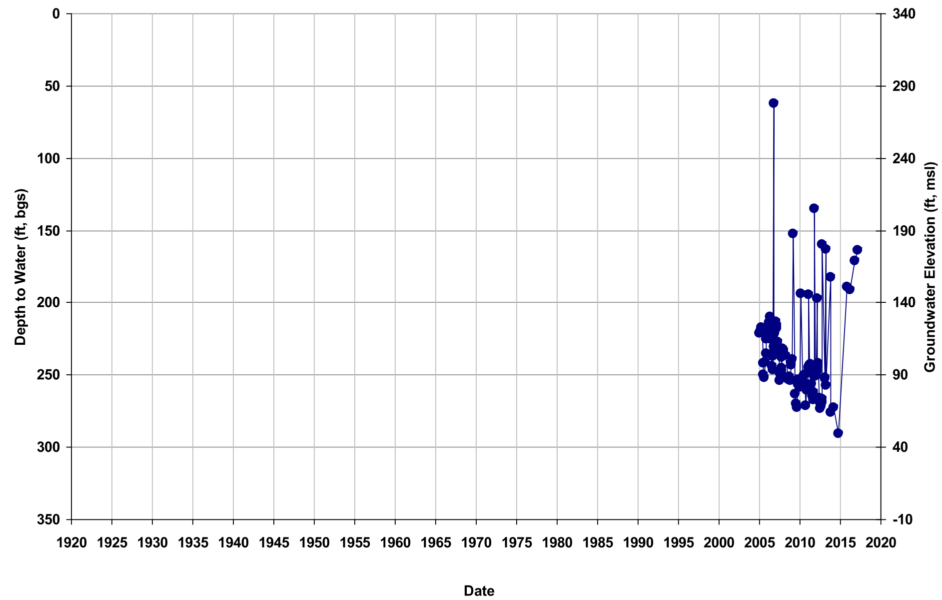
Well ID: 10S18E22B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 368
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



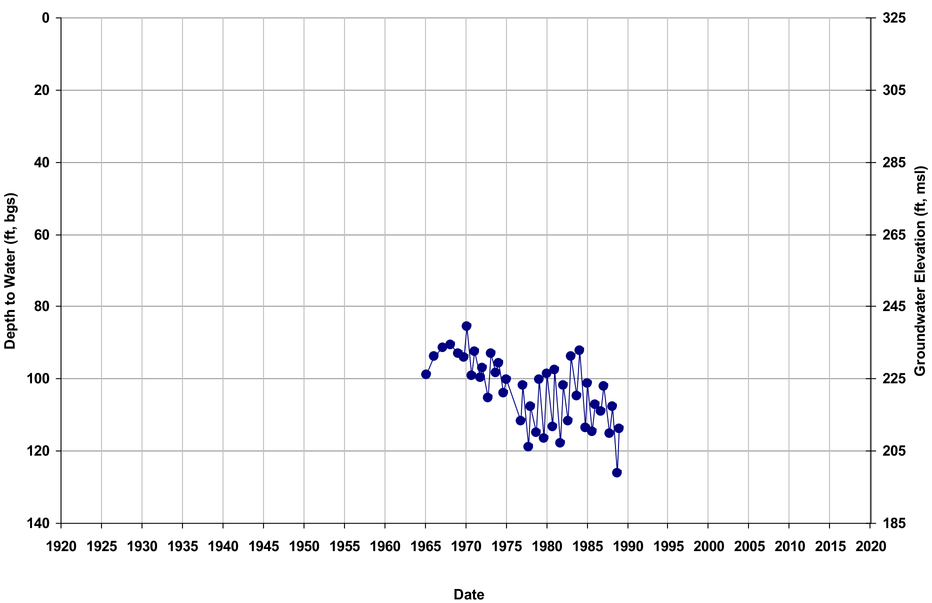
Well ID: 10S18E27N001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 340
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



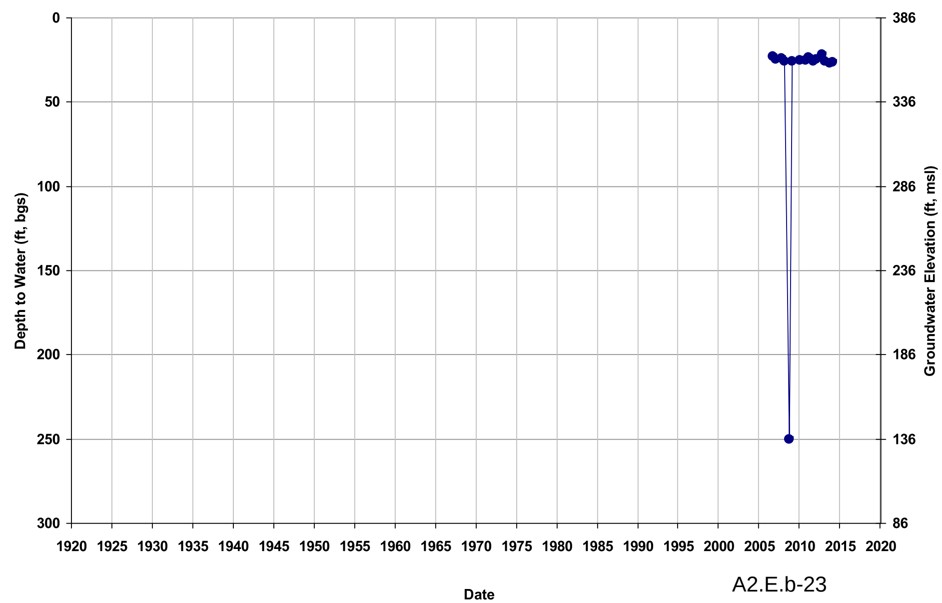
Well ID: 10S18E29Q001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

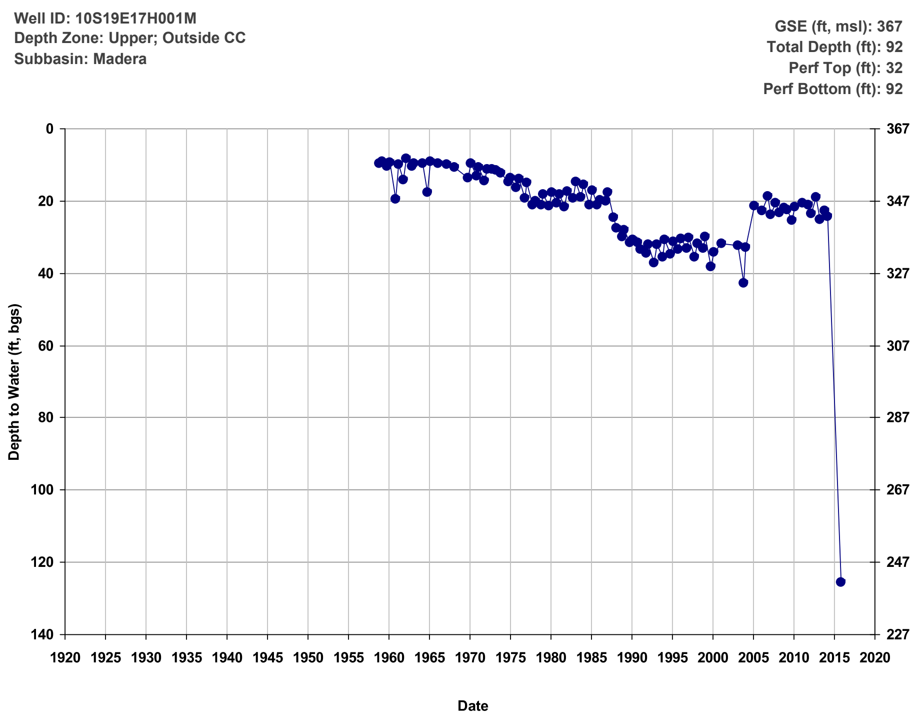
GSE (ft, msl): 325
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

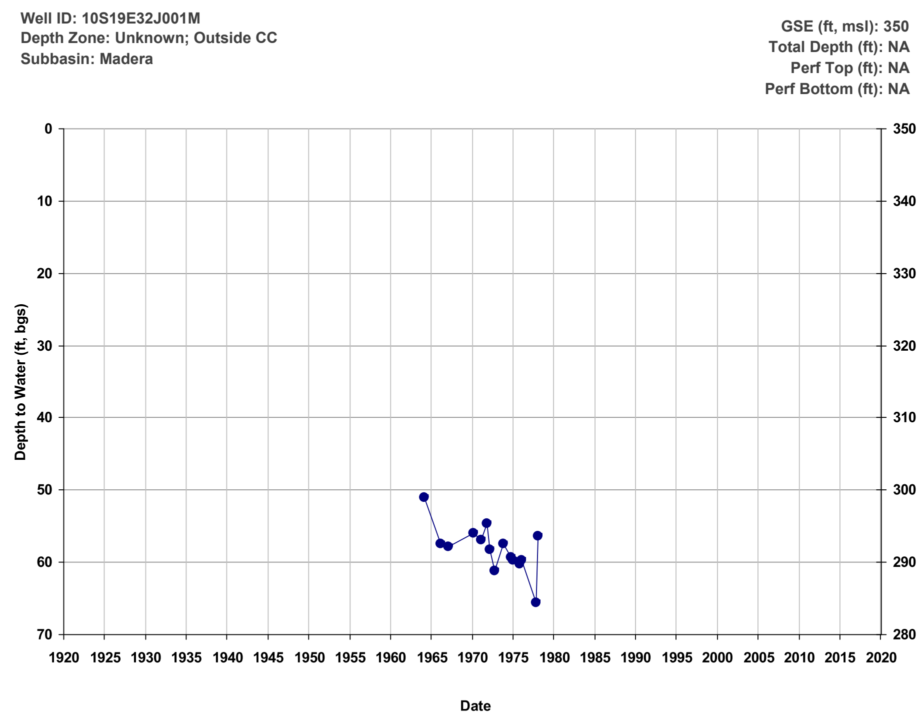


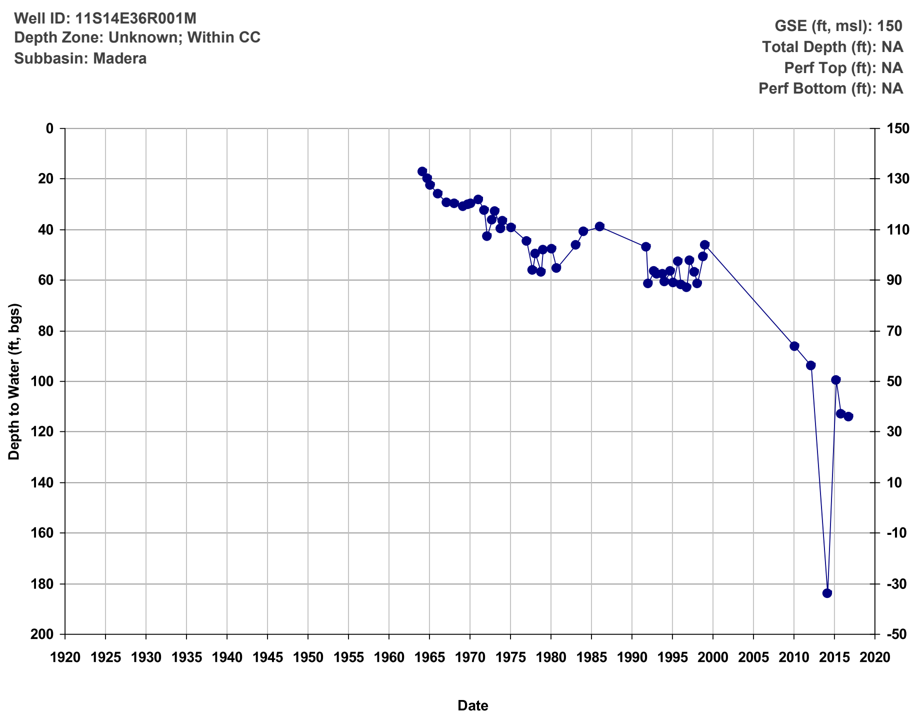
Well ID: 10S19E16D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

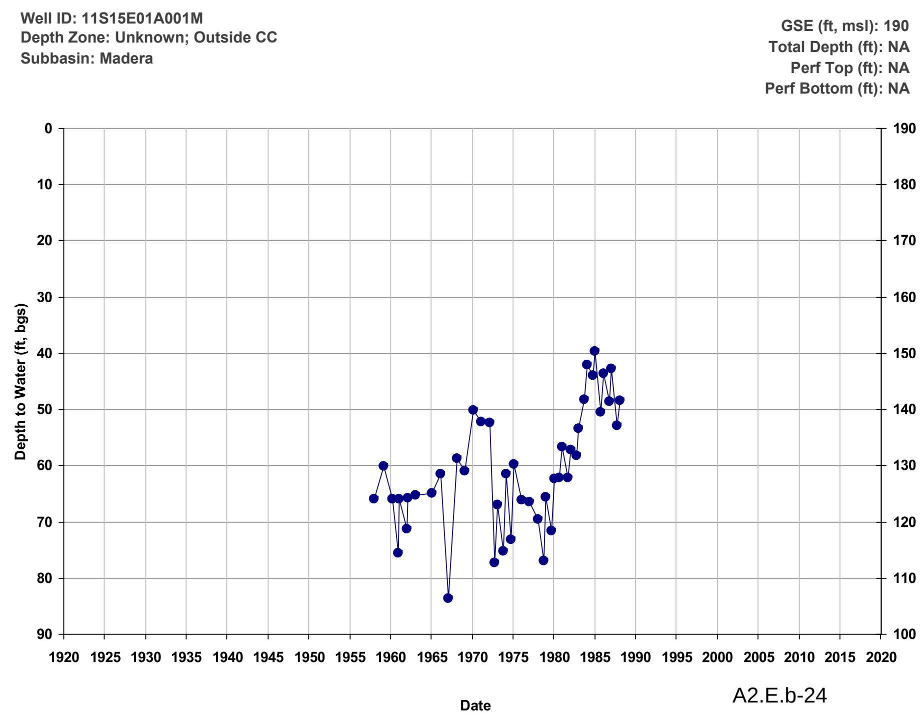
GSE (ft, msl): 386
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

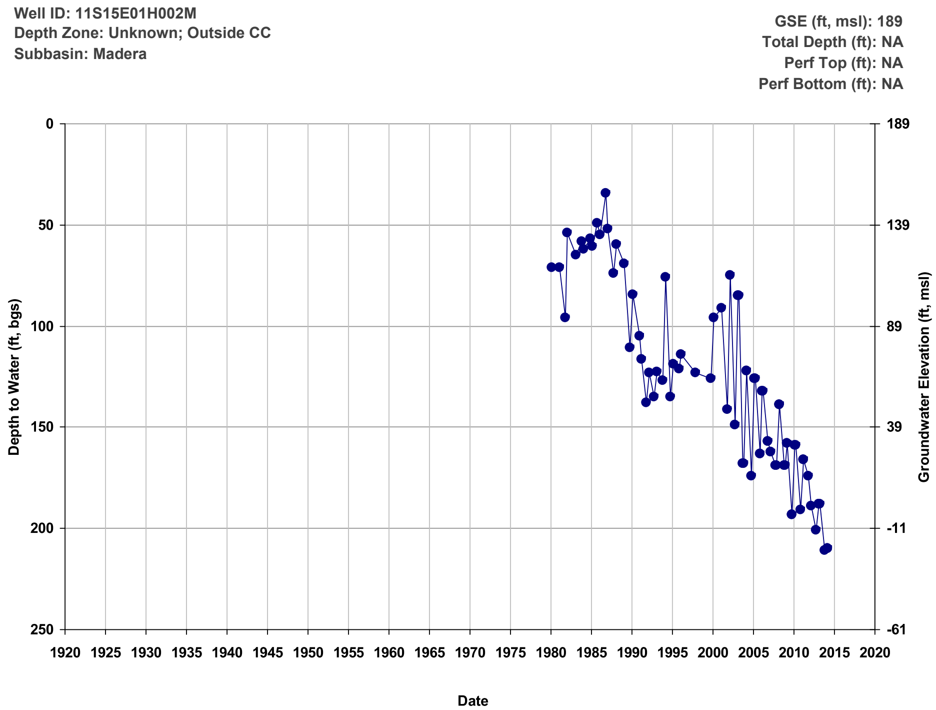


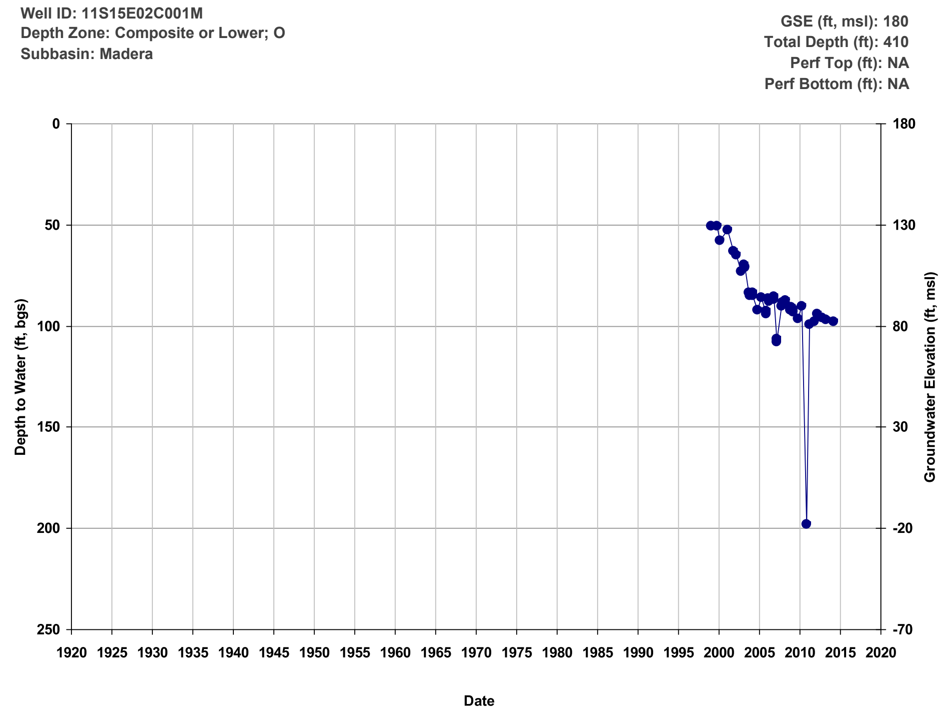

Well ID: 10S19E17H001M
Depth Zone: Upper; Outside CC
Subbasin: Madera
GSE (ft, msl): 367
Total Depth (ft): 92
Perf Top (ft): 32
Perf Bottom (ft): 92
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

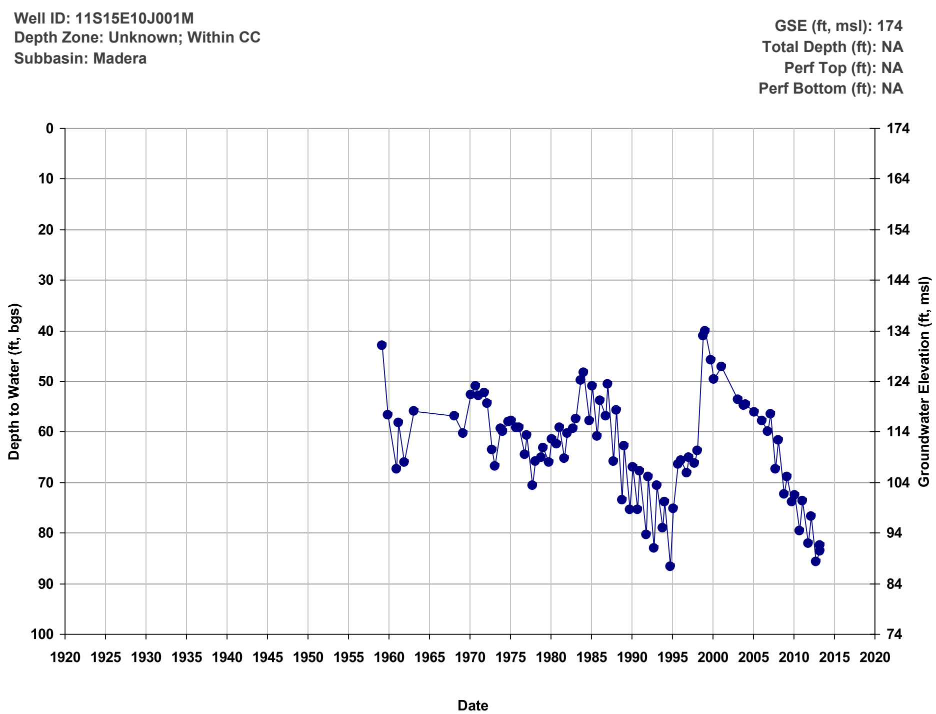

Well ID: 10S19E32J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 350
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

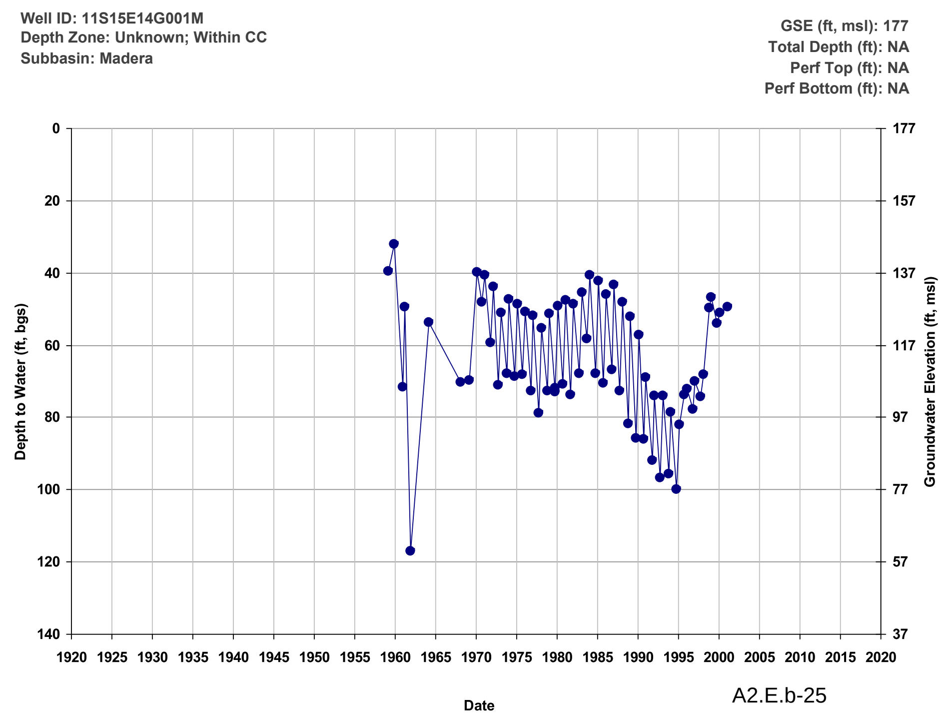

Well ID: 11S14E36R001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 150
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 11S15E01A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 190
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 11S15E01H002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 189
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

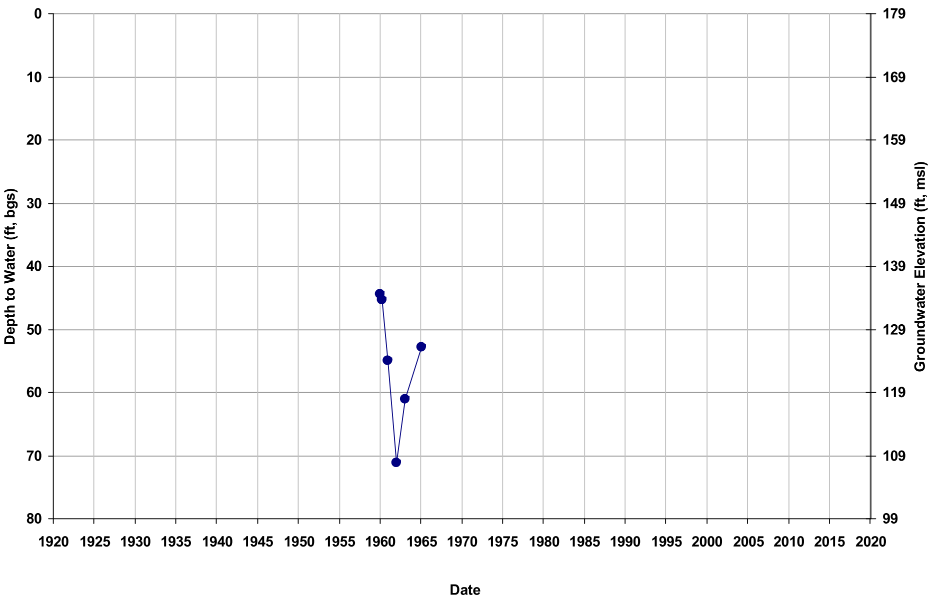

Well ID: 11S15E02C001M
Depth Zone: Composite or Lower; O
Subbasin: Madera
GSE (ft, msl): 180
Total Depth (ft): 410
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 11S15E10J001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 174
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 11S15E14G001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 177
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

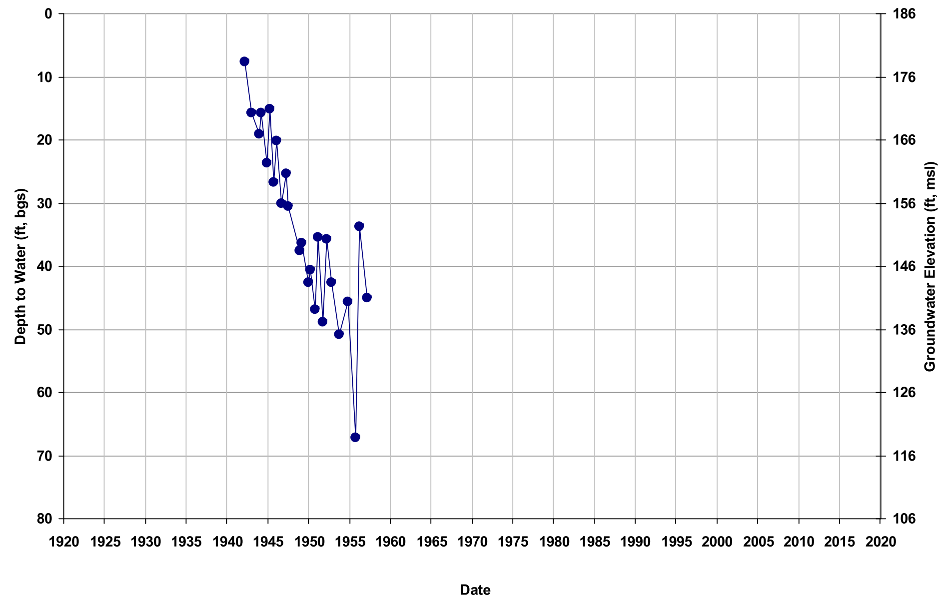
Well ID: 11S15E14R001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 179
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



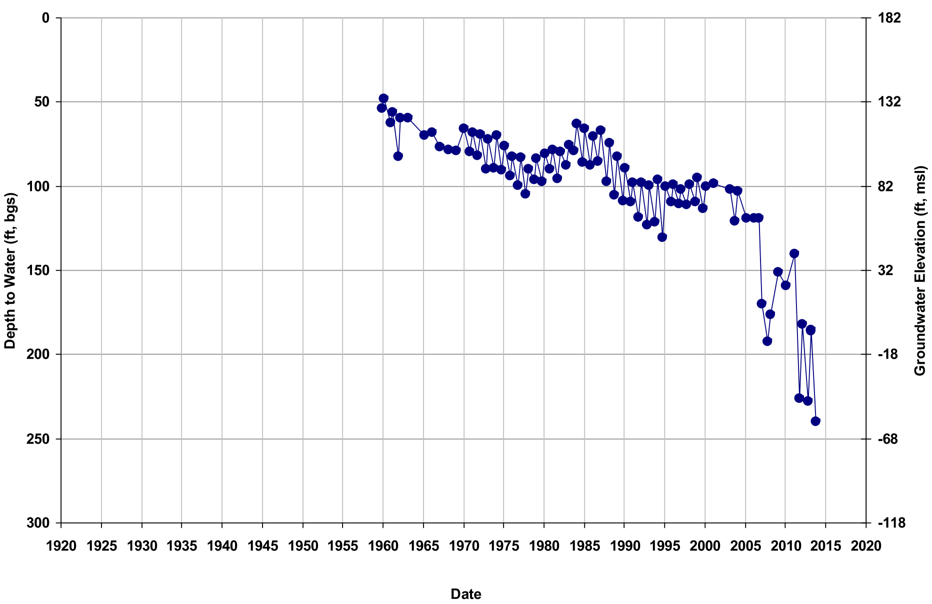
Well ID: 11S15E24A001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 186
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



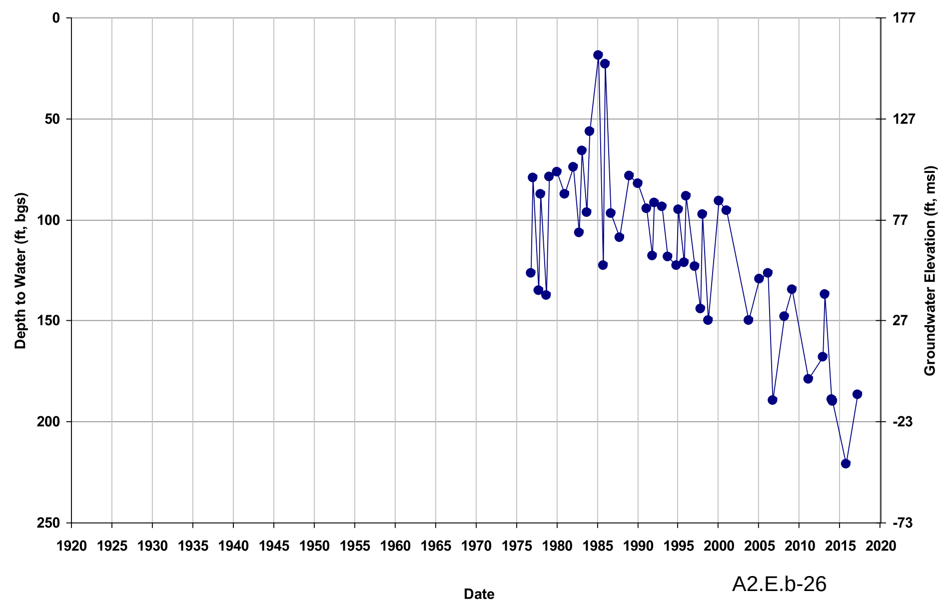
Well ID: 11S15E25A001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 182
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



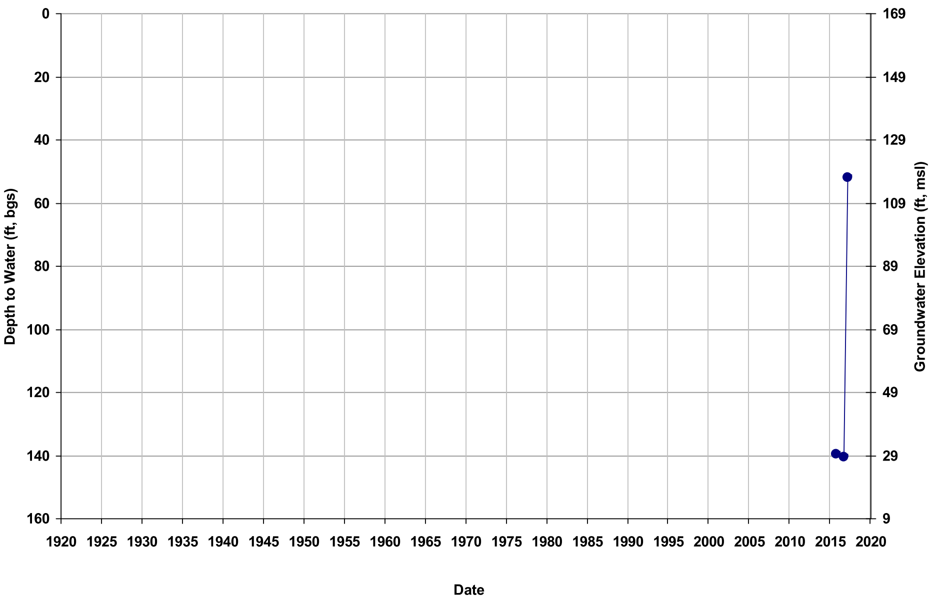
Well ID: 11S15E26R001M
Depth Zone: Composite; Within CC
Subbasin: Madera

GSE (ft, msl): 177
Total Depth (ft): 425
Perf Top (ft): 190
Perf Bottom (ft): 418



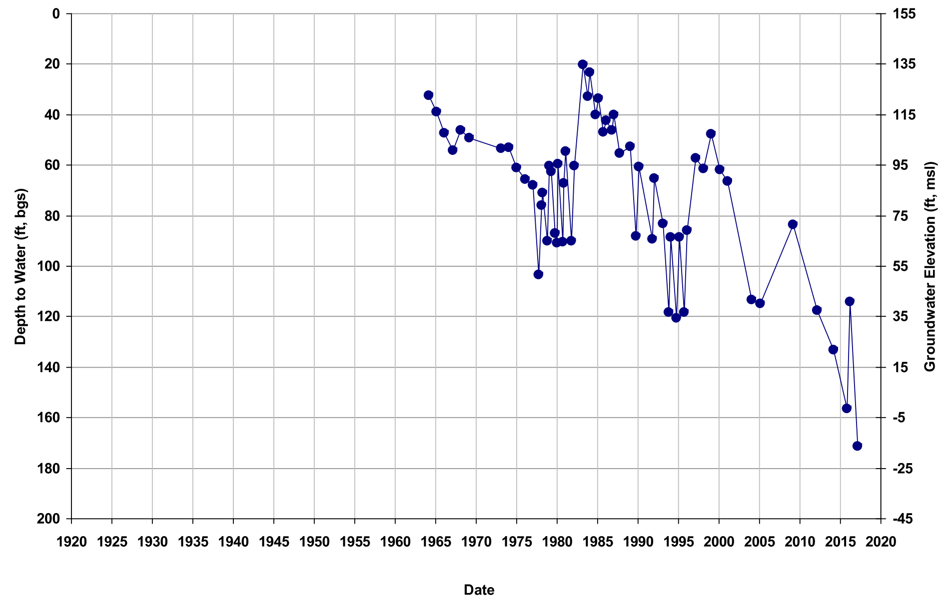
Well ID: 11S15E27L001M
Depth Zone: Composite or Lower; W
Subbasin: Madera

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



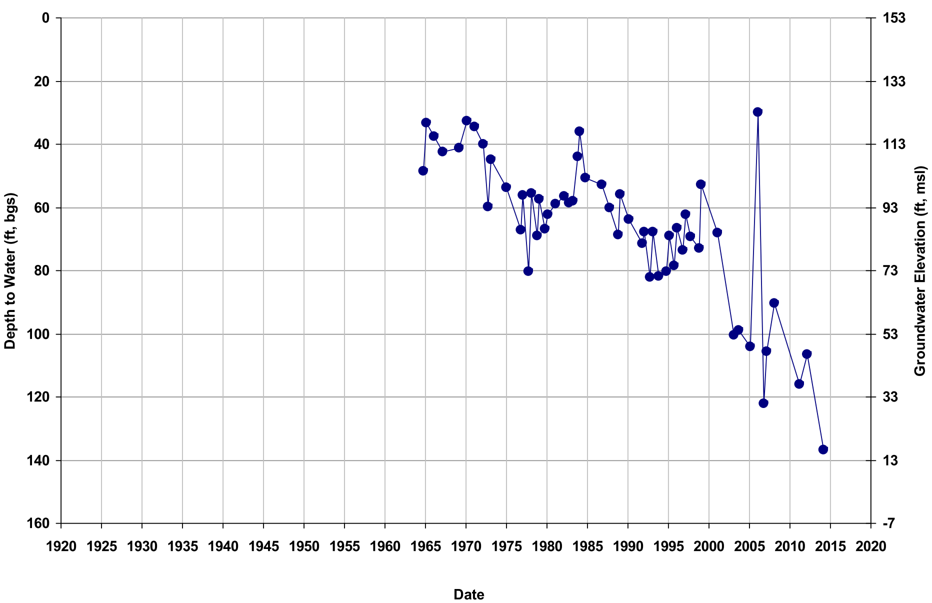
Well ID: 11S15E30A001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 155
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



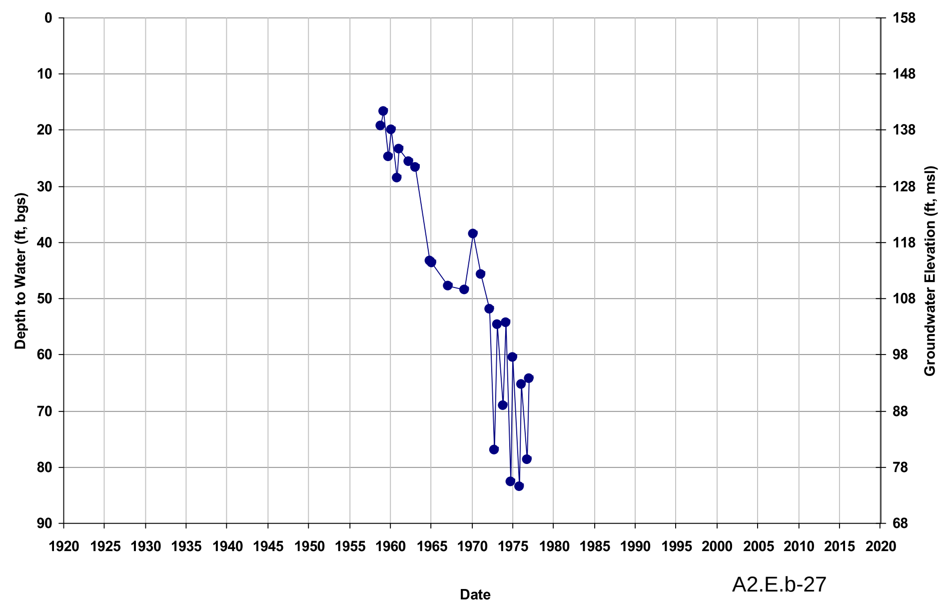
Well ID: 11S15E31J001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 153
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



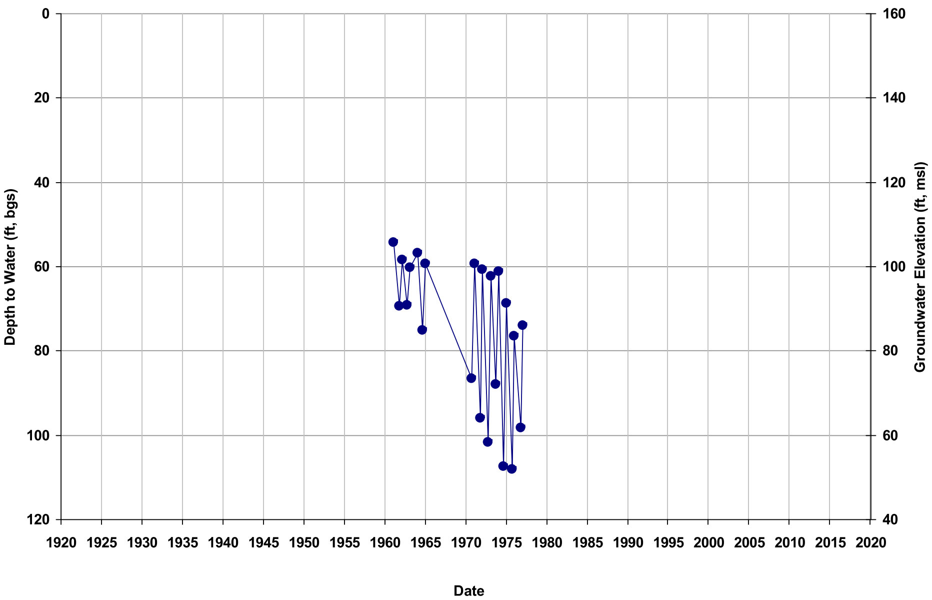
Well ID: 11S15E33E001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 158
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



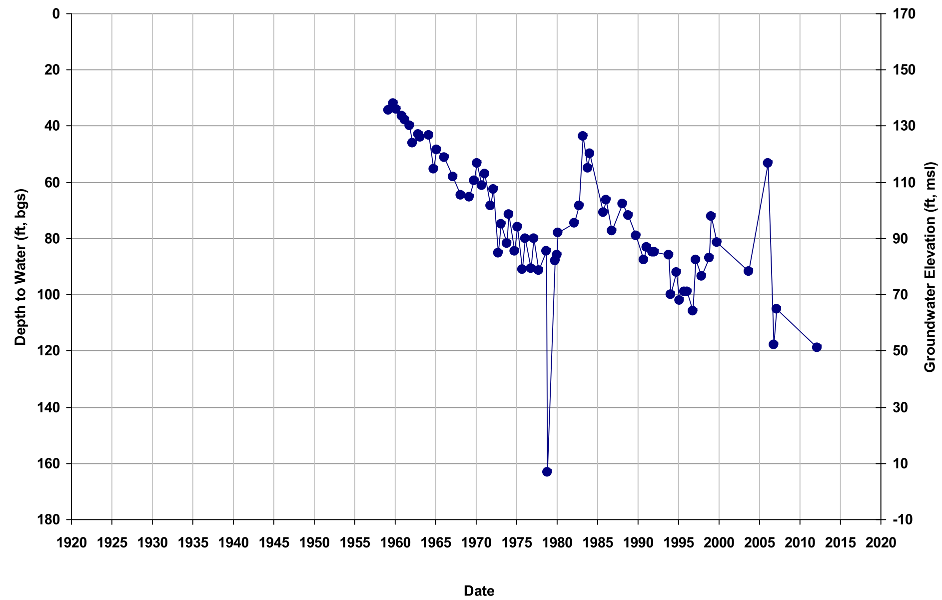
Well ID: 11S15E33P003M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 160
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



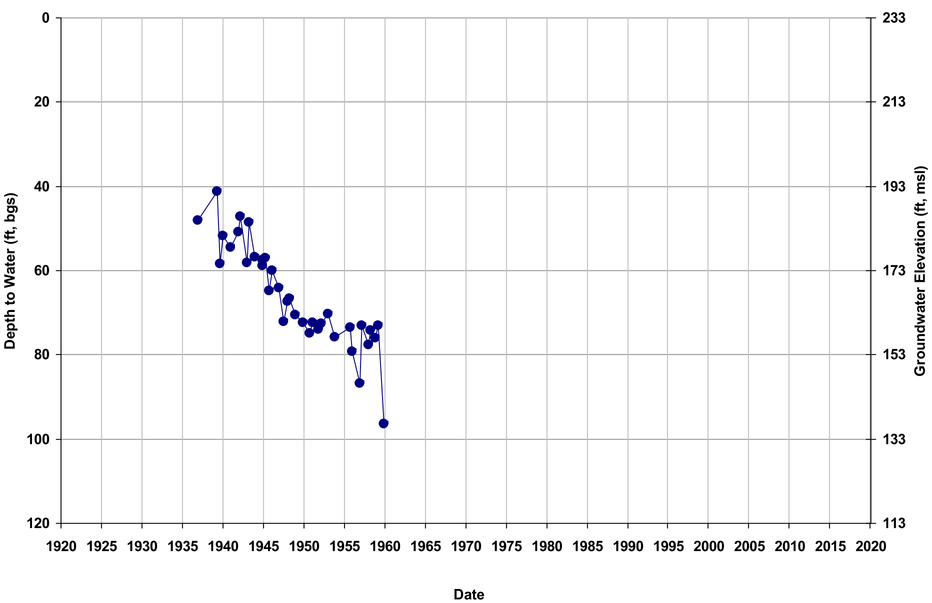
Well ID: 11S15E35P001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 170
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



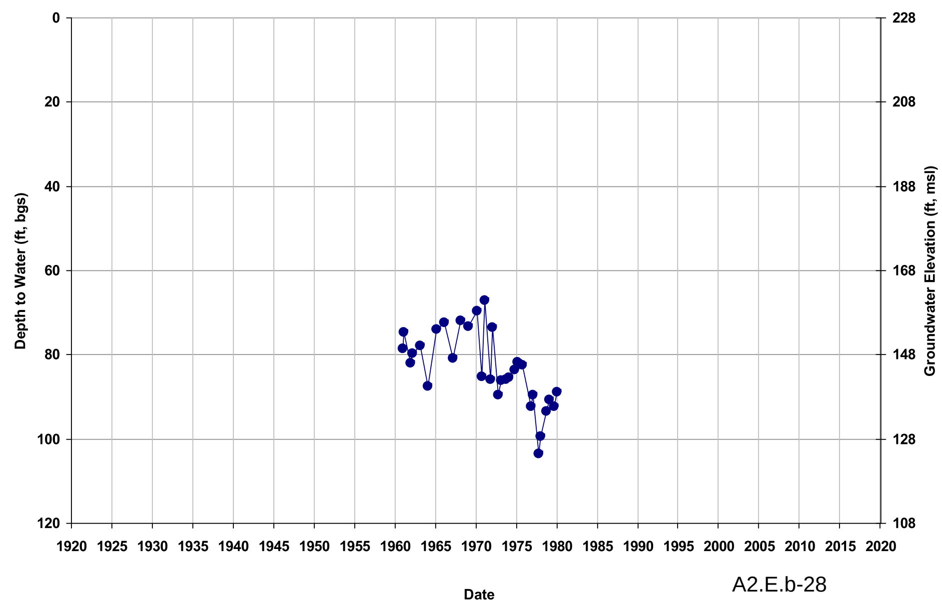
Well ID: 11S16E01D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 233
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



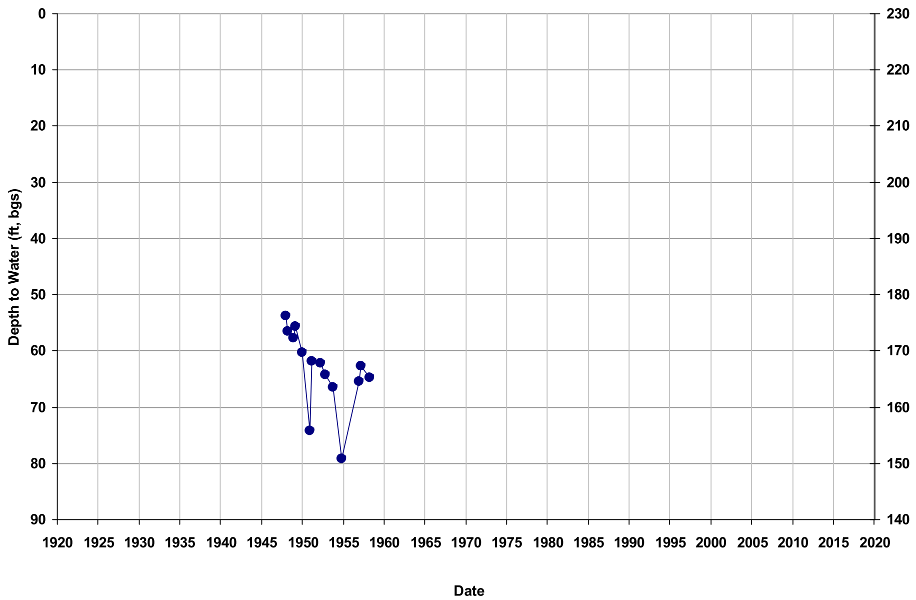
Well ID: 11S16E01D002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 228
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



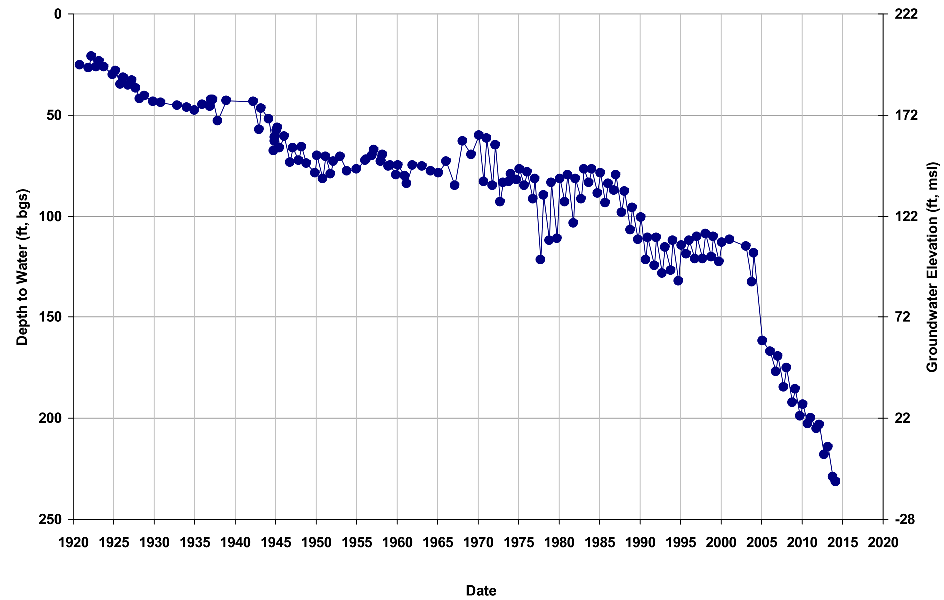
Well ID: 11S16E01J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 229
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



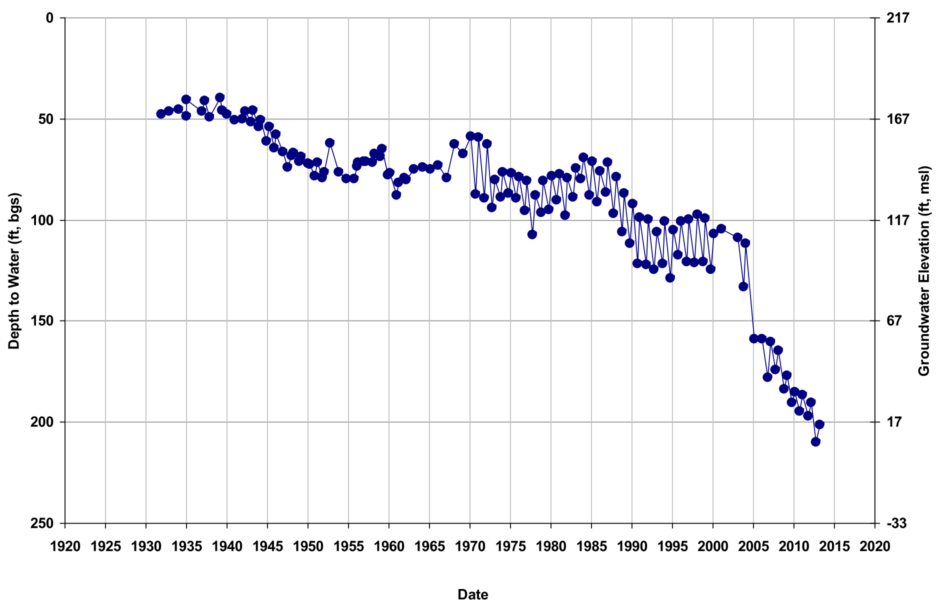
Well ID: 11S16E03A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 222
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



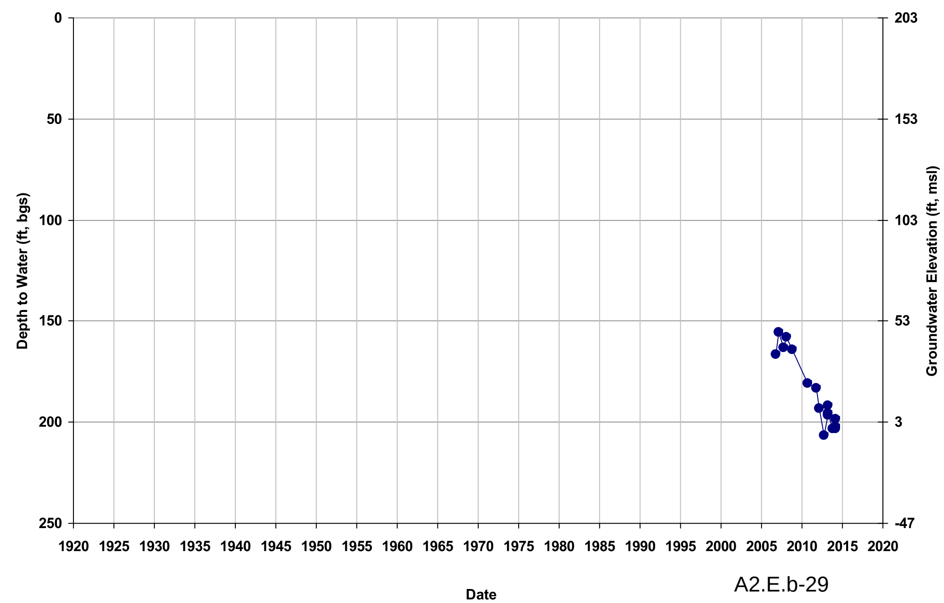
Well ID: 11S16E03C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 217
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



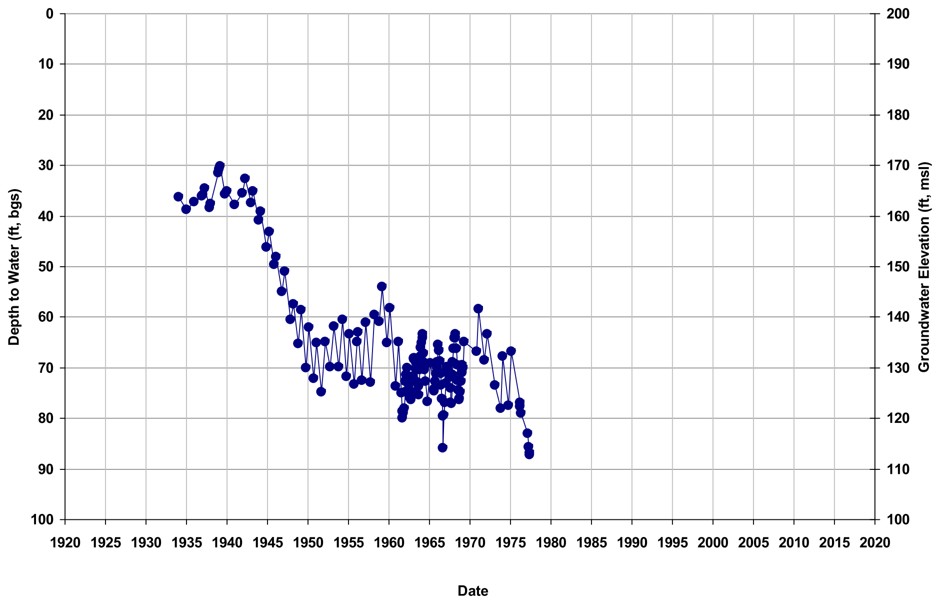
Well ID: 11S16E05H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 203
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



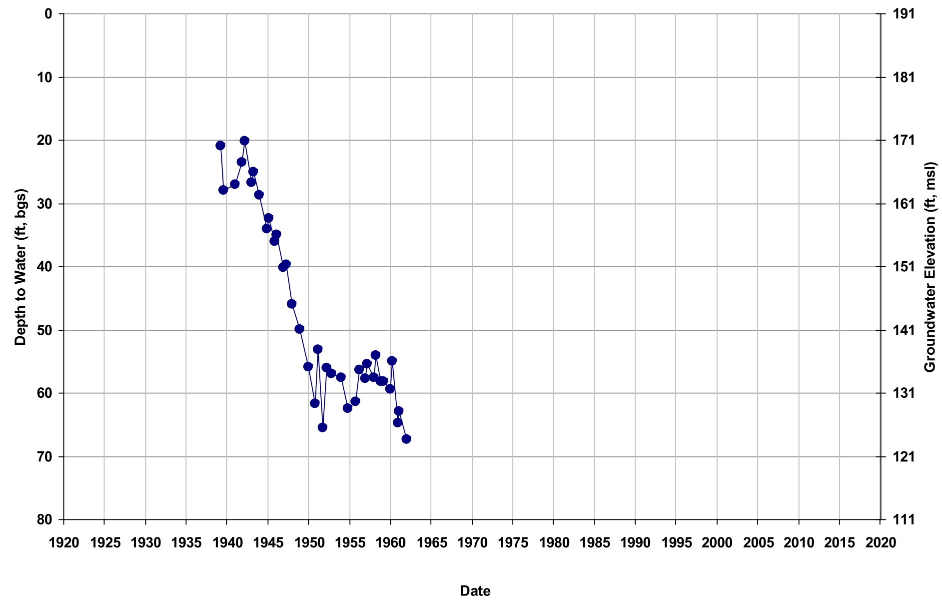
Well ID: 11S16E06A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 200
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



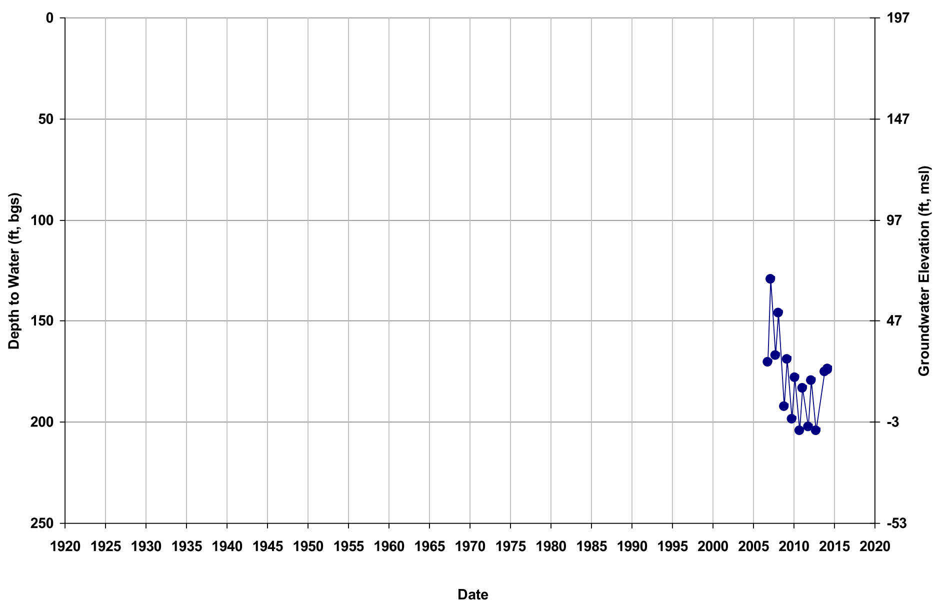
Well ID: 11S16E07D001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 190
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



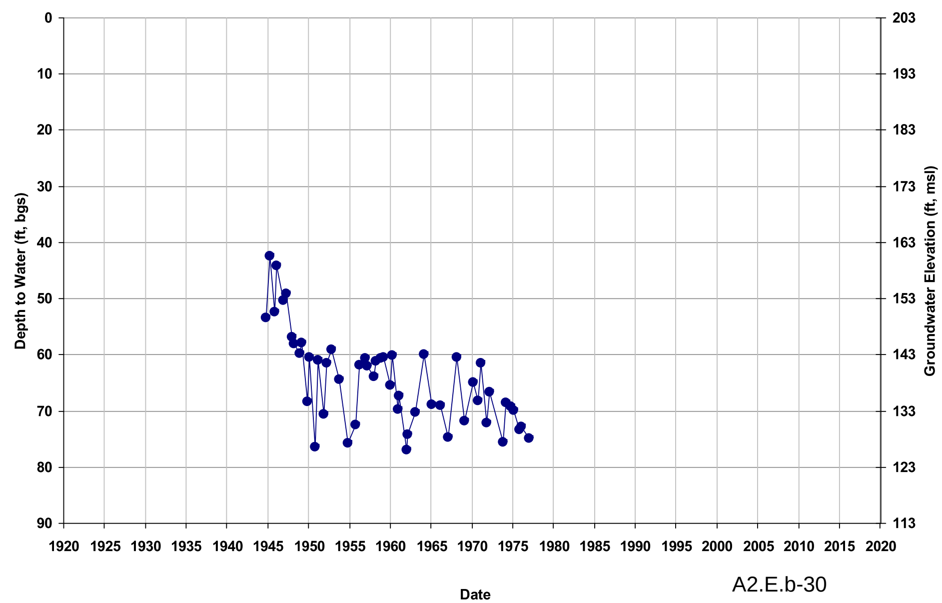
Well ID: 11S16E08L001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 197
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



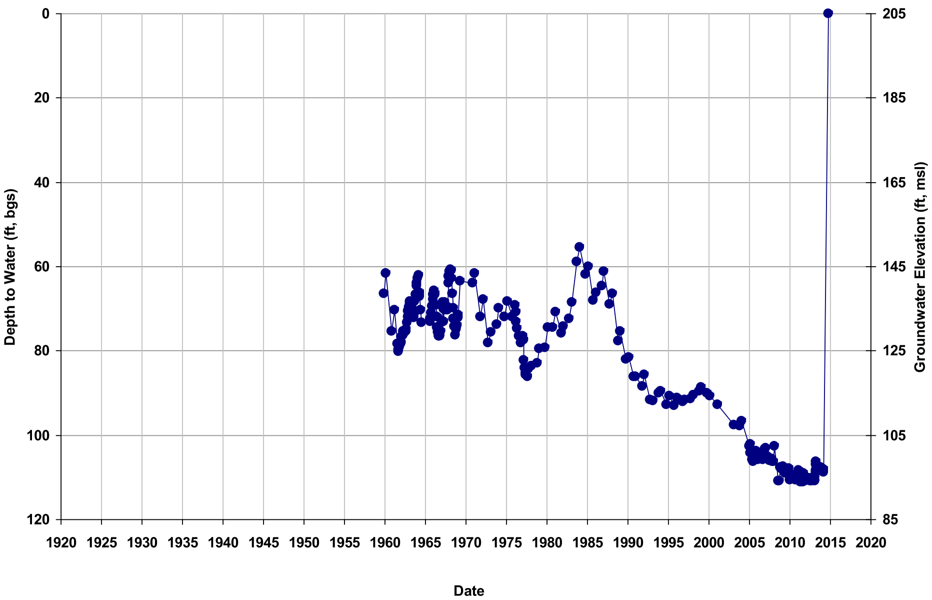
Well ID: 11S16E09F001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 203
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



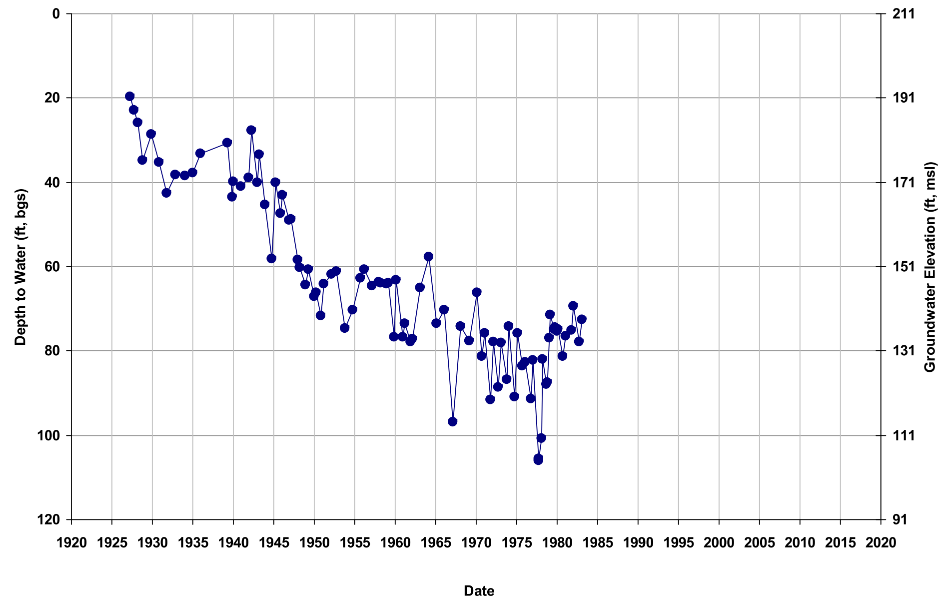
Well ID: 11S16E10N001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 204
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



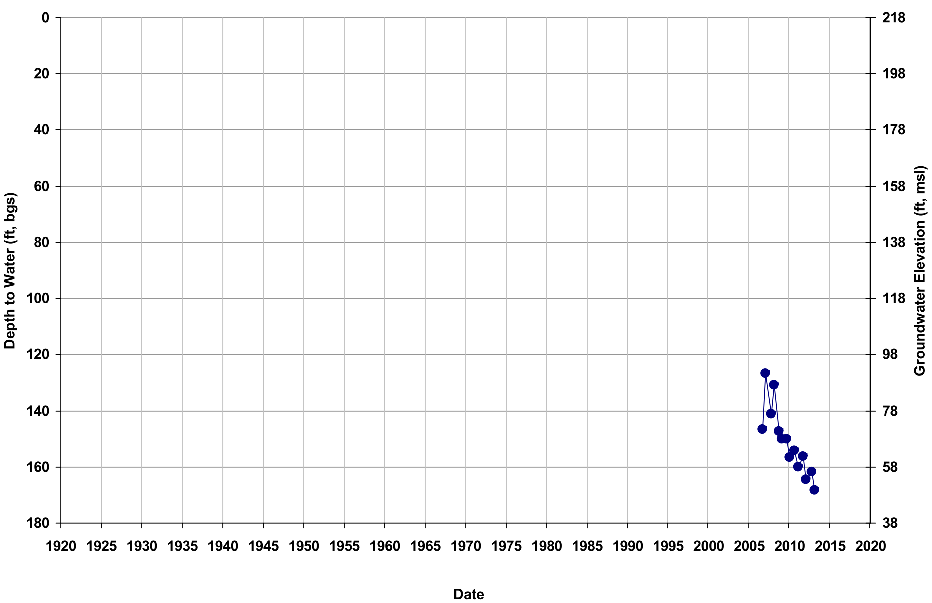
Well ID: 11S16E10P001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 211
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



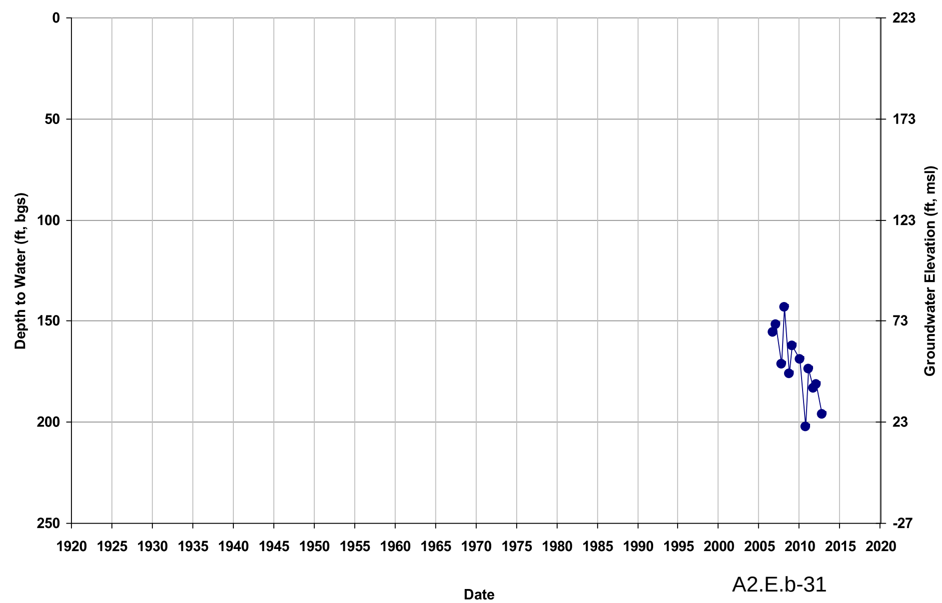
Well ID: 11S16E11E001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

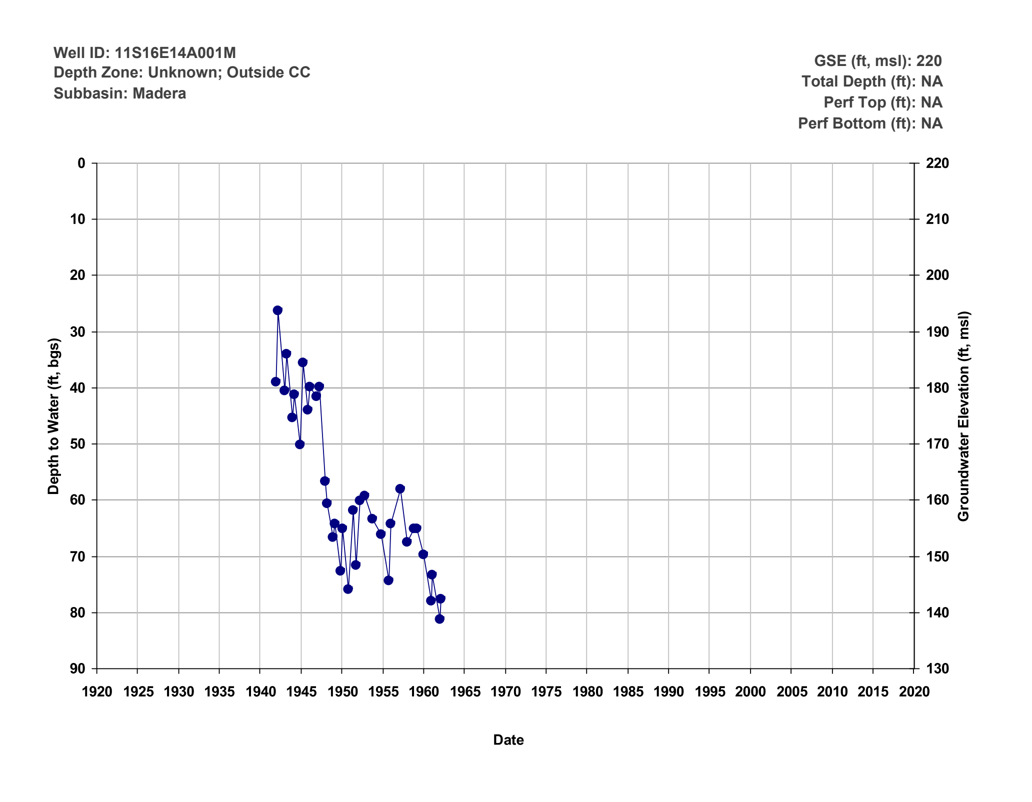
GSE (ft, msl): 217
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

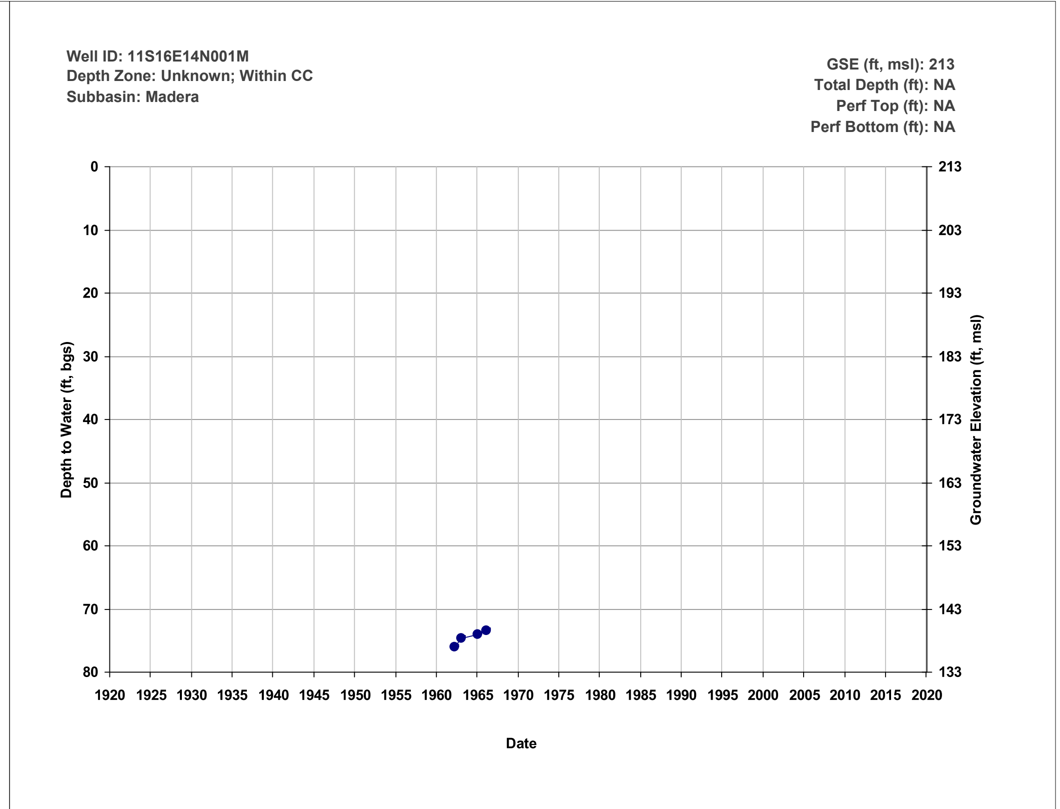


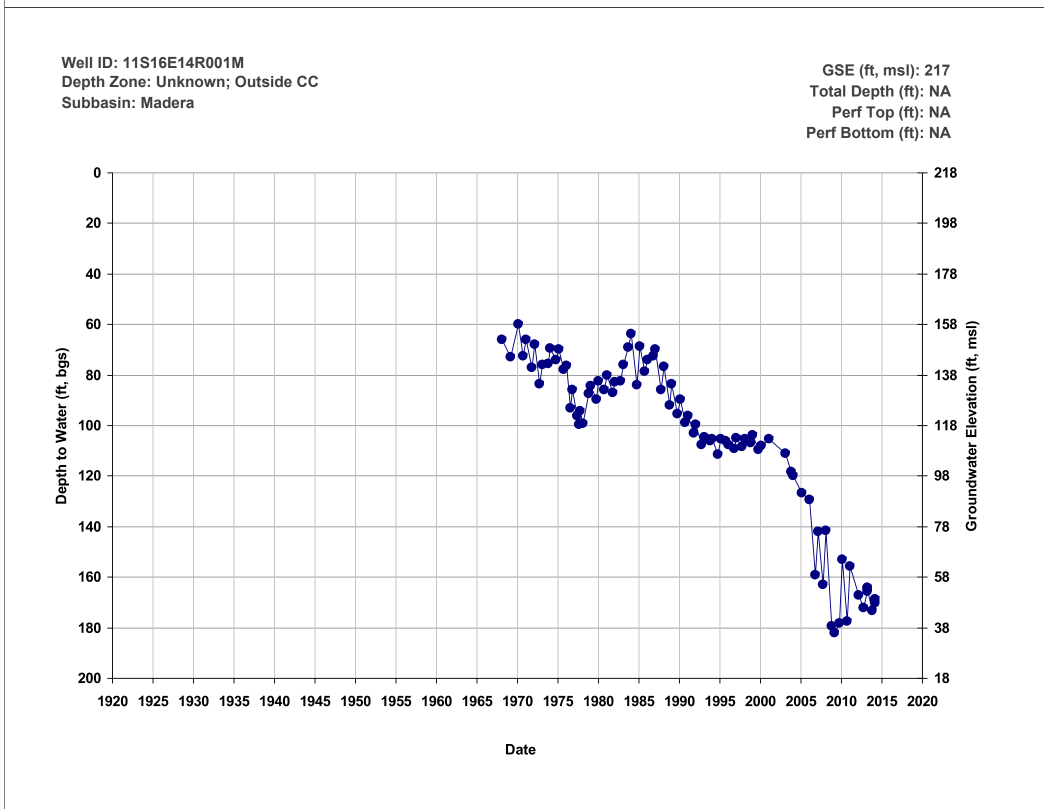
Well ID: 11S16E12K001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

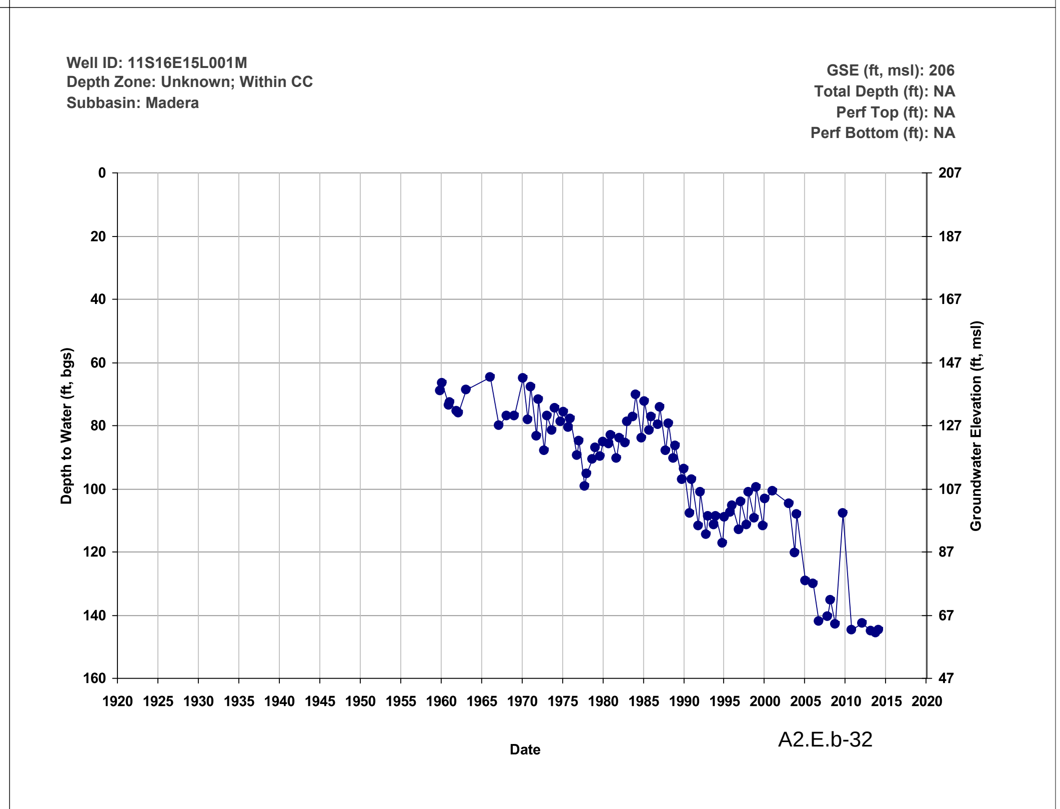
GSE (ft, msl): 223
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA




Well ID: 11S16E14A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 220
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

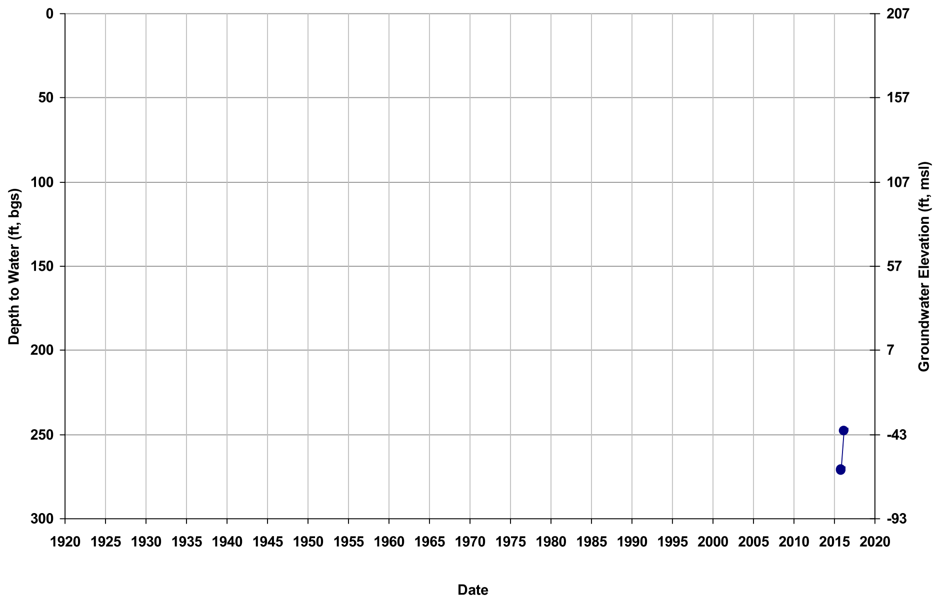

Well ID: 11S16E14N001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 213
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 11S16E14R001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 217
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 11S16E15L001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 206
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

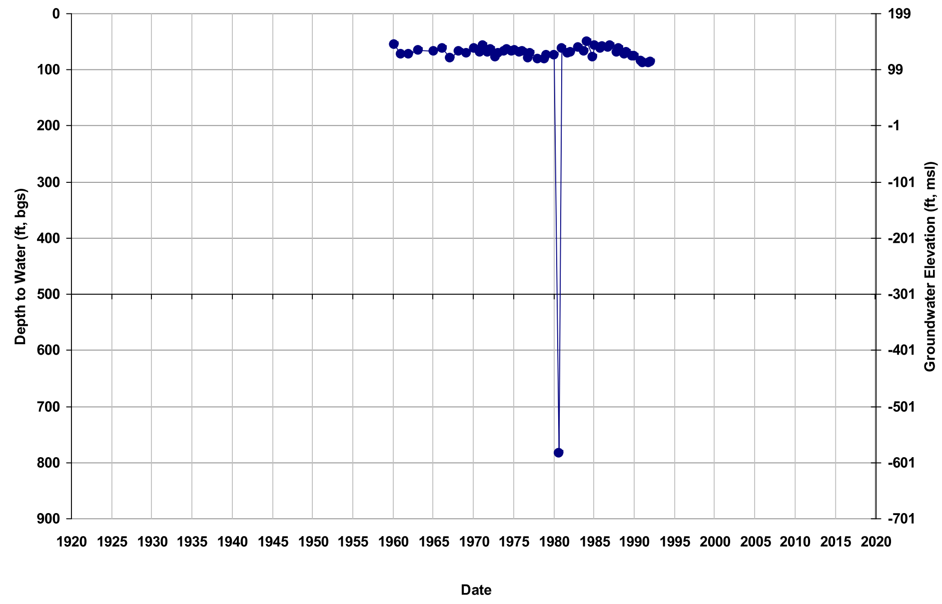
Well ID: 11S16E15P001M
Depth Zone: Lower; Within CC
Subbasin: Madera

GSE (ft, msl): 207
Total Depth (ft): 800
Perf Top (ft): 220
Perf Bottom (ft): 800



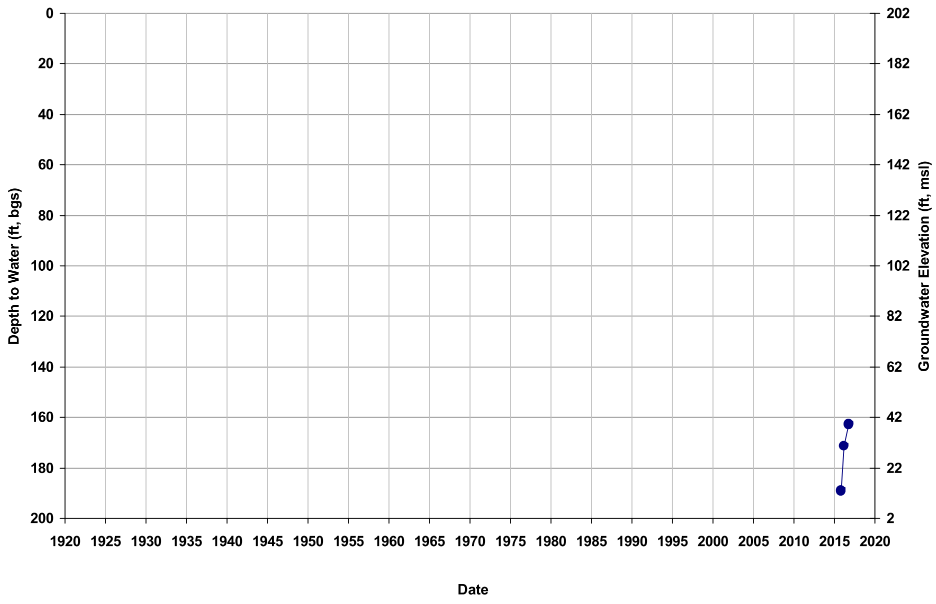
Well ID: 11S16E16D001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 199
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



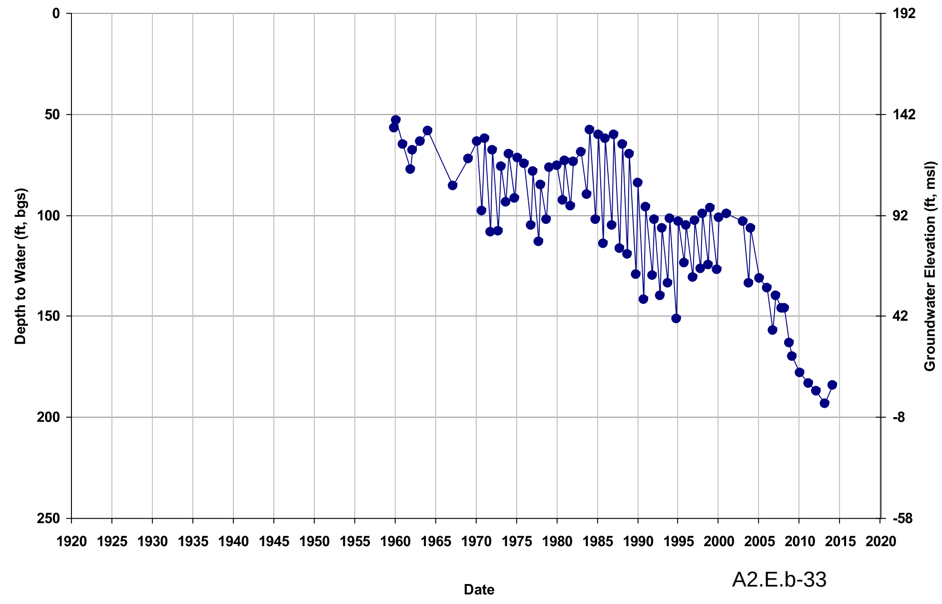
Well ID: 11S16E16K001M
Depth Zone: Lower; Within CC
Subbasin: Madera

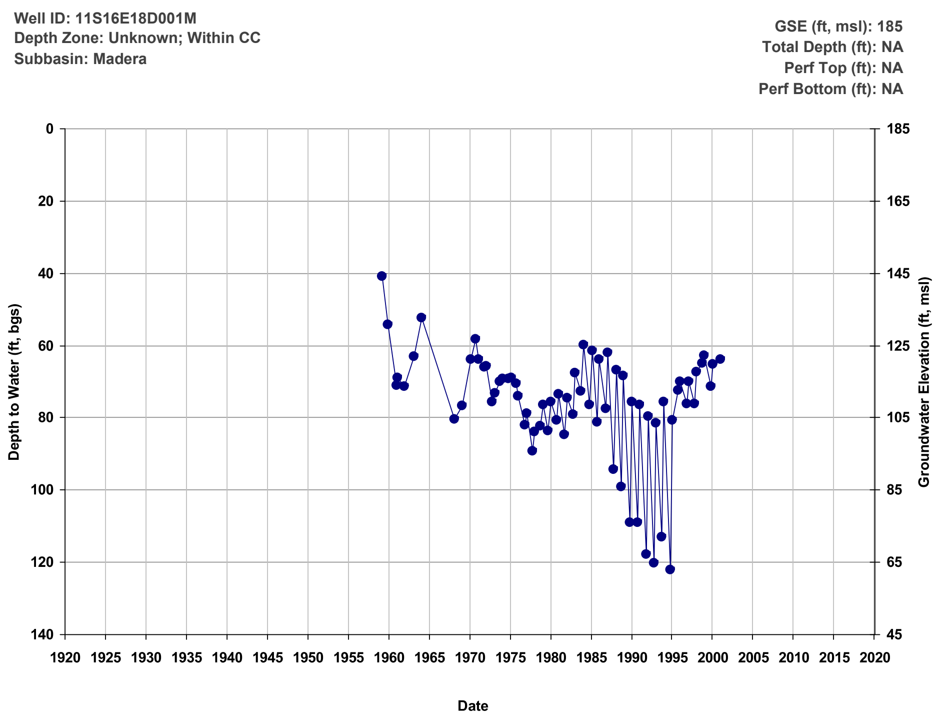
GSE (ft, msl): 201
Total Depth (ft): 474
Perf Top (ft): 204
Perf Bottom (ft): 474

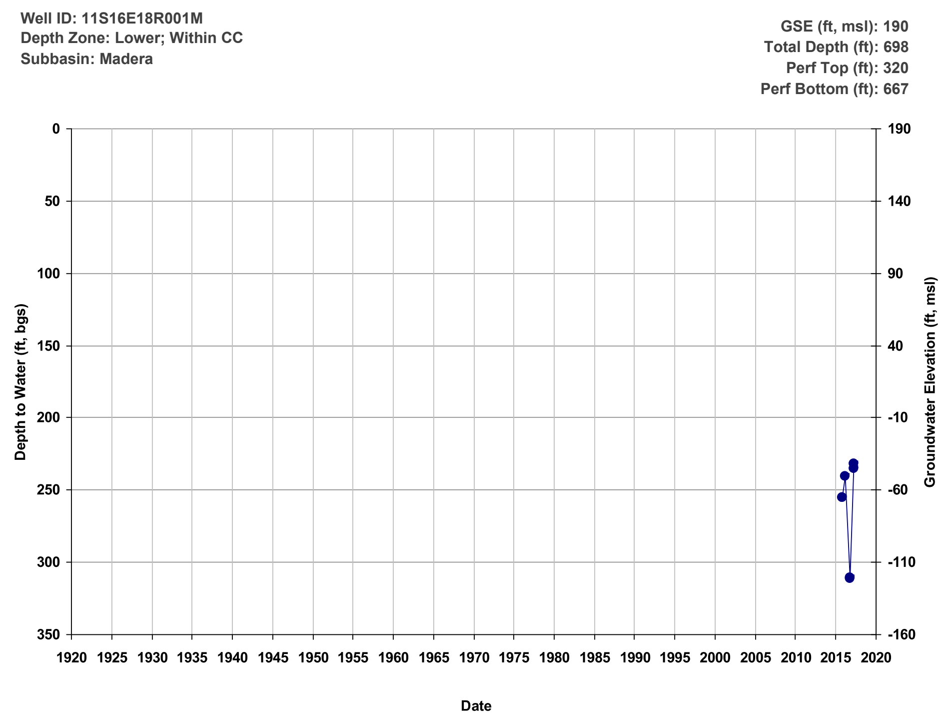


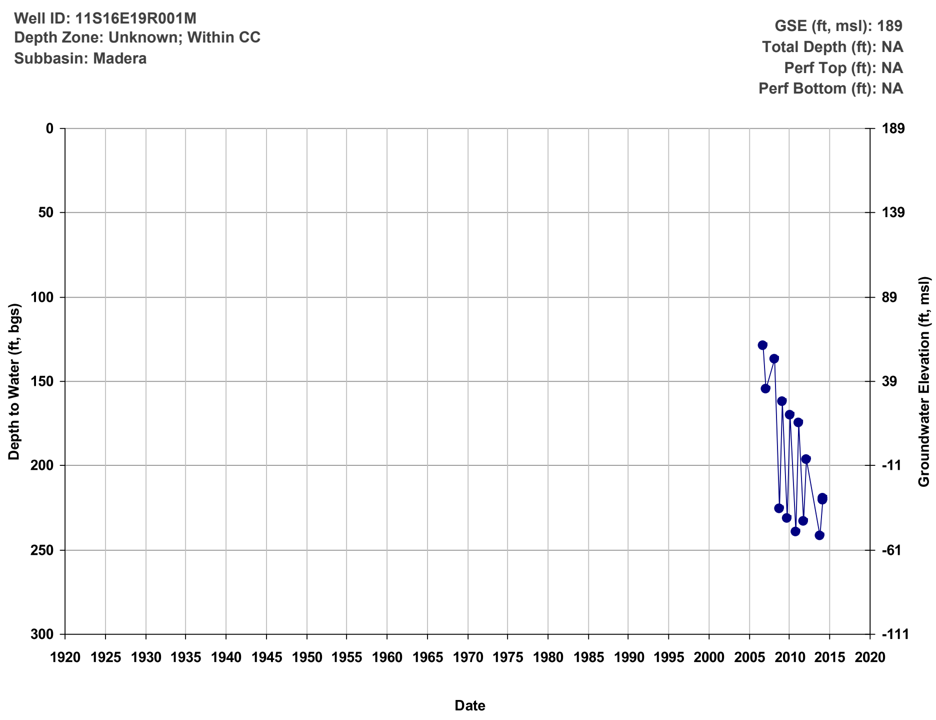
Well ID: 11S16E17D001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

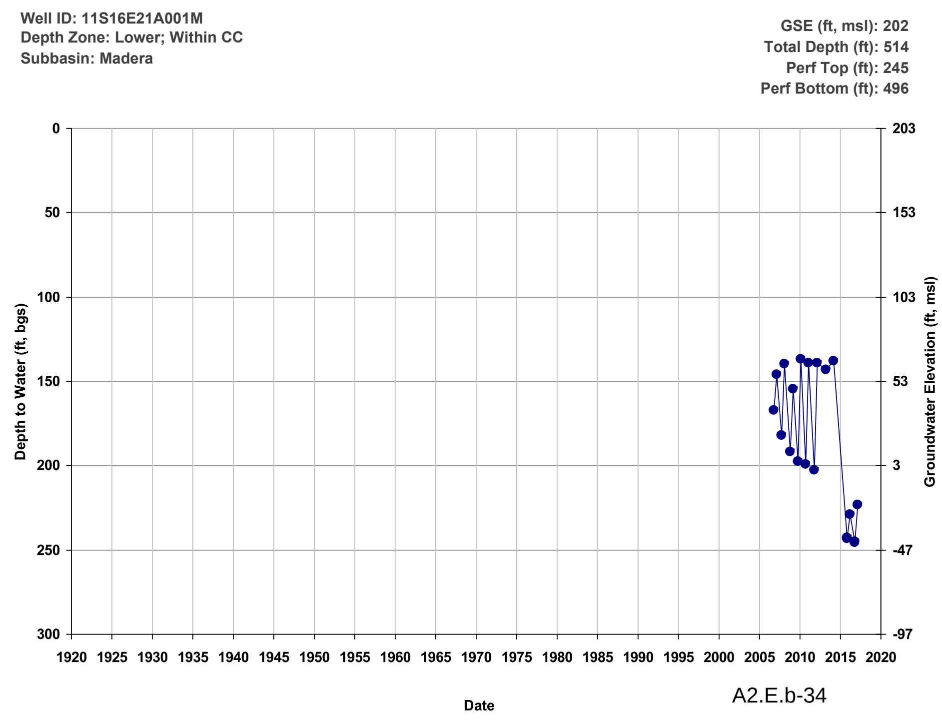
GSE (ft, msl): 192
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA




Well ID: 11S16E18D001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 185
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

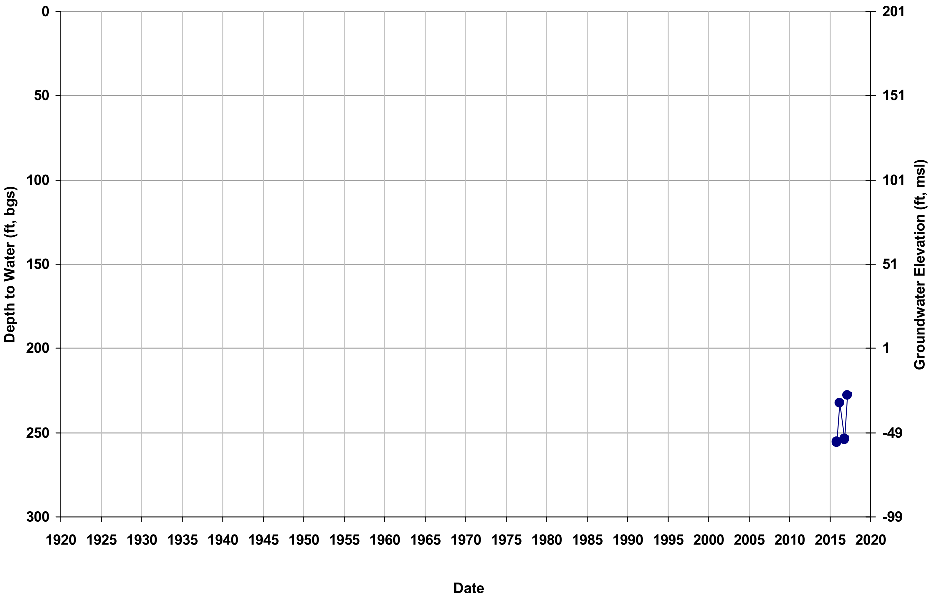

Well ID: 11S16E18R001M
Depth Zone: Lower; Within CC
Subbasin: Madera
GSE (ft, msl): 190
Total Depth (ft): 698
Perf Top (ft): 320
Perf Bottom (ft): 667
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 11S16E19R001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 189
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 11S16E21A001M
Depth Zone: Lower; Within CC
Subbasin: Madera
GSE (ft, msl): 202
Total Depth (ft): 514
Perf Top (ft): 245
Perf Bottom (ft): 496
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

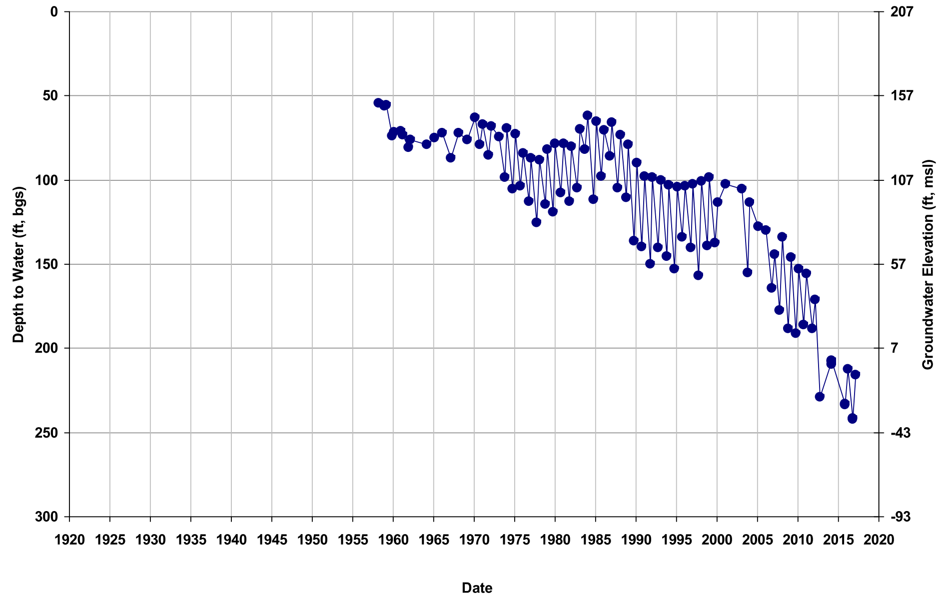
Well ID: 11S16E21H001M
Depth Zone: Lower; Within CC
Subbasin: Madera

GSE (ft, msl): 200
Total Depth (ft): 600
Perf Top (ft): 400
Perf Bottom (ft): 600



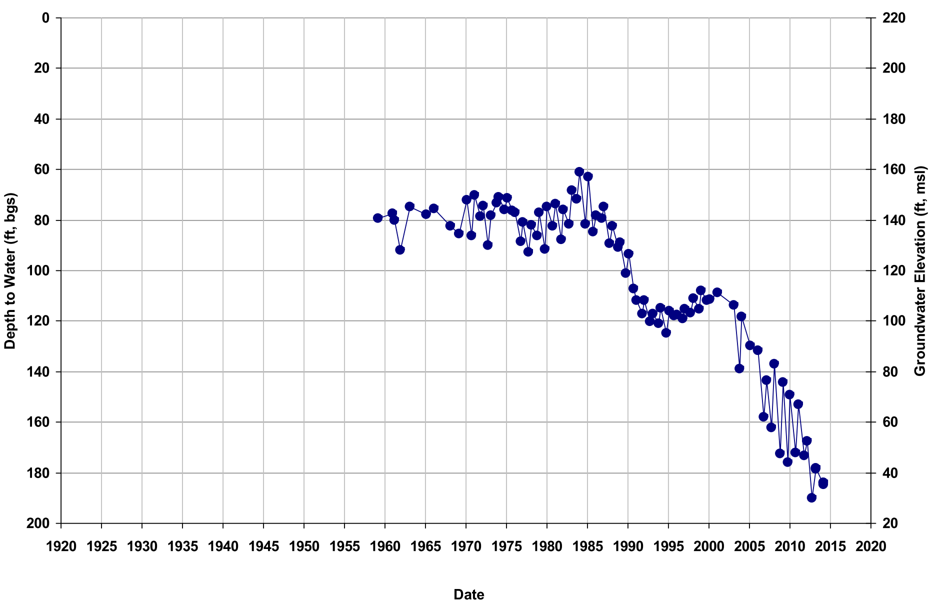
Well ID: 11S16E22K001M
Depth Zone: Lower; Within CC
Subbasin: Madera

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



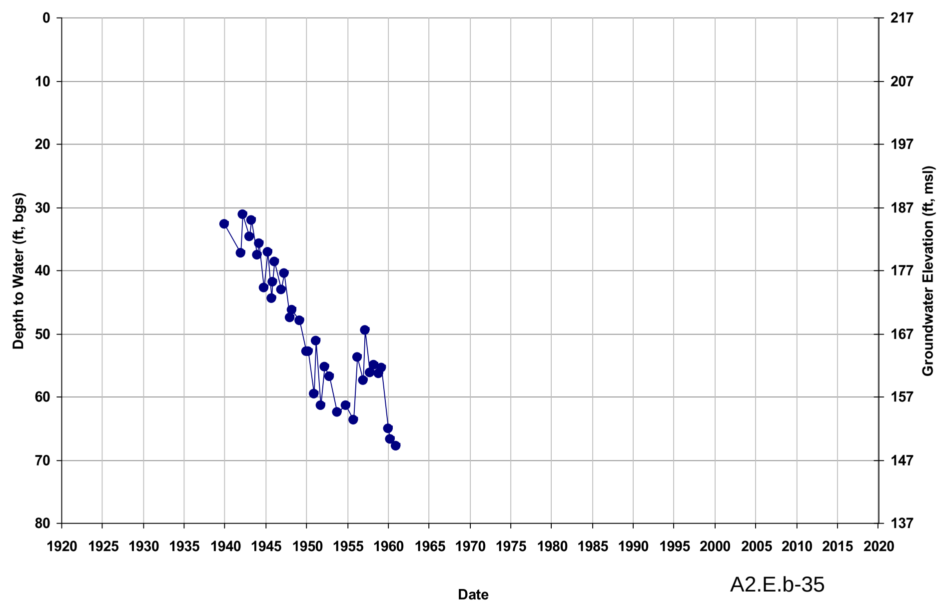
Well ID: 11S16E24M001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 219
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



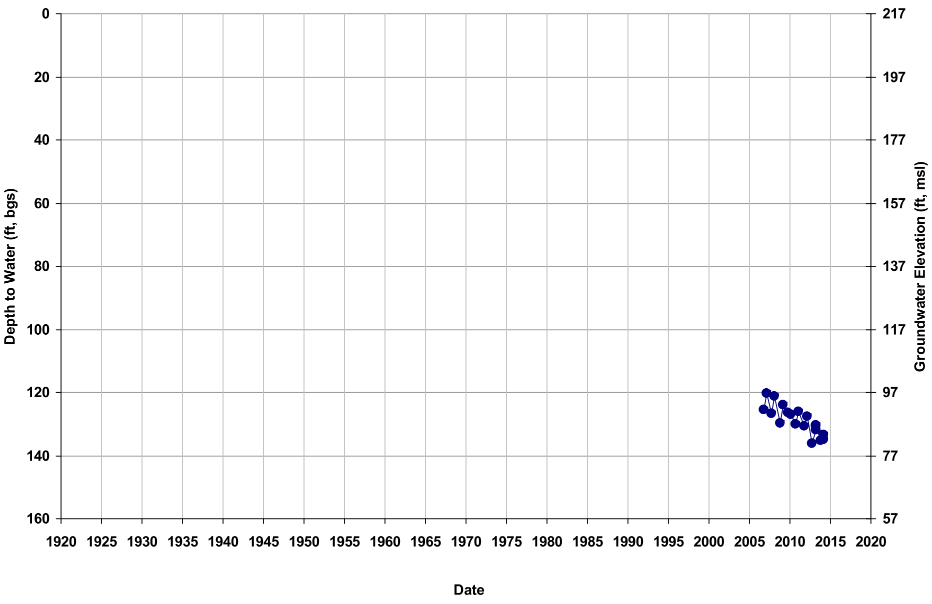
Well ID: 11S16E25L001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 217
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



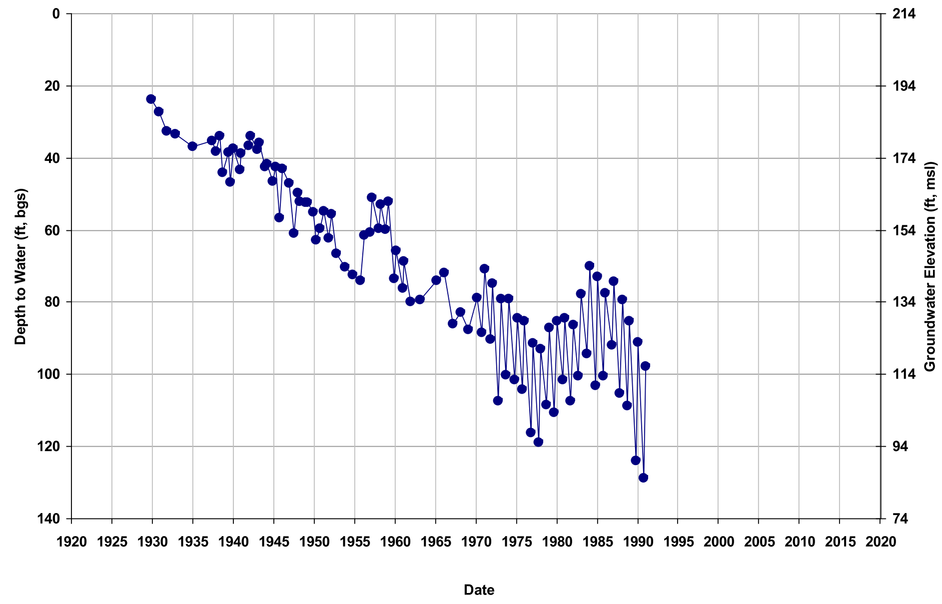
Well ID: 11S16E26A001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 217
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



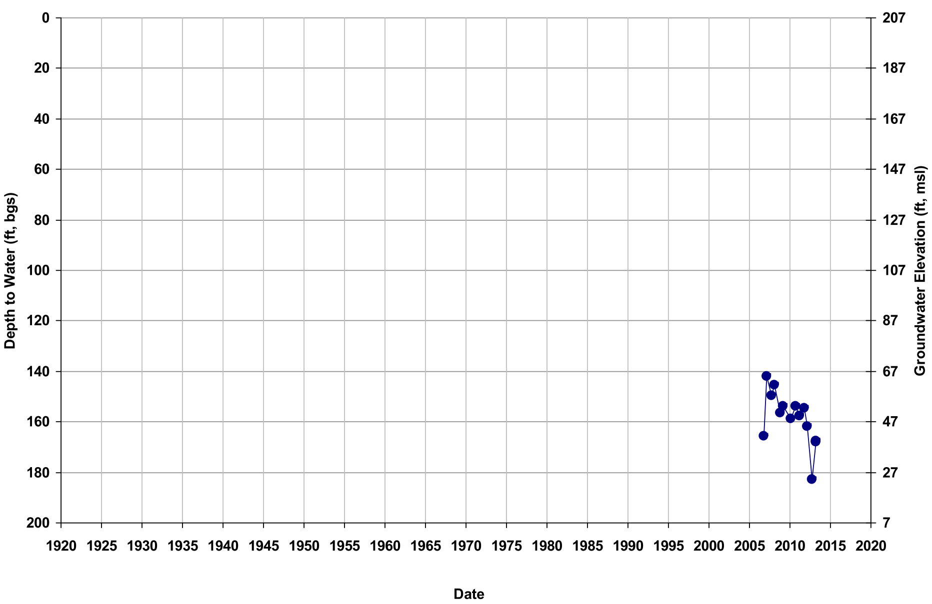
Well ID: 11S16E26L001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 214
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



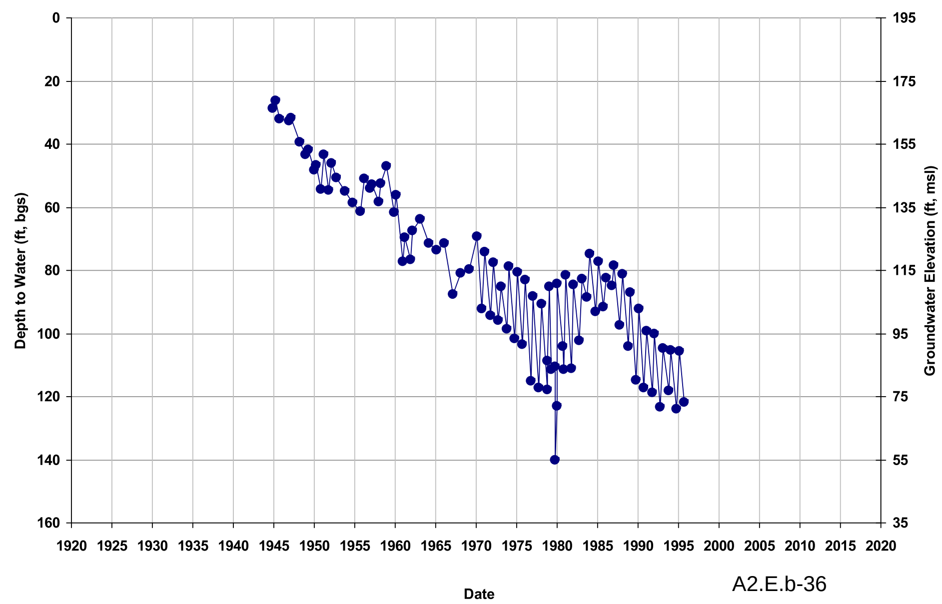
Well ID: 11S16E27H001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 207
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



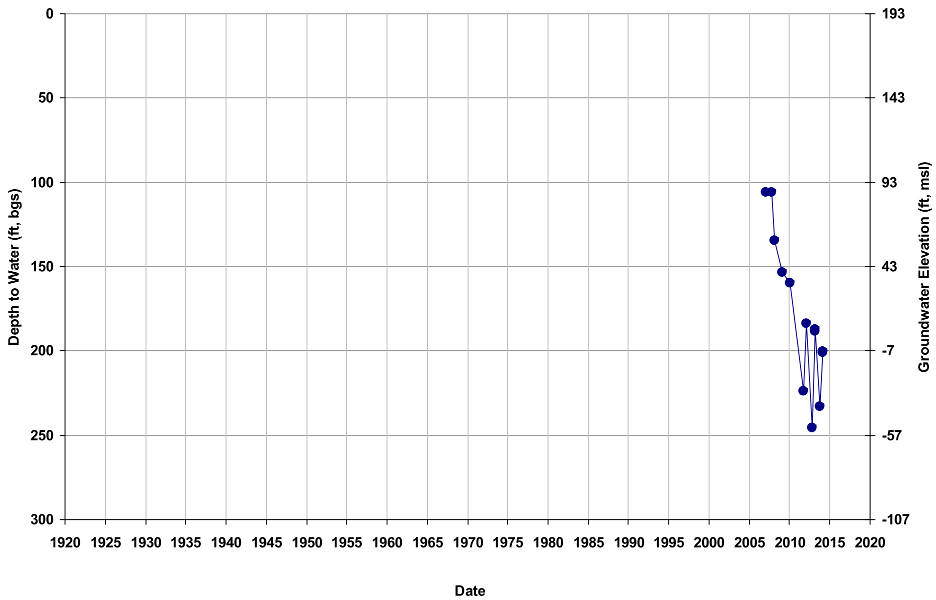
Well ID: 11S16E28C001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 195
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



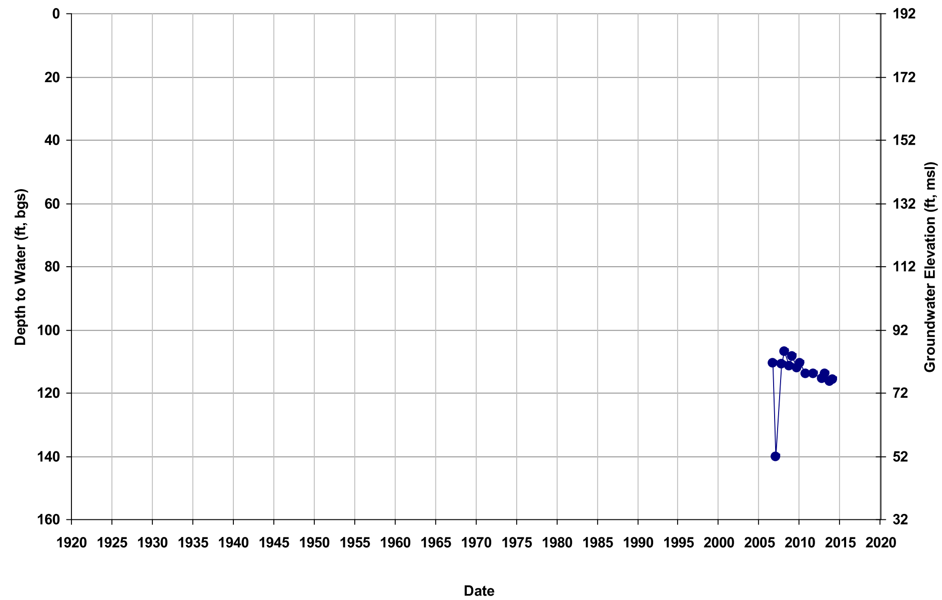
Well ID: 11S16E29H001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 192
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



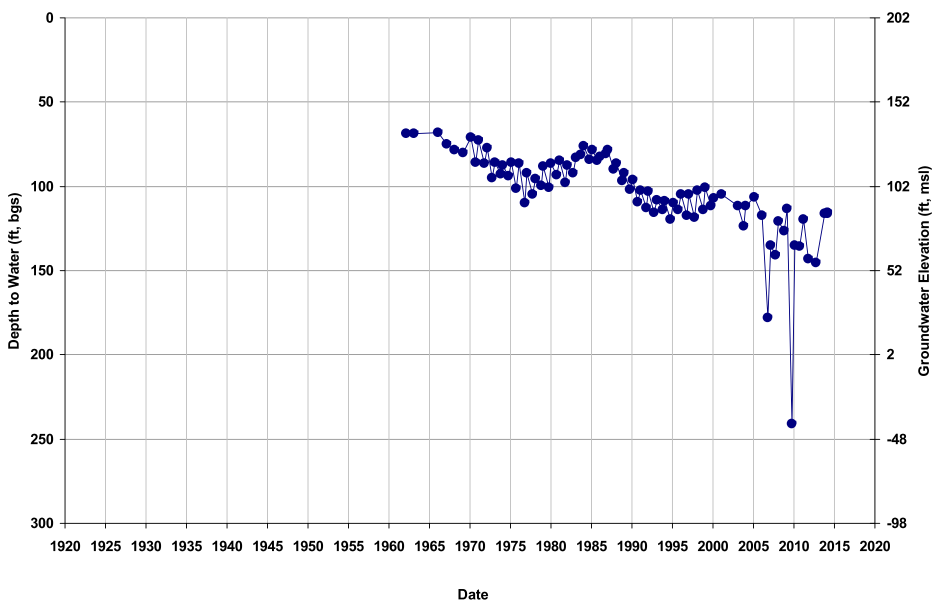
Well ID: 11S16E32R001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 192
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



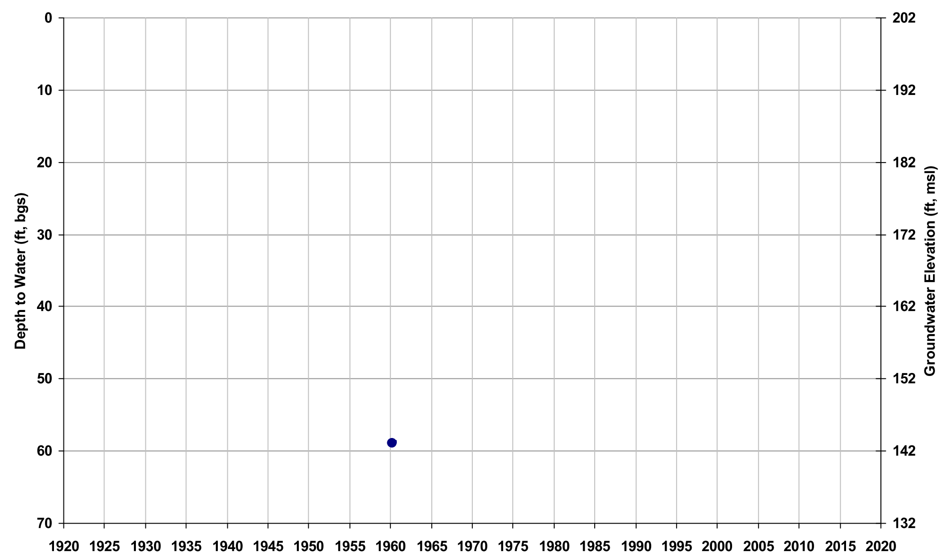
Well ID: 11S16E34D001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 202
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



Well ID: 11S16E34F001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

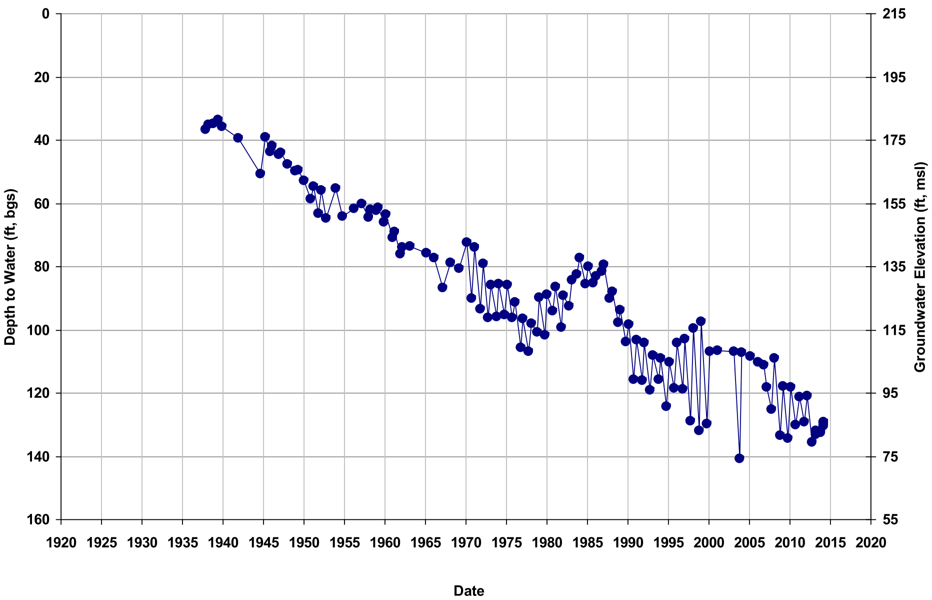
GSE (ft, msl): 202
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



Date

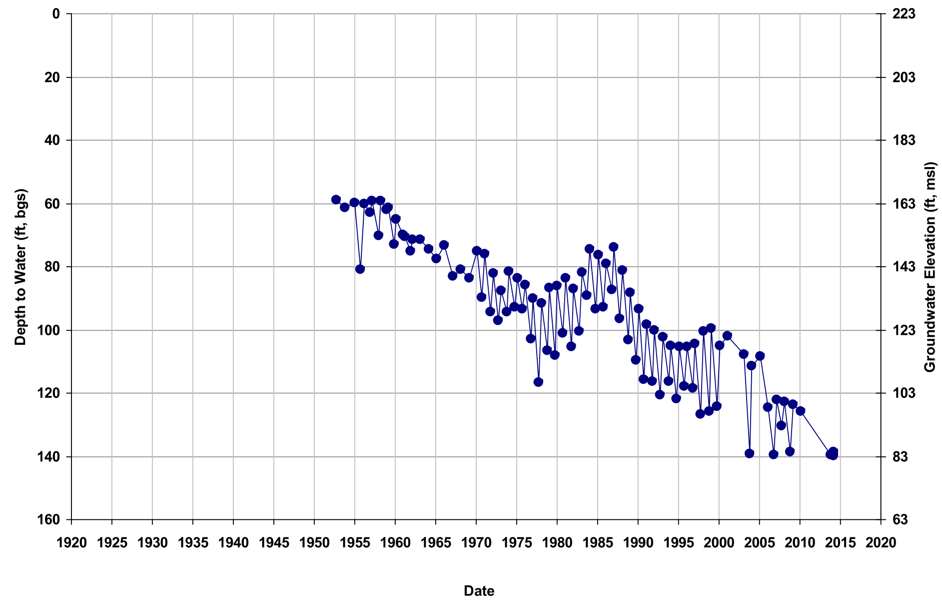
Well ID: 11S16E35H001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

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



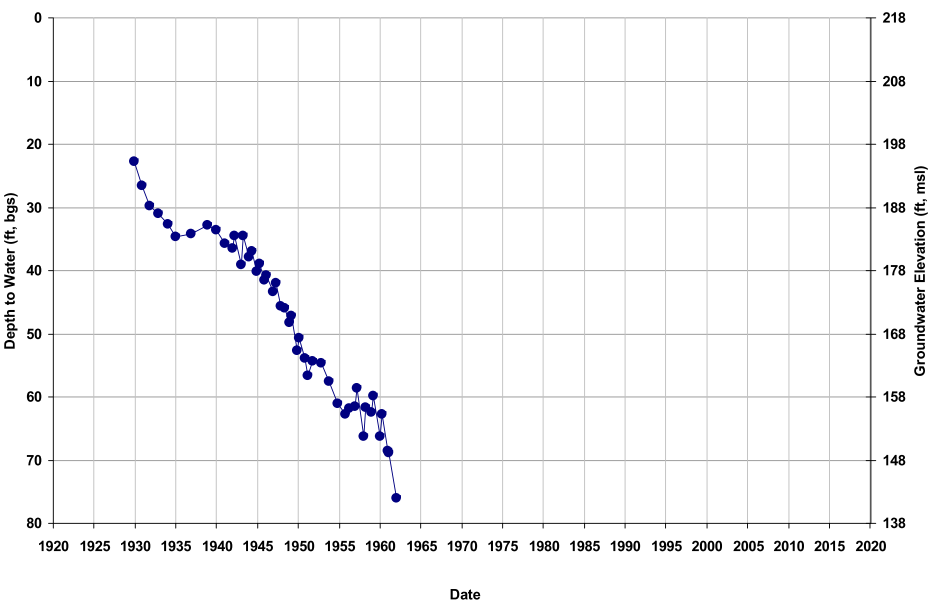
Well ID: 11S16E36J001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 222
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



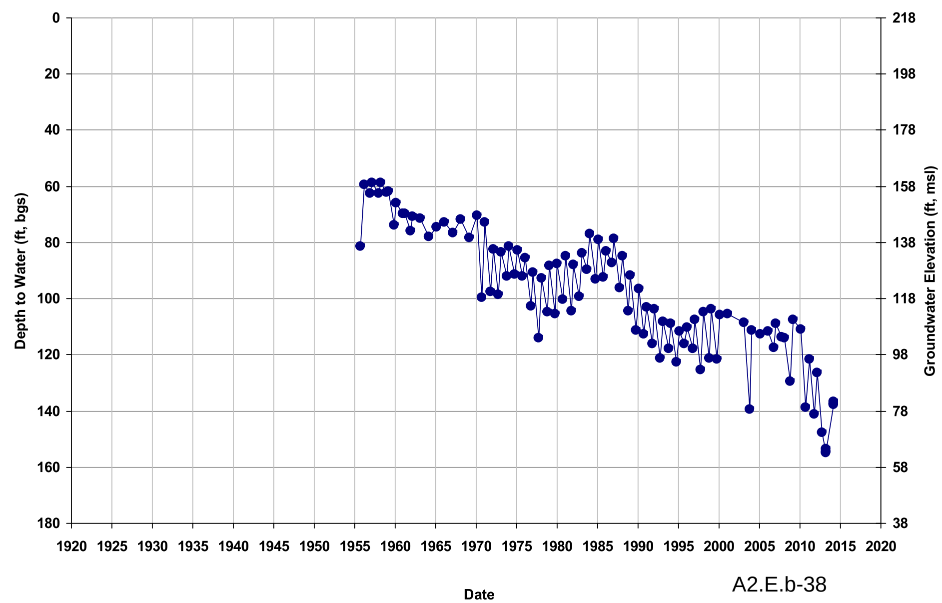
Well ID: 11S16E36M001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 217
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



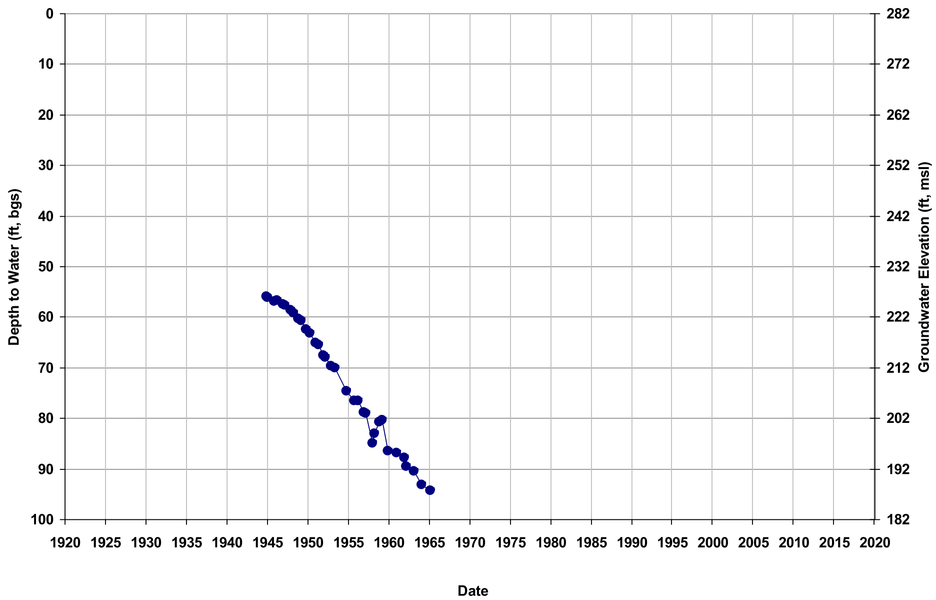
Well ID: 11S16E36Q001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 218
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



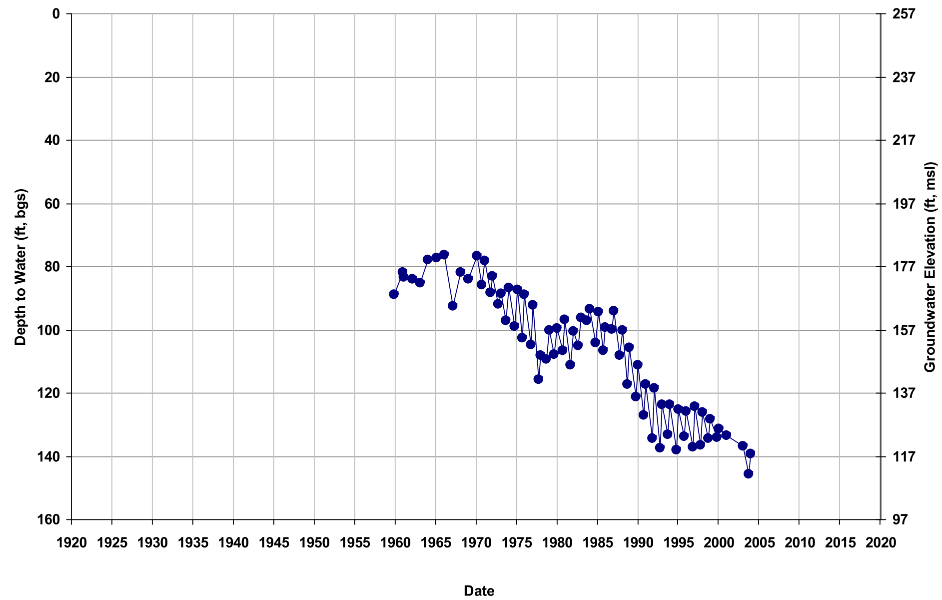
Well ID: 11S17E02Q001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 282
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



Well ID: 11S17E04R001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 257
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

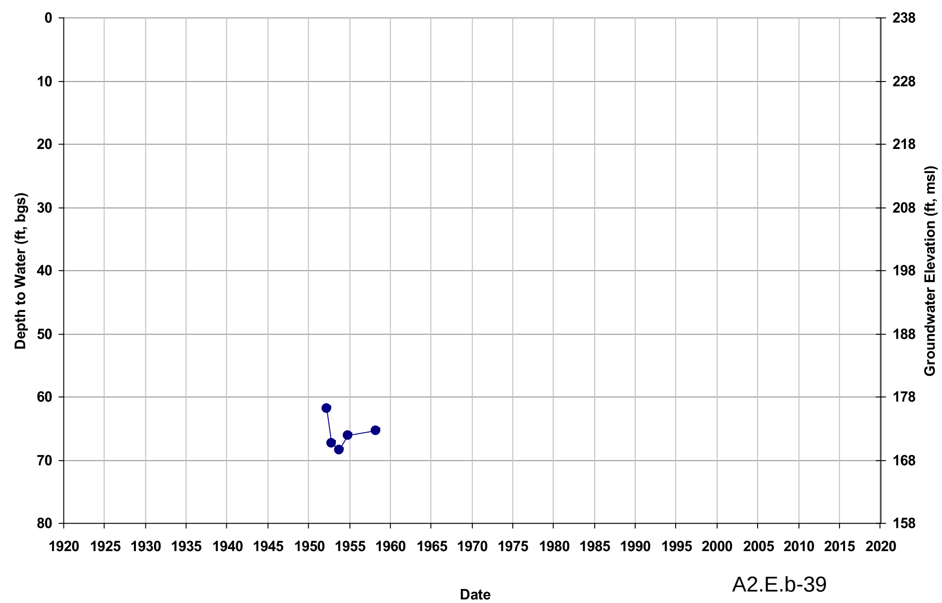


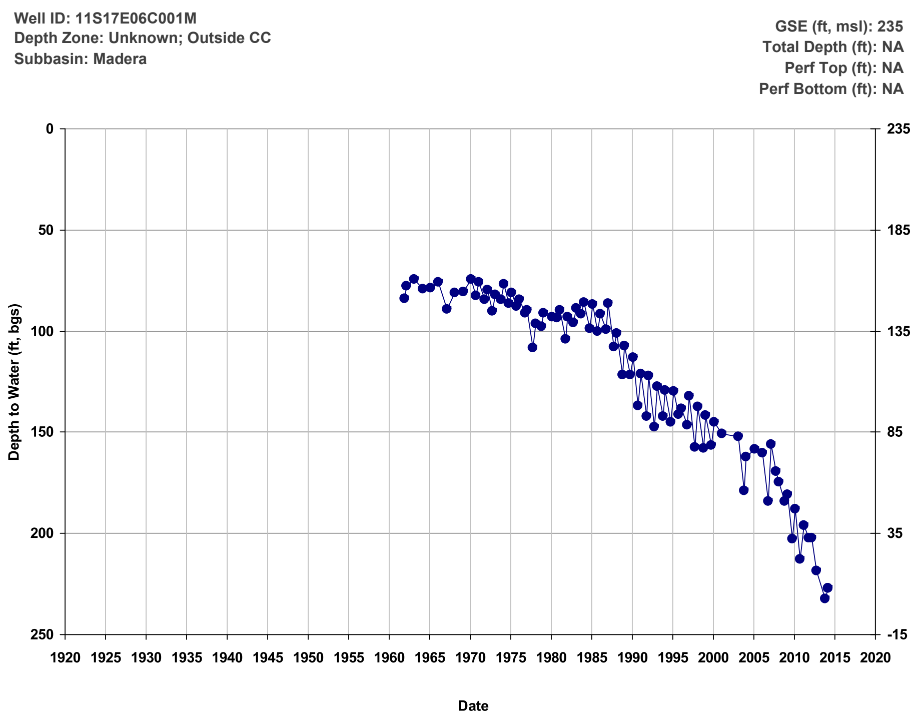
Well ID: 11S17E05R001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

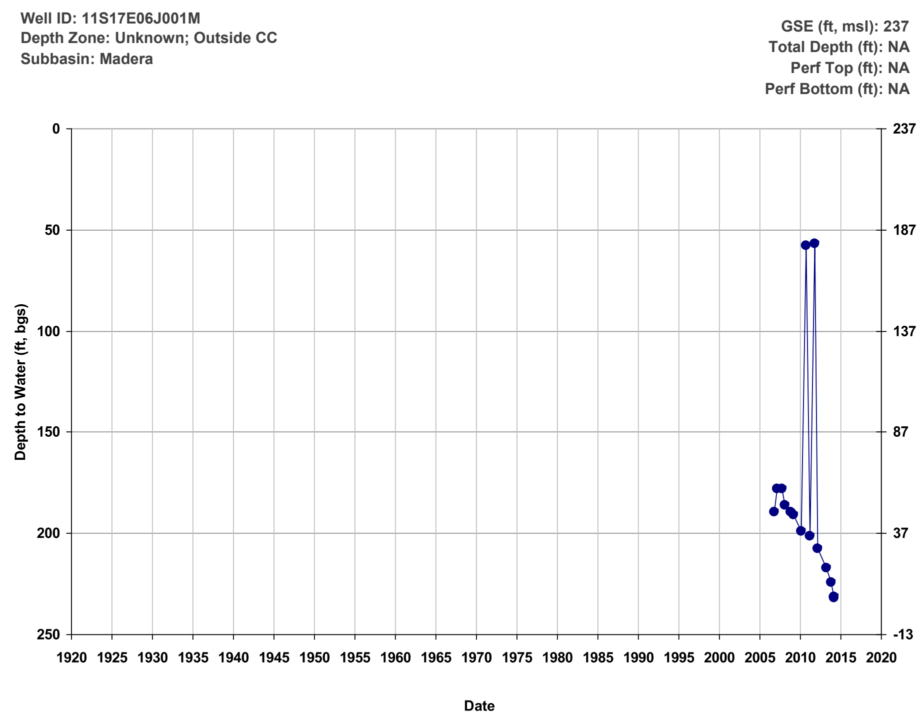
GSE (ft, msl): 244
Total Depth (ft): 700
Perf Top (ft): 265
Perf Bottom (ft): 696

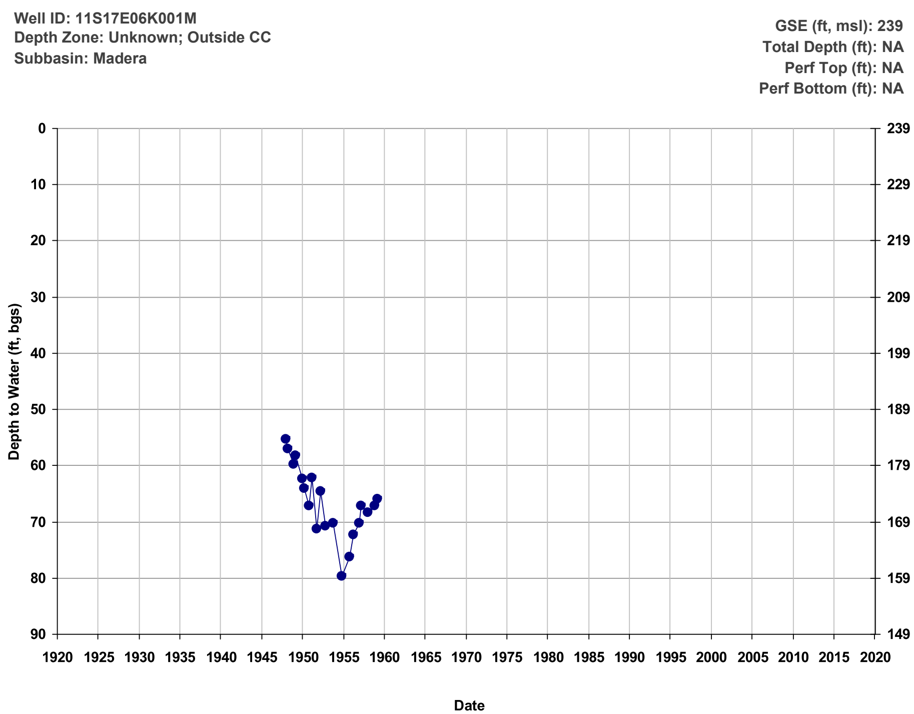
Well ID: 11S17E06B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

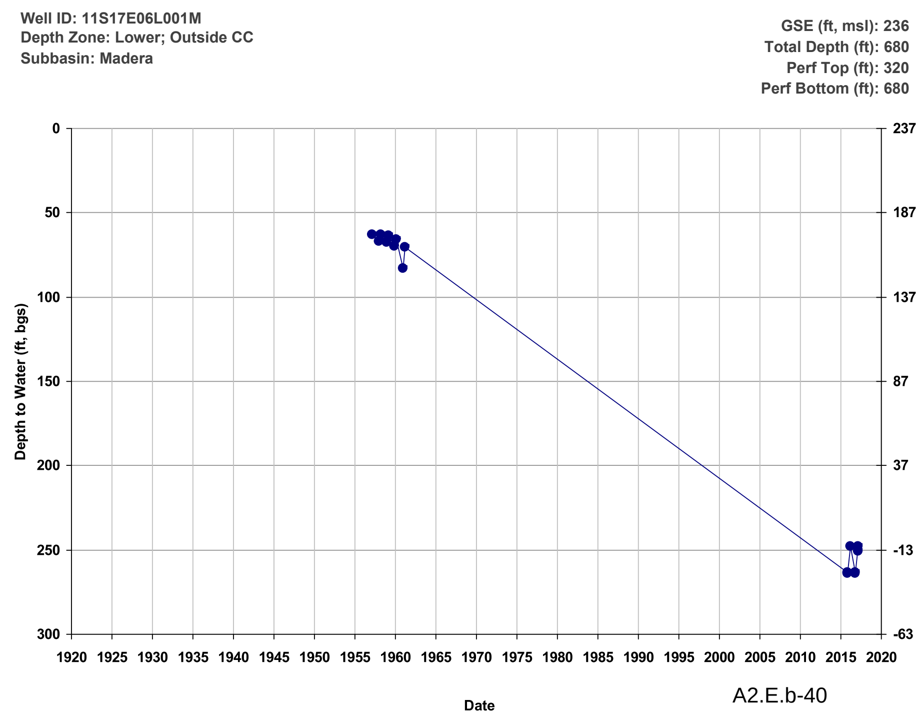
GSE (ft, msl): 237
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA




Well ID: 11S17E06C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 235
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

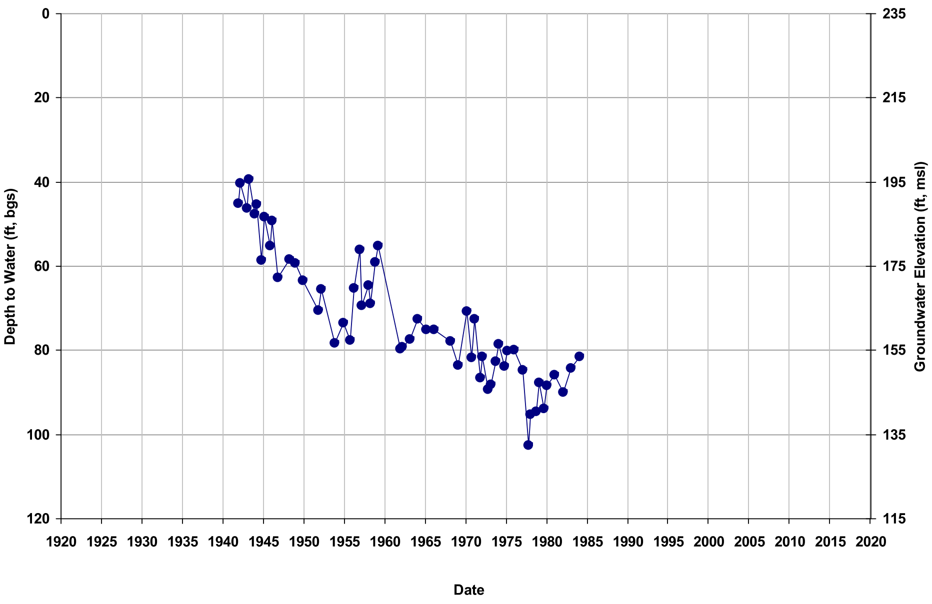

Well ID: 11S17E06J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 237
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 11S17E06K001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 239
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 11S17E06L001M
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 236
Total Depth (ft): 680
Perf Top (ft): 320
Perf Bottom (ft): 680
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

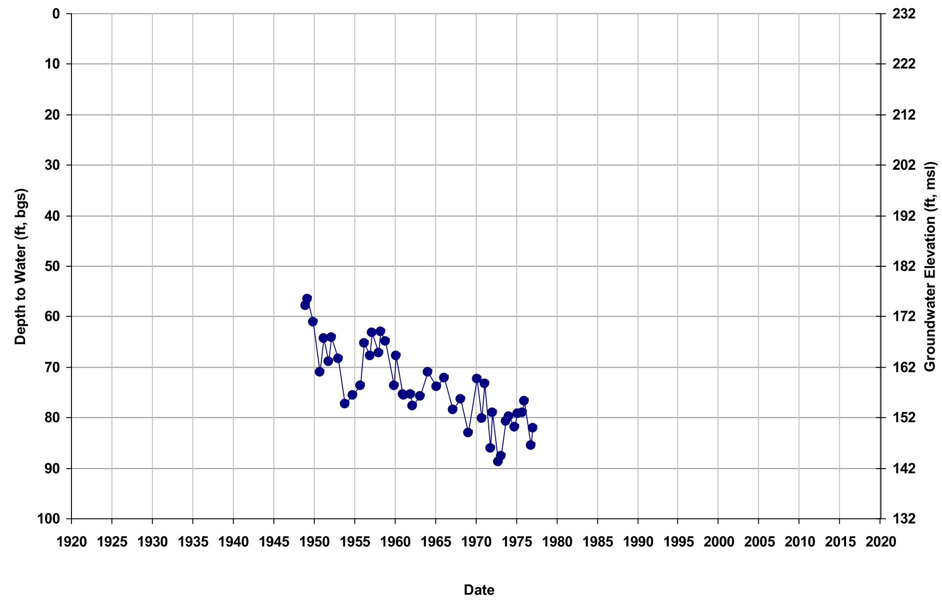
Well ID: 11S17E07A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 234
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



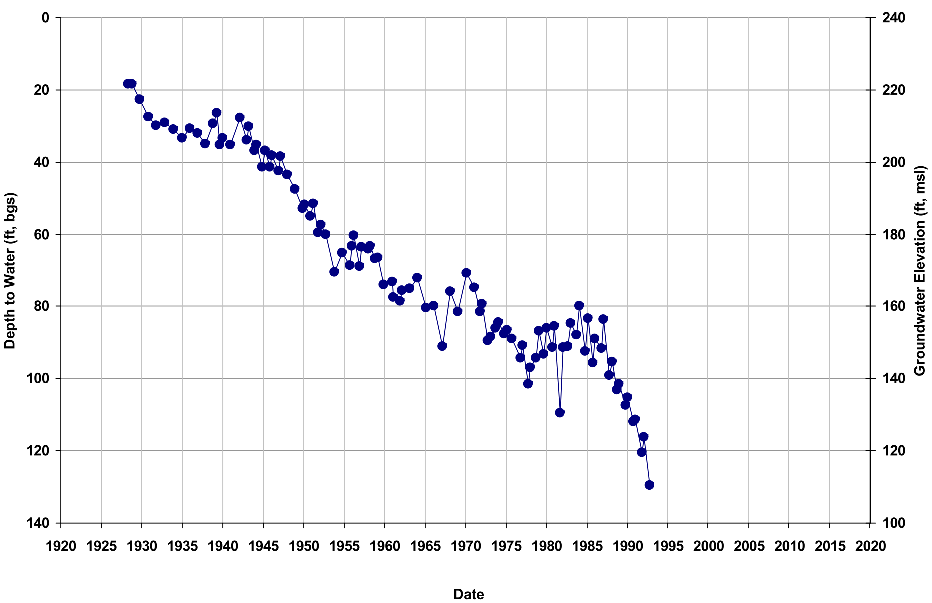
Well ID: 11S17E07D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 231
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



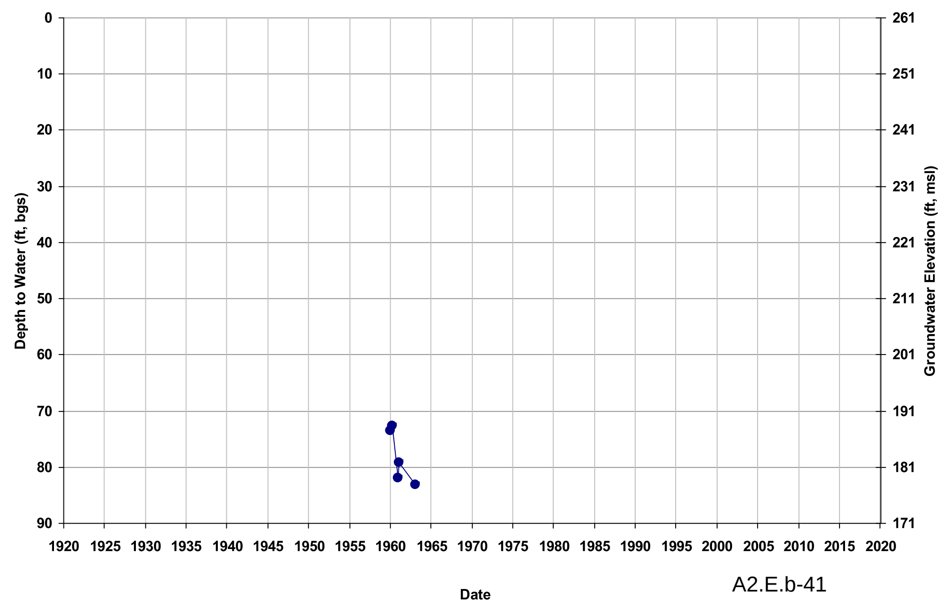
Well ID: 11S17E08H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 240
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



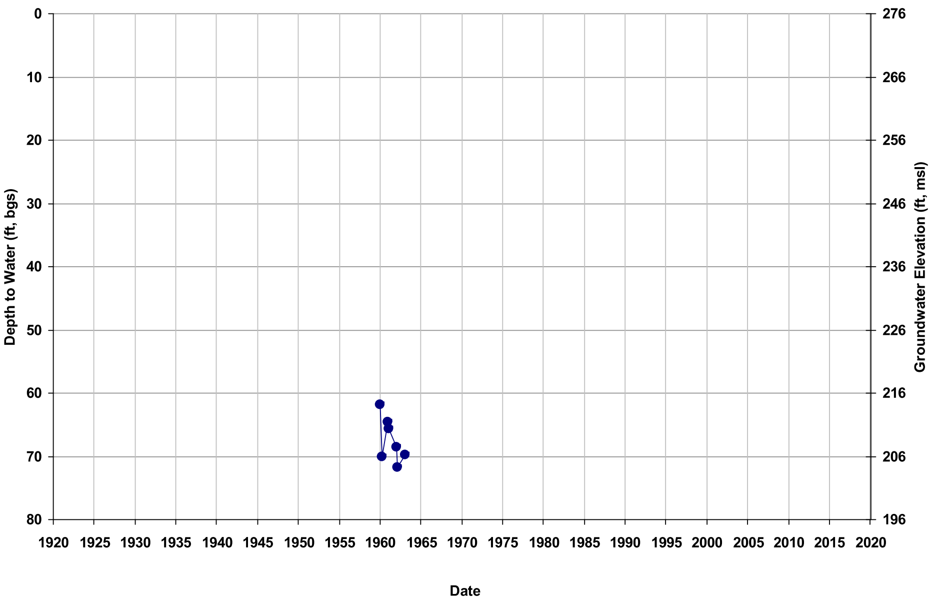
Well ID: 11S17E10Q001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 261
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



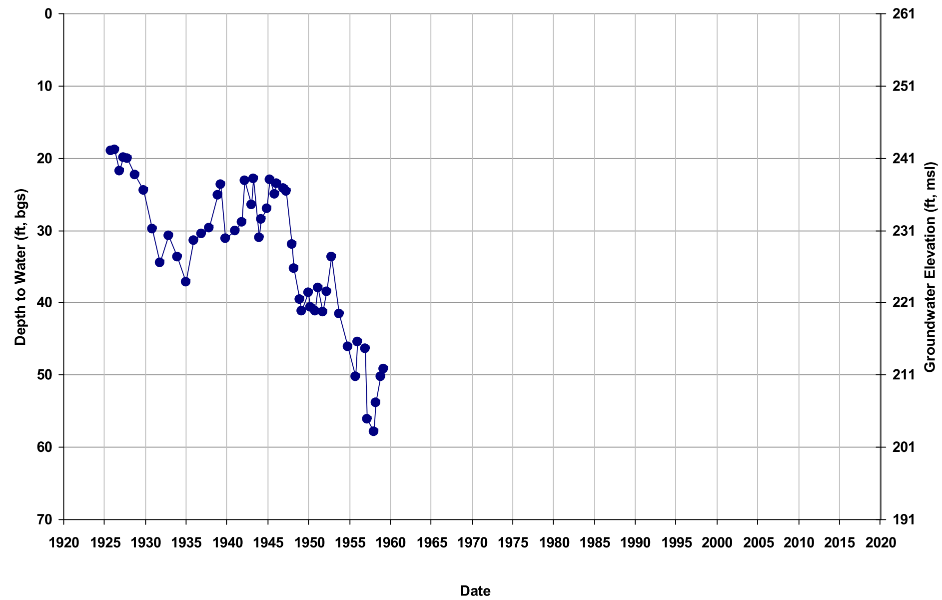
Well ID: 11S17E12E001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 276
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



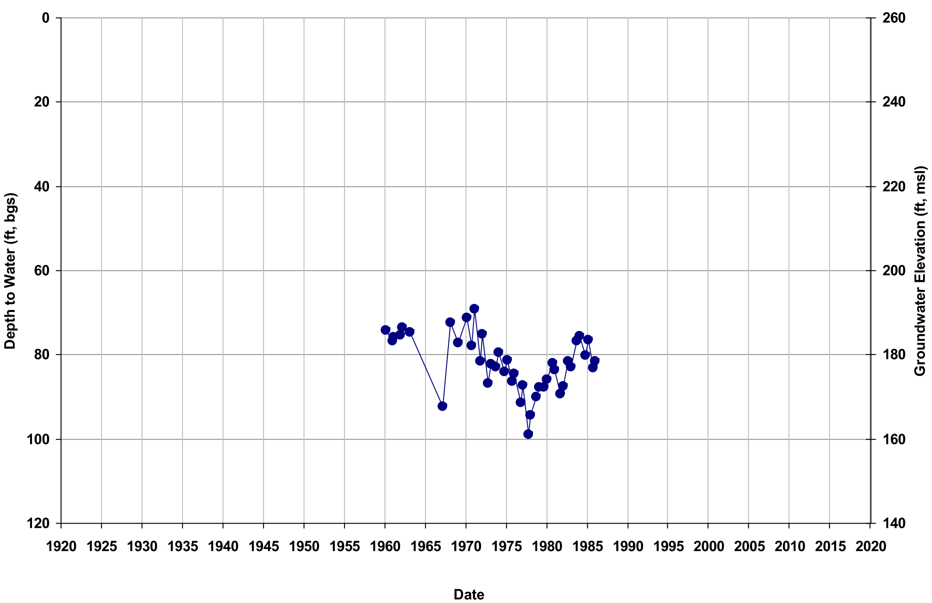
Well ID: 11S17E14M001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 260
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



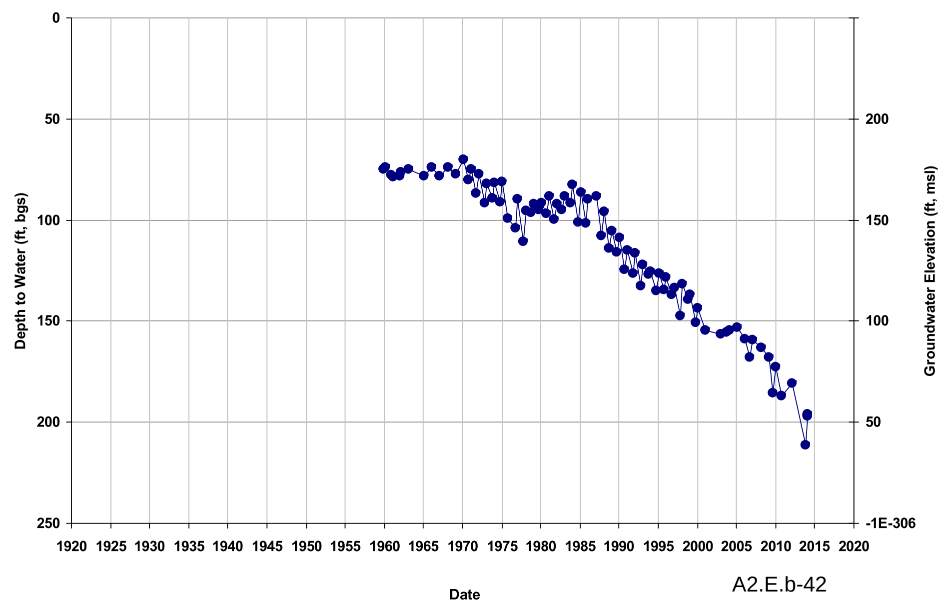
Well ID: 11S17E14M002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 259
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



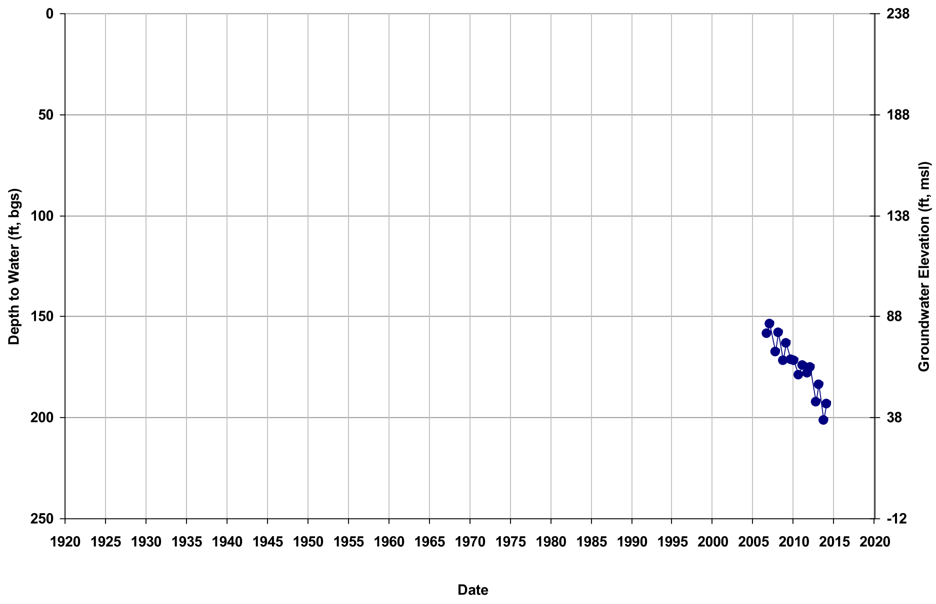
Well ID: 11S17E16H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 249
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



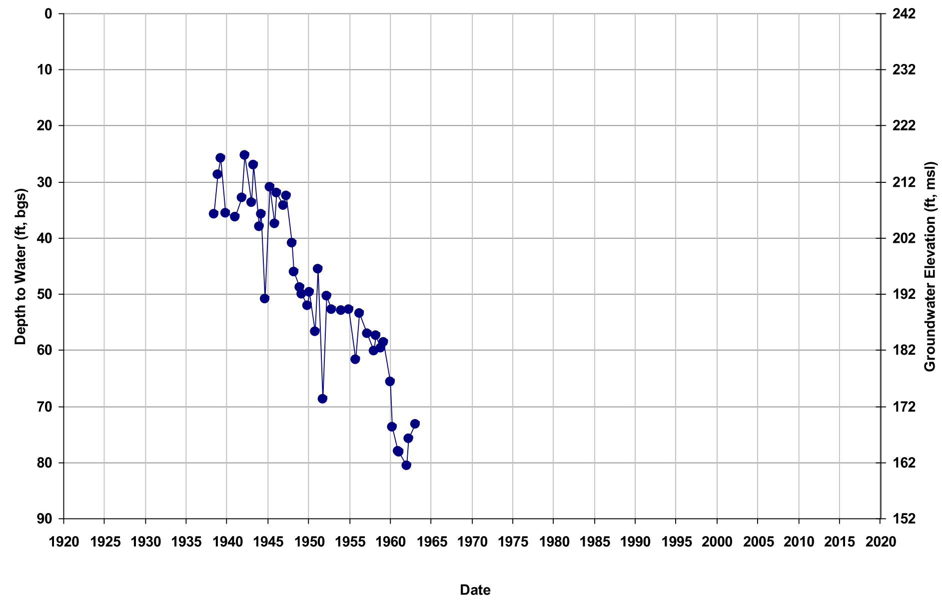
Well ID: 11S17E17C001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 238
Total Depth (ft): 580
Perf Top (ft): 260
Perf Bottom (ft): 504



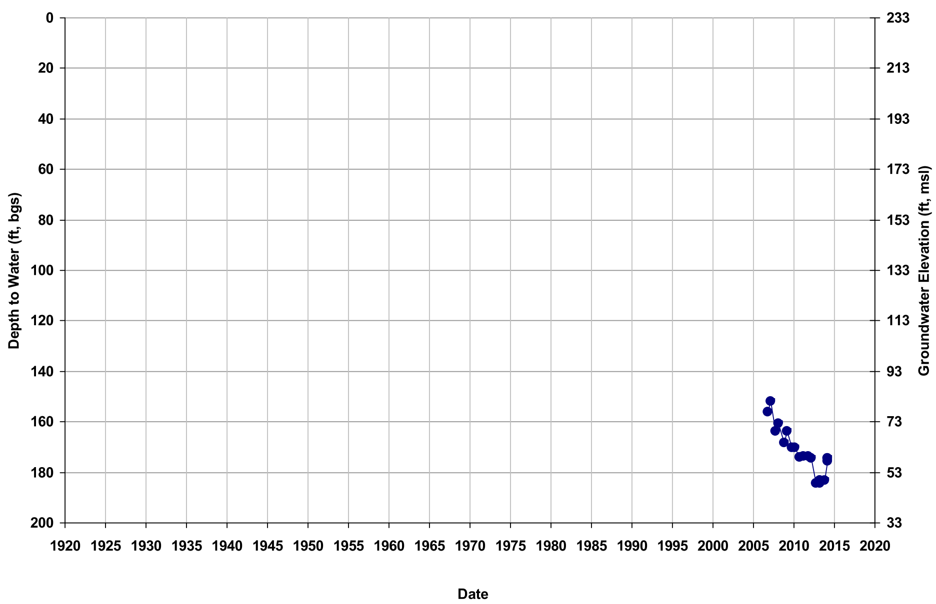
Well ID: 11S17E17J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 241
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



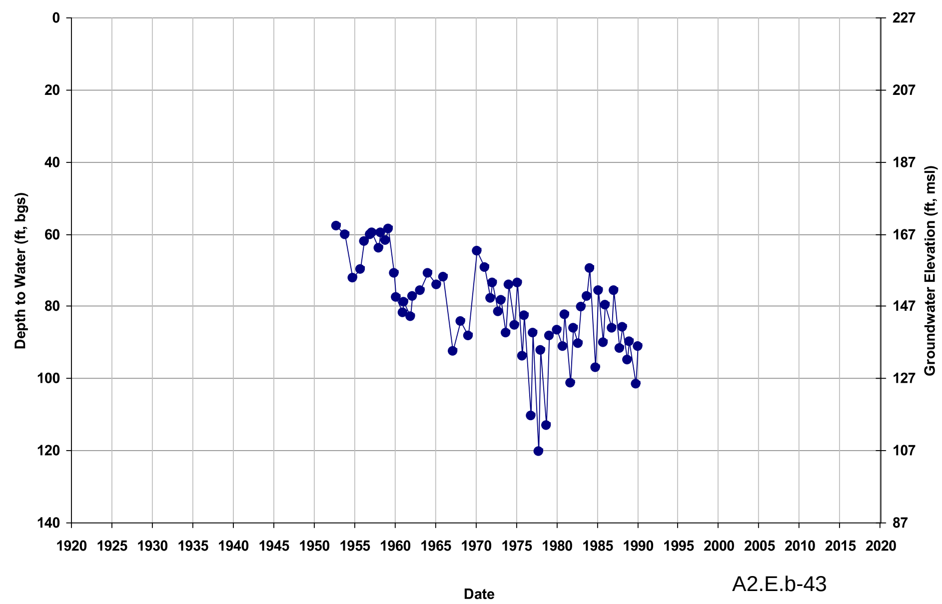
Well ID: 11S17E18B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

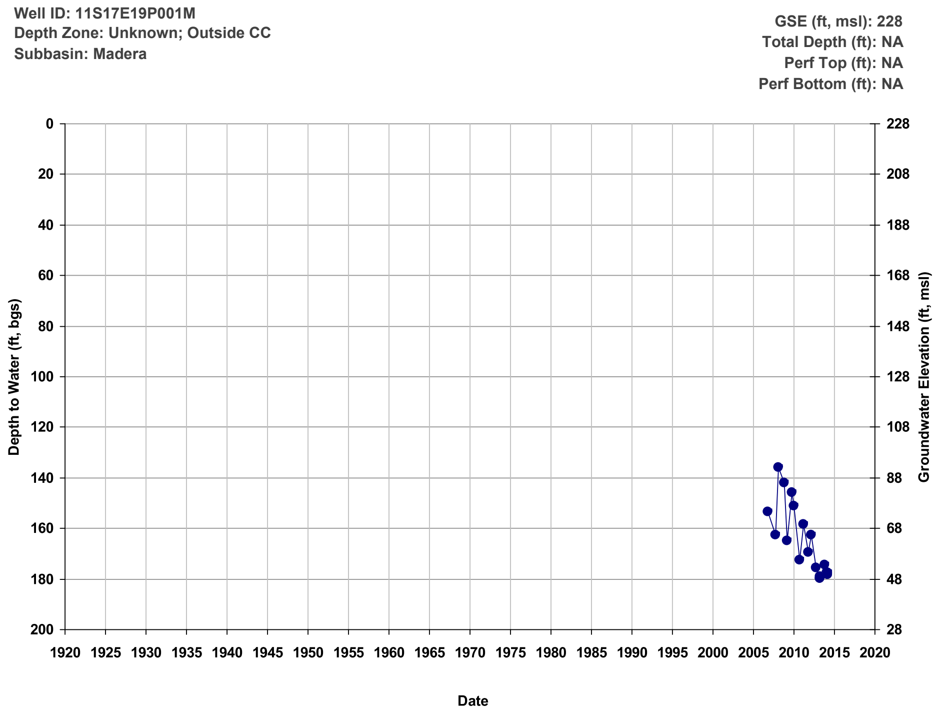
GSE (ft, msl): 233
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



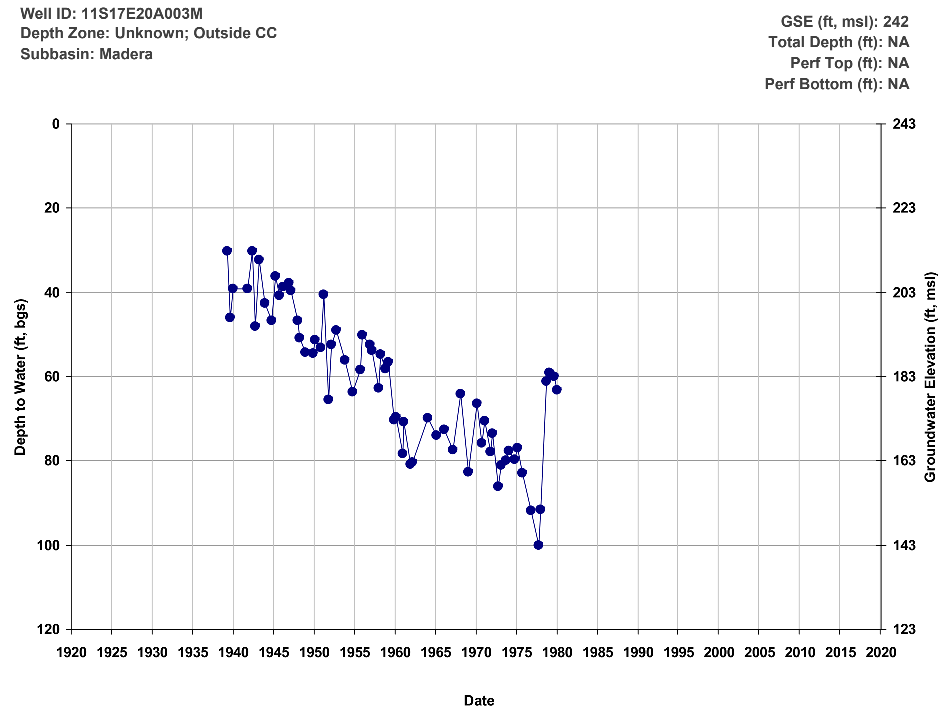
Well ID: 11S17E18N001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 227
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

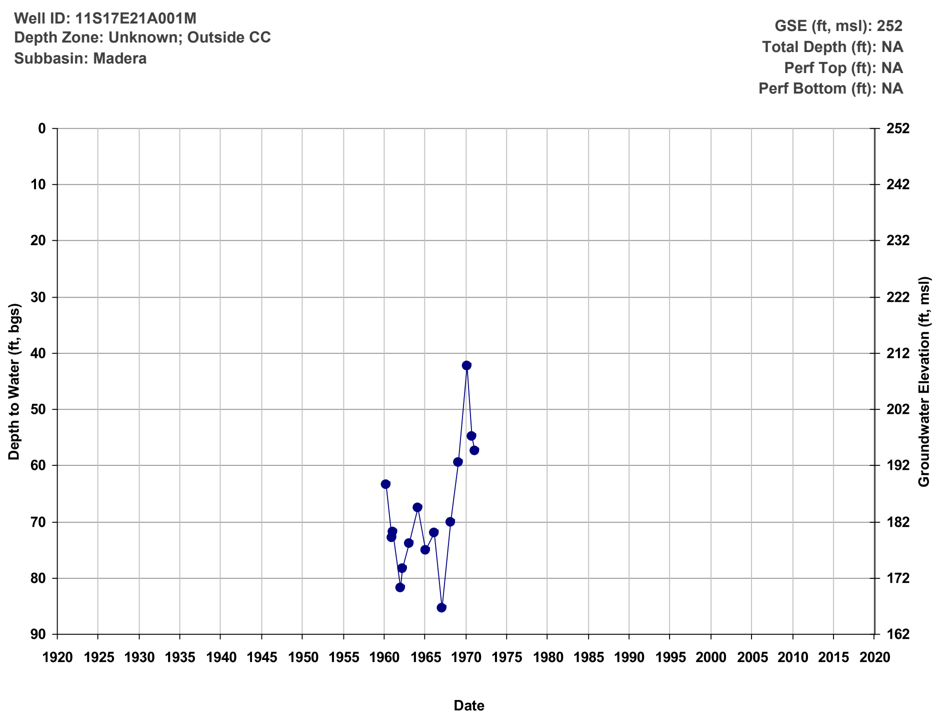




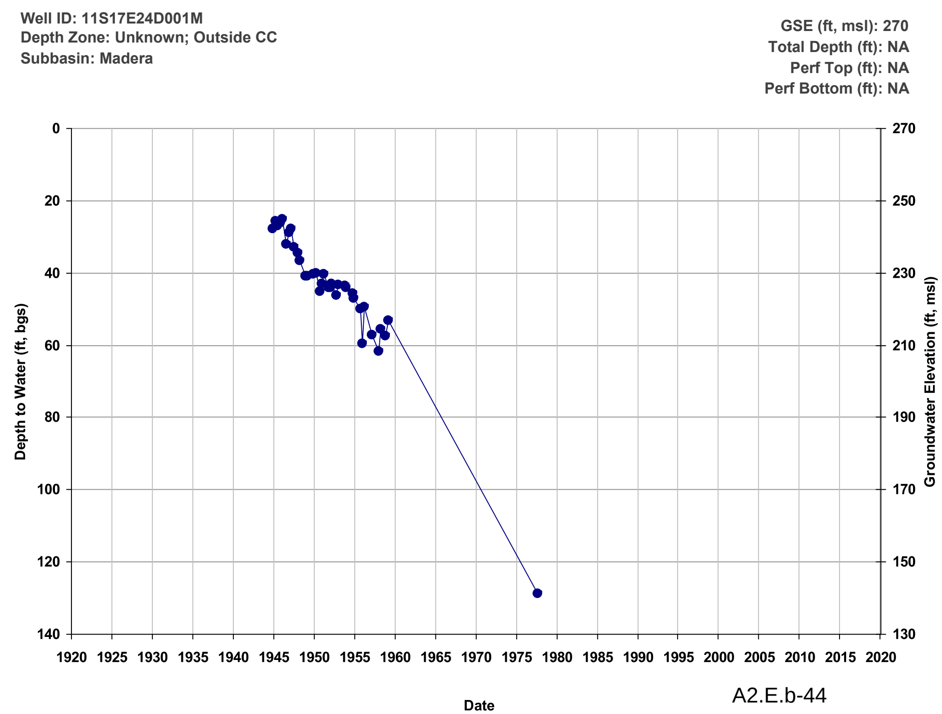
Well ID: 11S17E19P001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 228
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



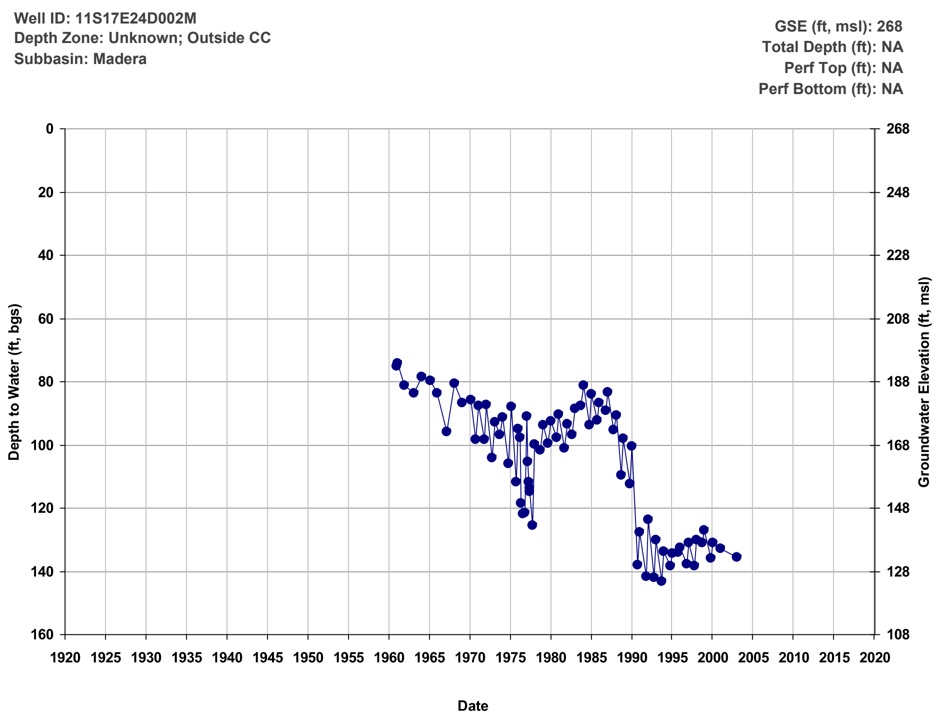
Well ID: 11S17E20A003M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 242
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

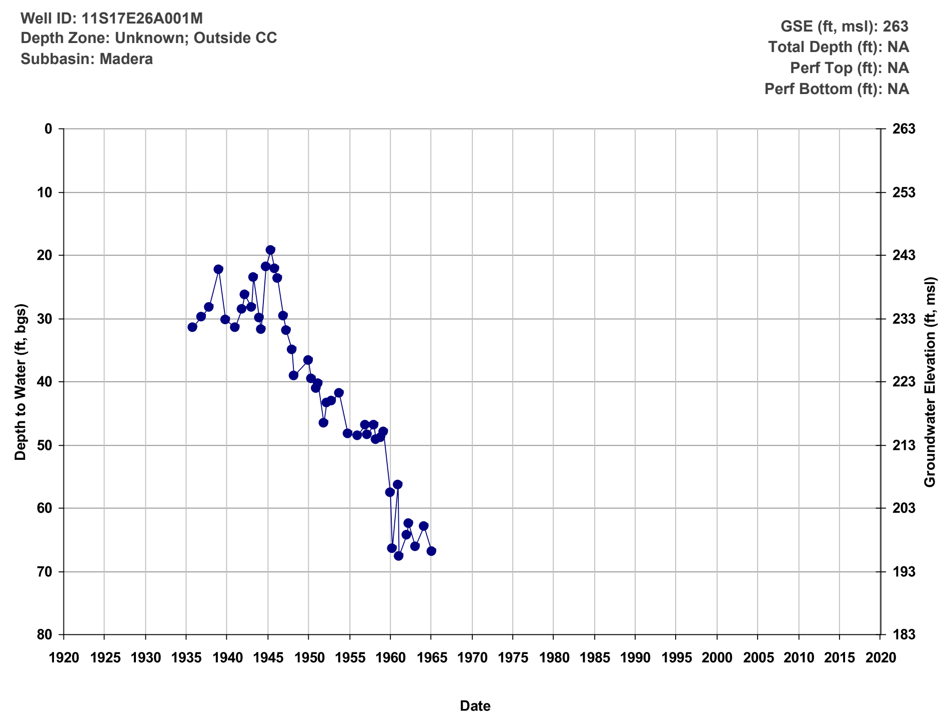


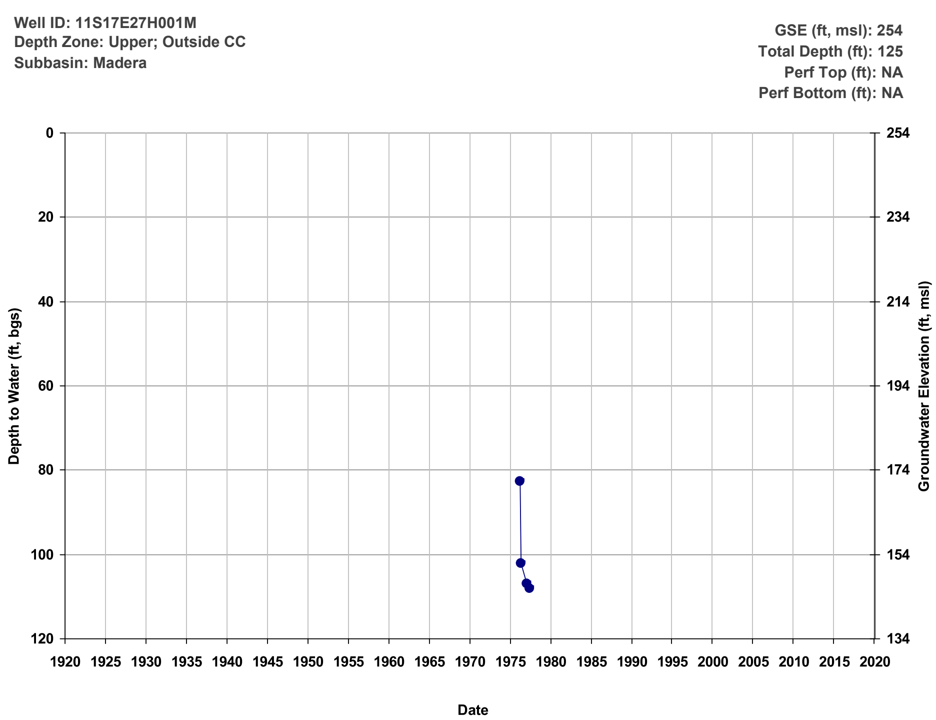
Well ID: 11S17E21A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 252
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

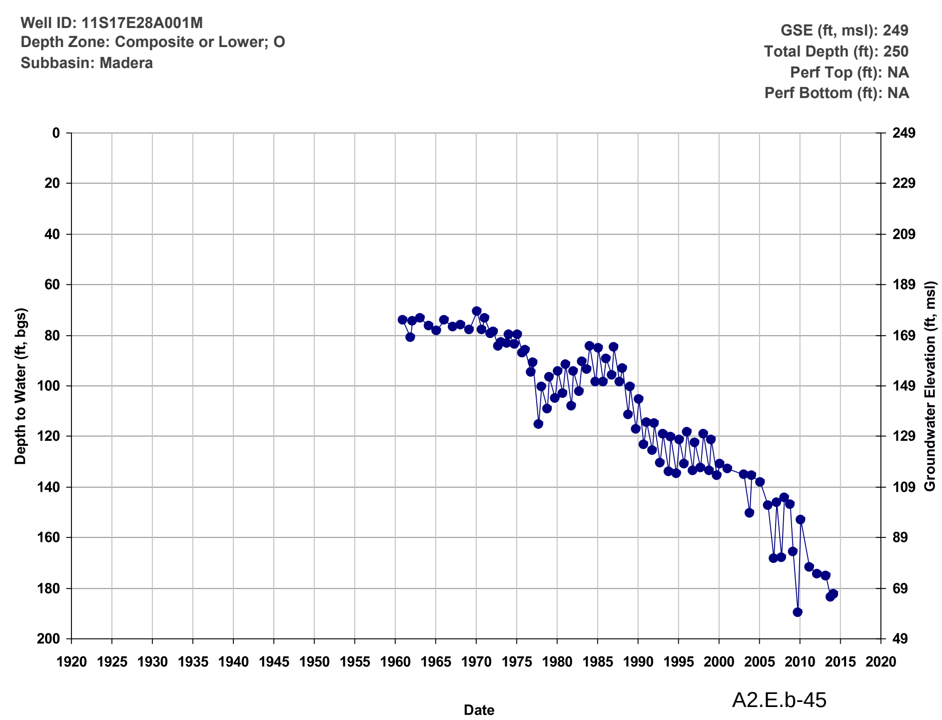


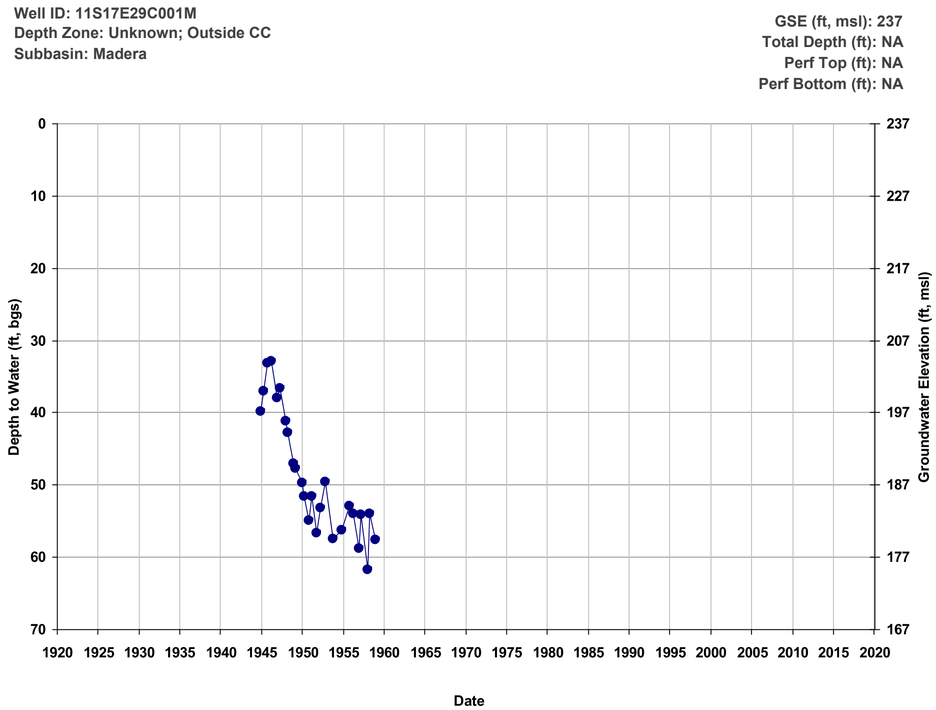
Well ID: 11S17E24D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 270
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

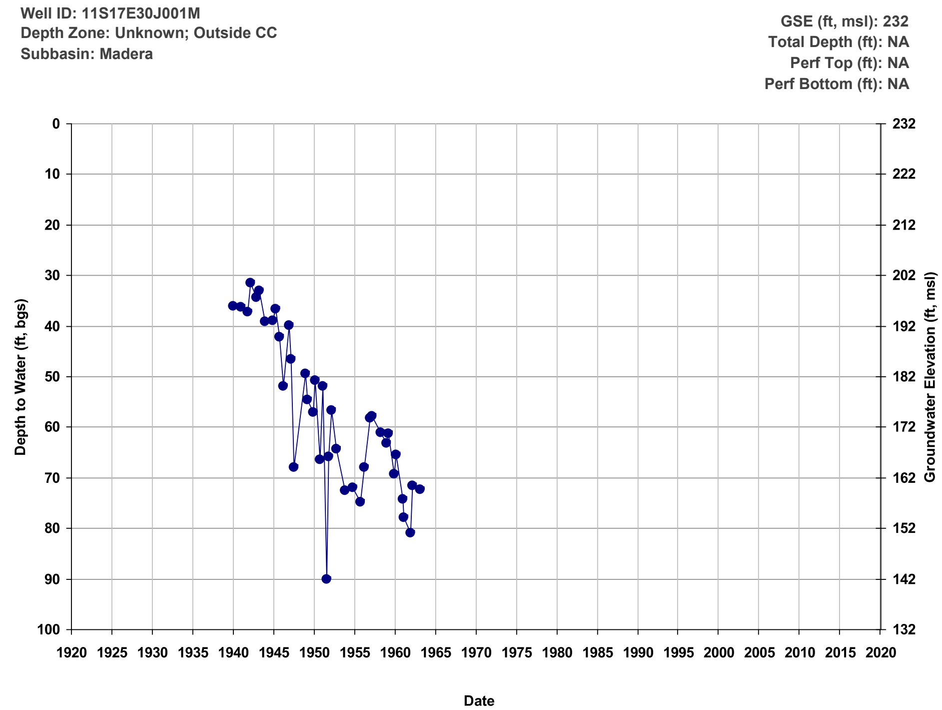

Well ID: 11S17E24D002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 268
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

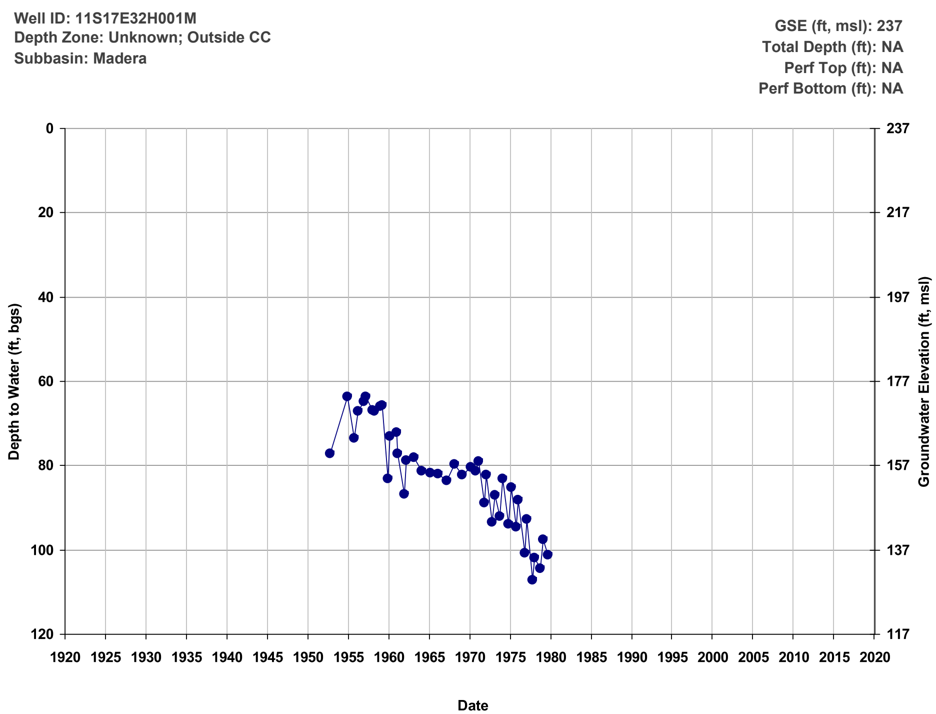

Well ID: 11S17E26A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 263
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

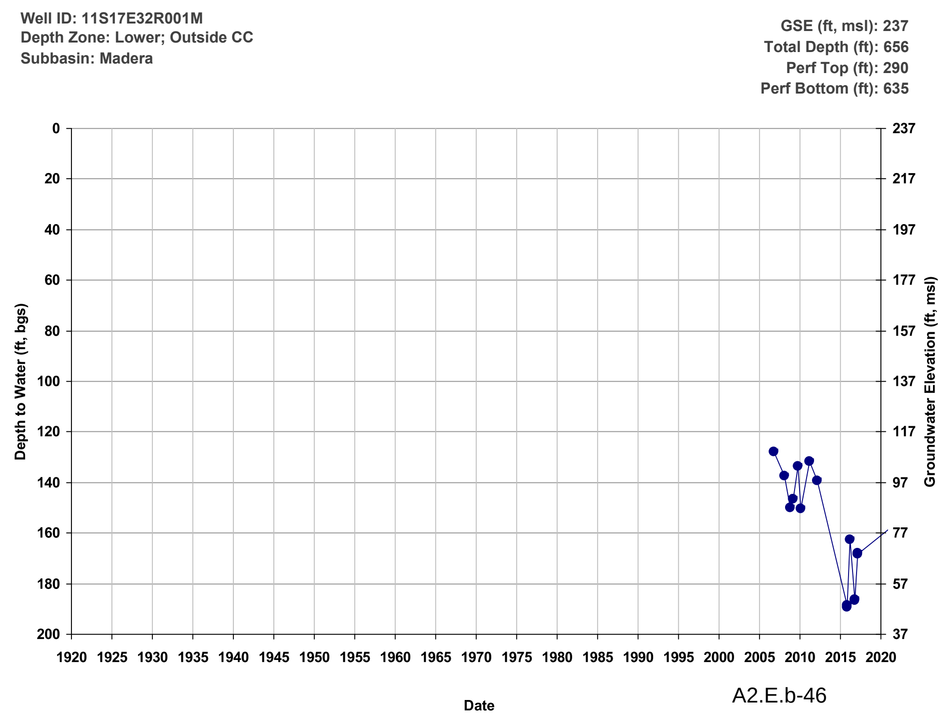

Well ID: 11S17E27H001M
Depth Zone: Upper; Outside CC
Subbasin: Madera
GSE (ft, msl): 254
Total Depth (ft): 125
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

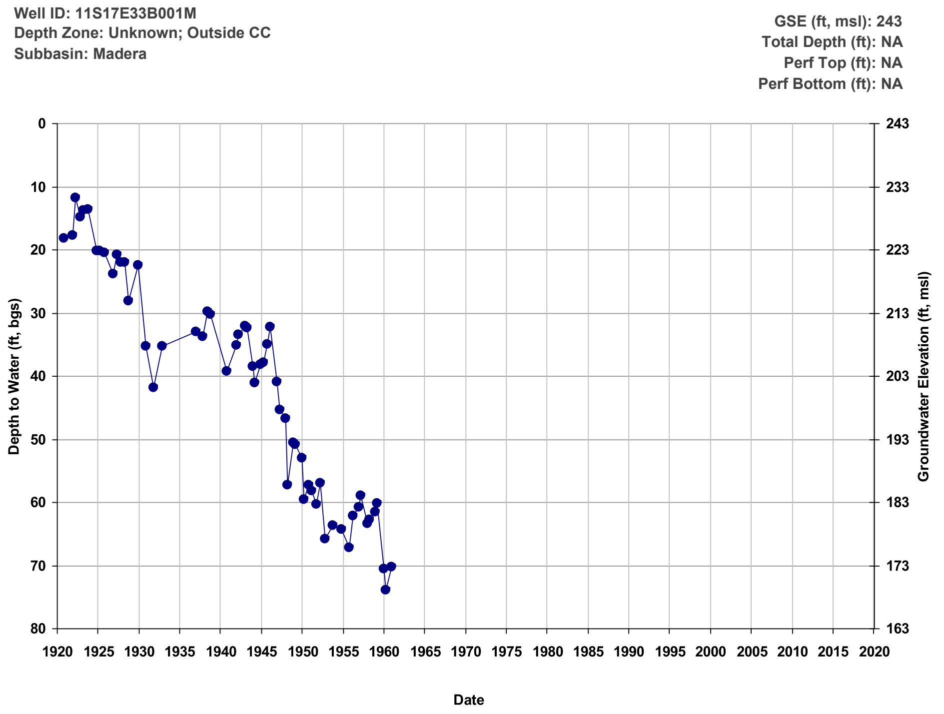

Well ID: 11S17E28A001M
Depth Zone: Composite or Lower; O
Subbasin: Madera
GSE (ft, msl): 249
Total Depth (ft): 250
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

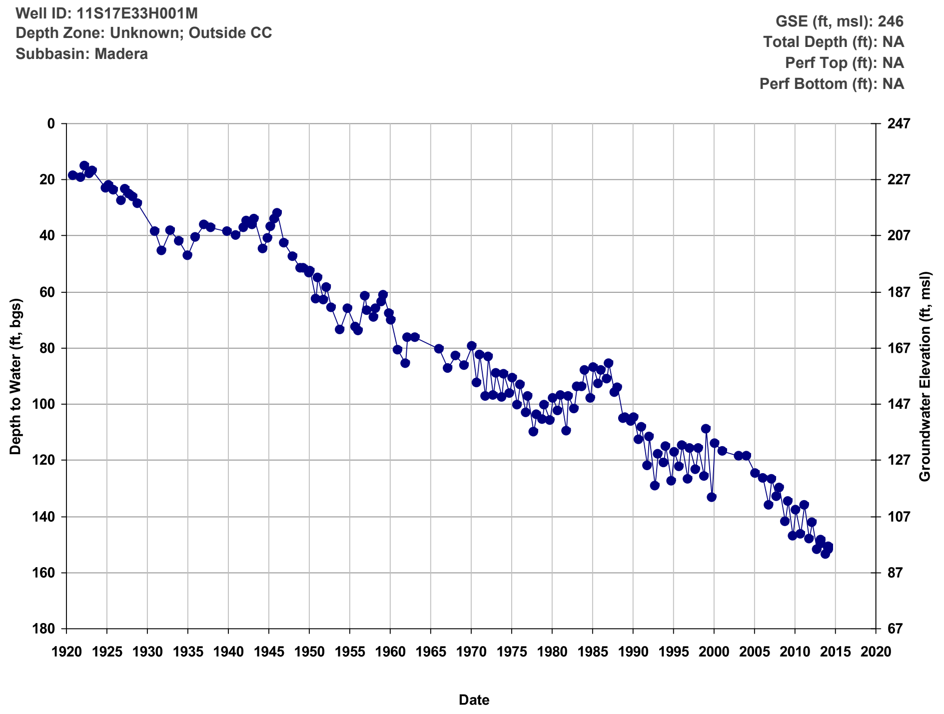

Well ID: 11S17E29C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 237
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date
0
10
20
30
40
50
60
70
237
227
217
207
197
187
177
167
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020

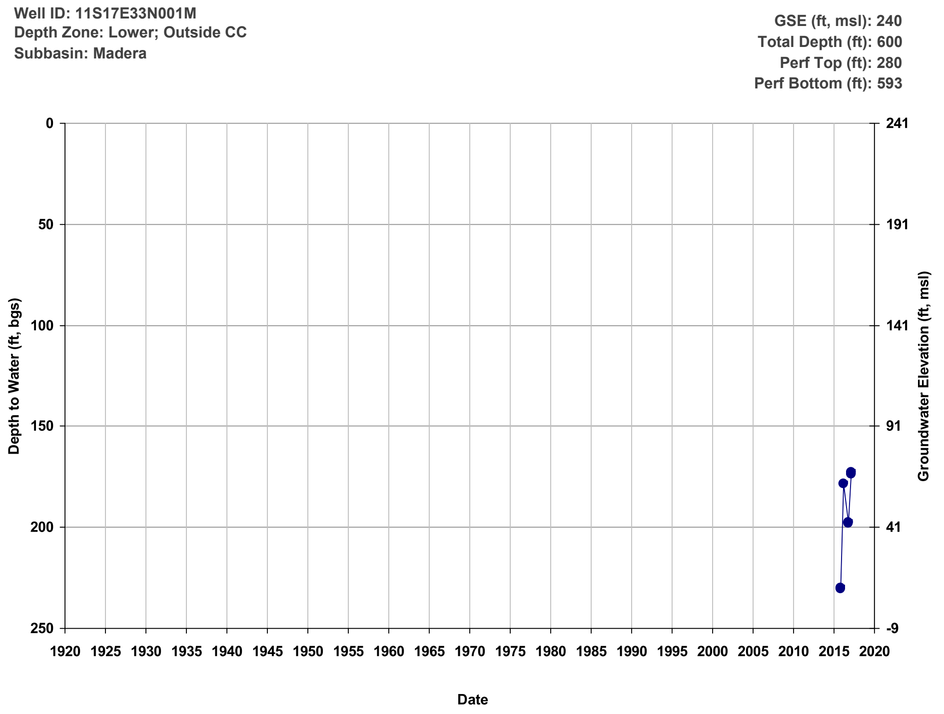

Well ID: 11S17E30J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 232
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date
0
10
20
30
40
50
60
70
80
90
100
232
222
212
202
192
182
172
162
152
142
132
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020

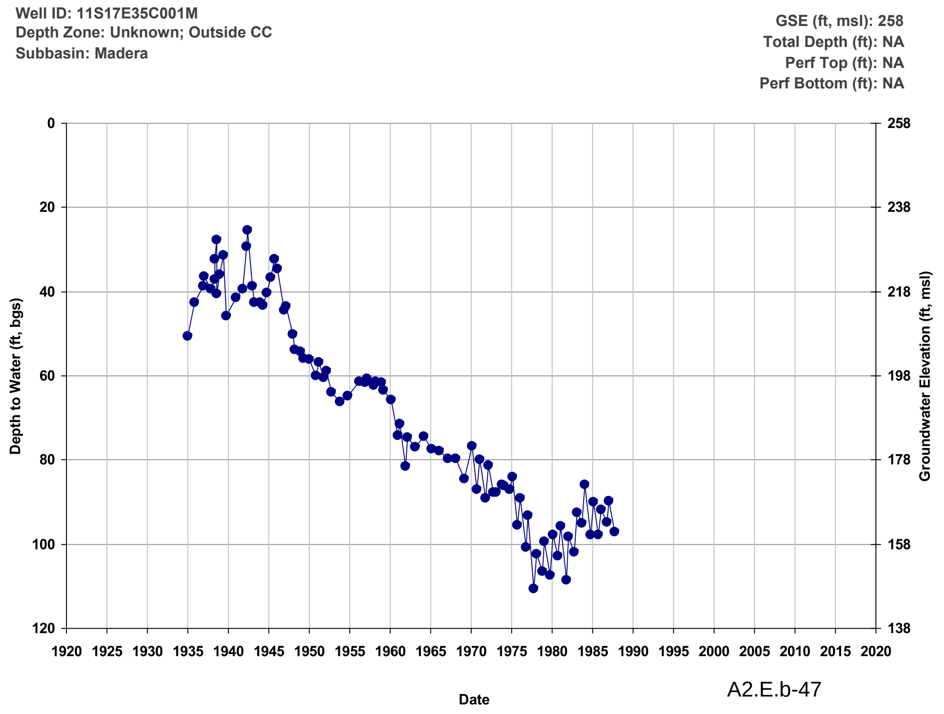

Well ID: 11S17E32H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 237
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date
0
20
40
60
80
100
120
237
217
197
177
157
137
117
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020


Well ID: 11S17E32R001M
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 237
Total Depth (ft): 656
Perf Top (ft): 290
Perf Bottom (ft): 635
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date
0
20
40
60
80
100
120
140
160
180
200
237
217
197
177
157
137
117
97
77
57
37
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020


Well ID: 11S17E33B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 243
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

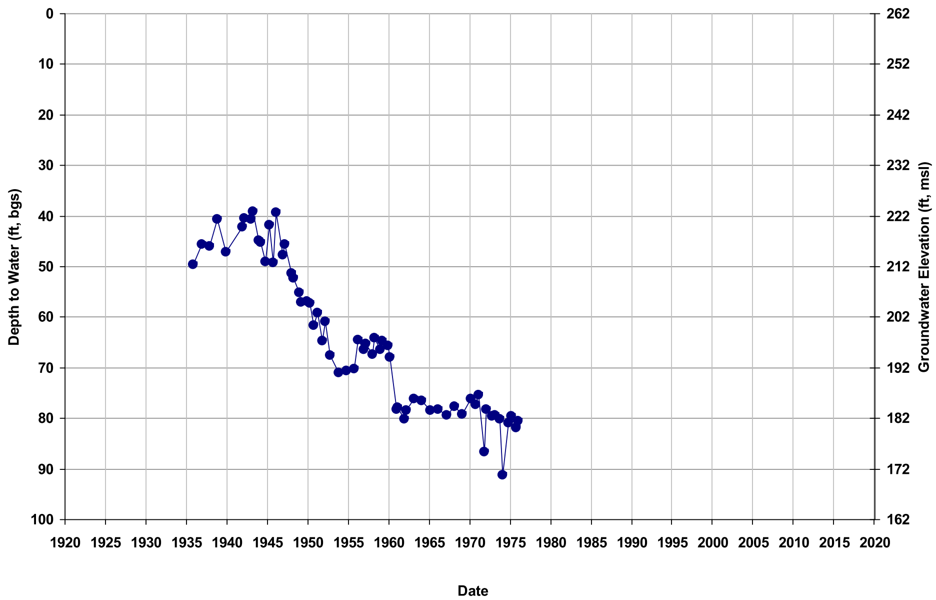

Well ID: 11S17E33H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 246
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 11S17E33N001M
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 240
Total Depth (ft): 600
Perf Top (ft): 280
Perf Bottom (ft): 593
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 11S17E35C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 258
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

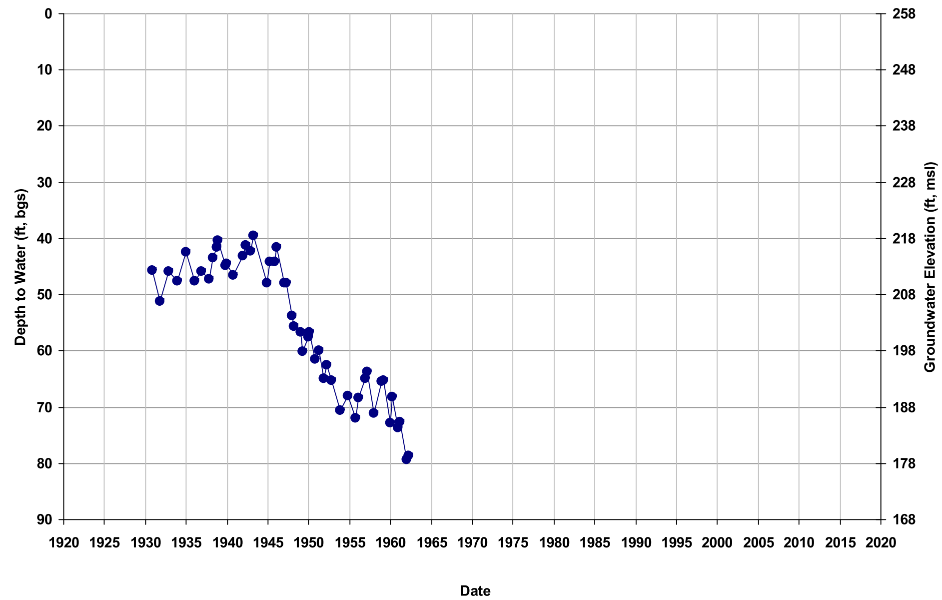
Well ID: 11S17E36B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 261
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



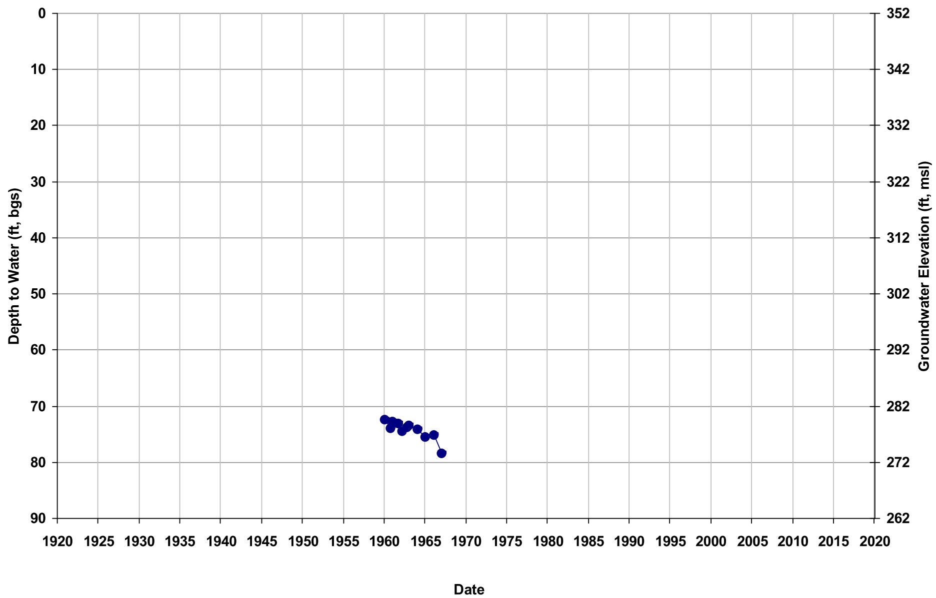
Well ID: 11S17E36R001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 258
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



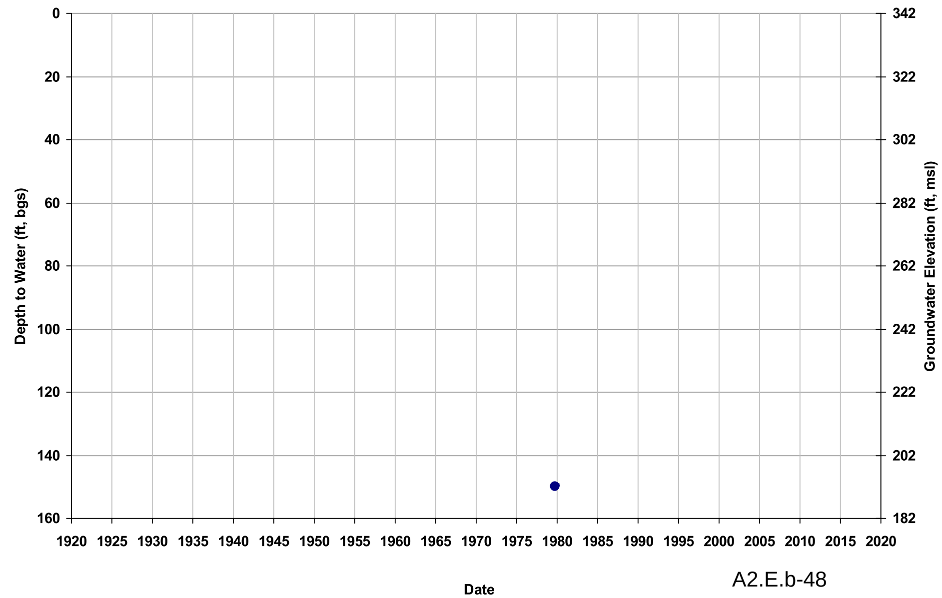
Well ID: 11S18E01B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 352
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



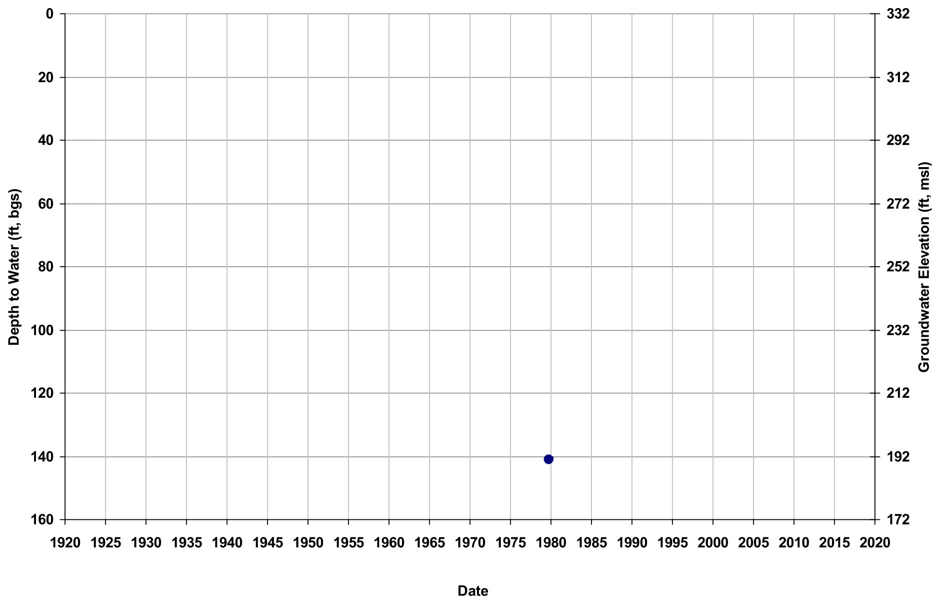
Well ID: 11S18E01M001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 342
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



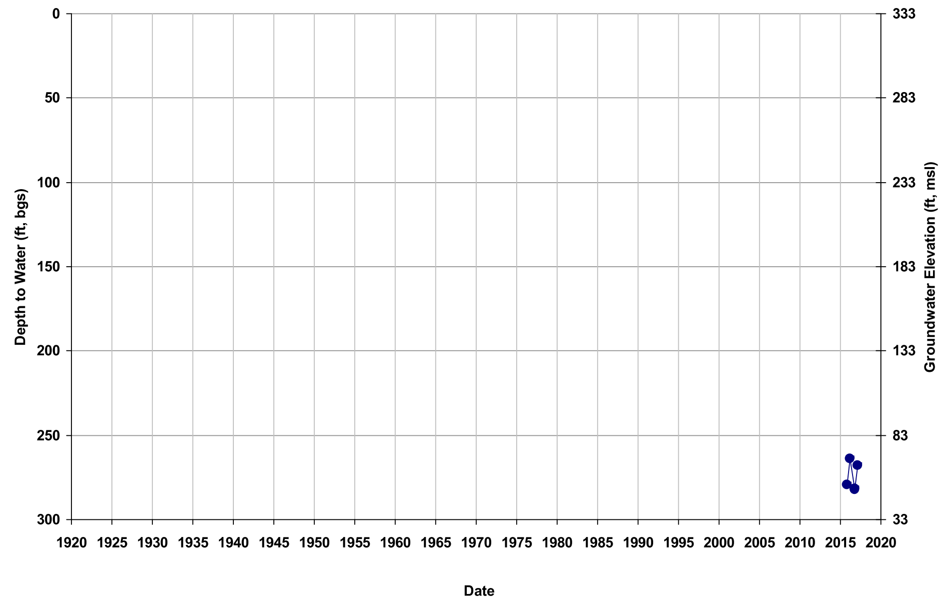
Well ID: 11S18E02H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 332
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



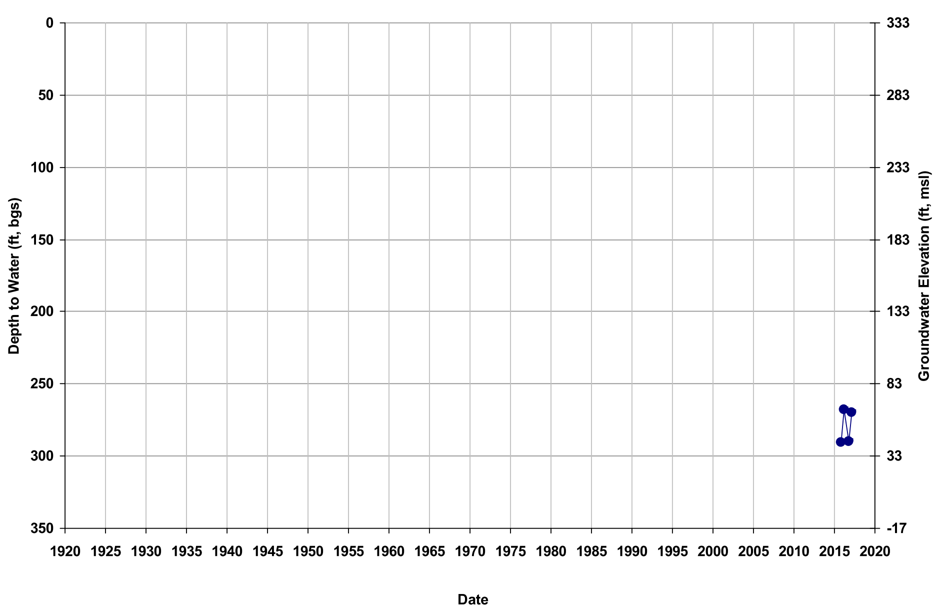
Well ID: 11S18E02M001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 332
Total Depth (ft): 360
Perf Top (ft): 300
Perf Bottom (ft): 360



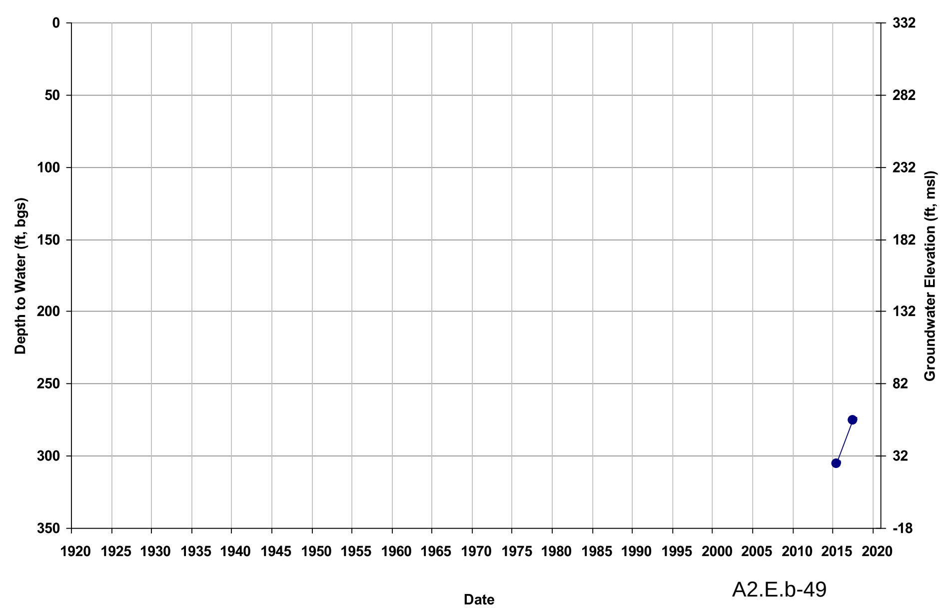
Well ID: 11S18E02M002M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 333
Total Depth (ft): 400
Perf Top (ft): 320
Perf Bottom (ft): 400



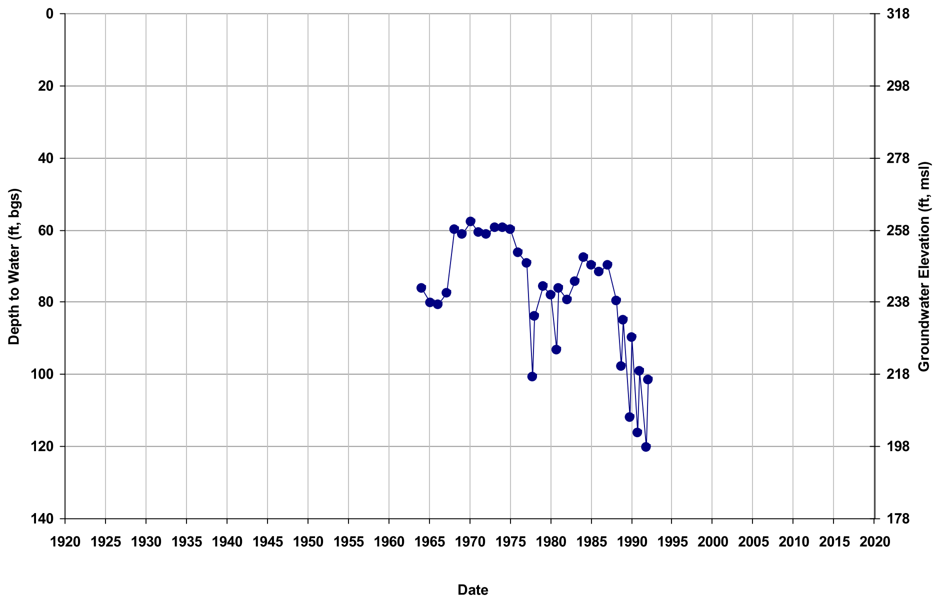
Well ID: 11S18E03J001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

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



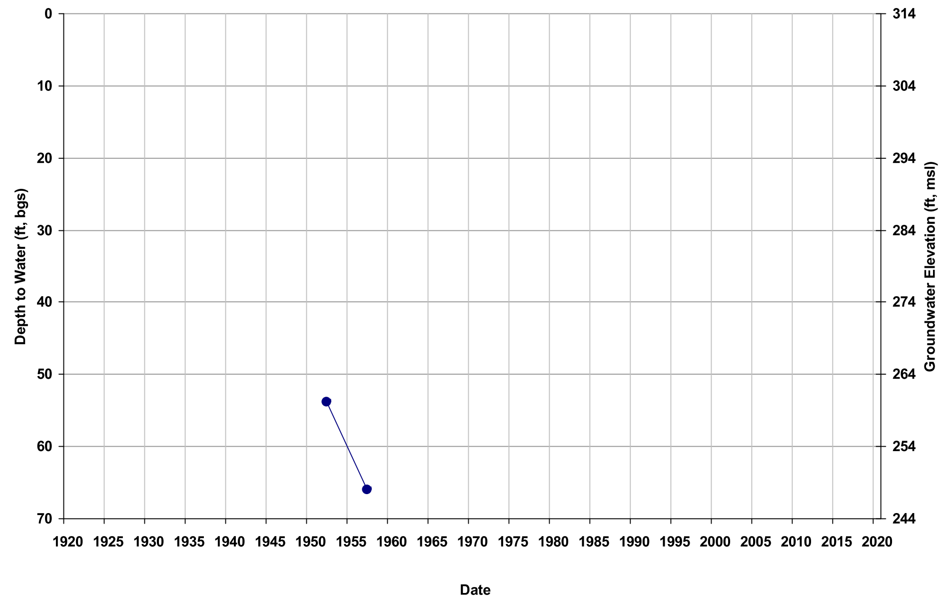
Well ID: 11S18E04E001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 318
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



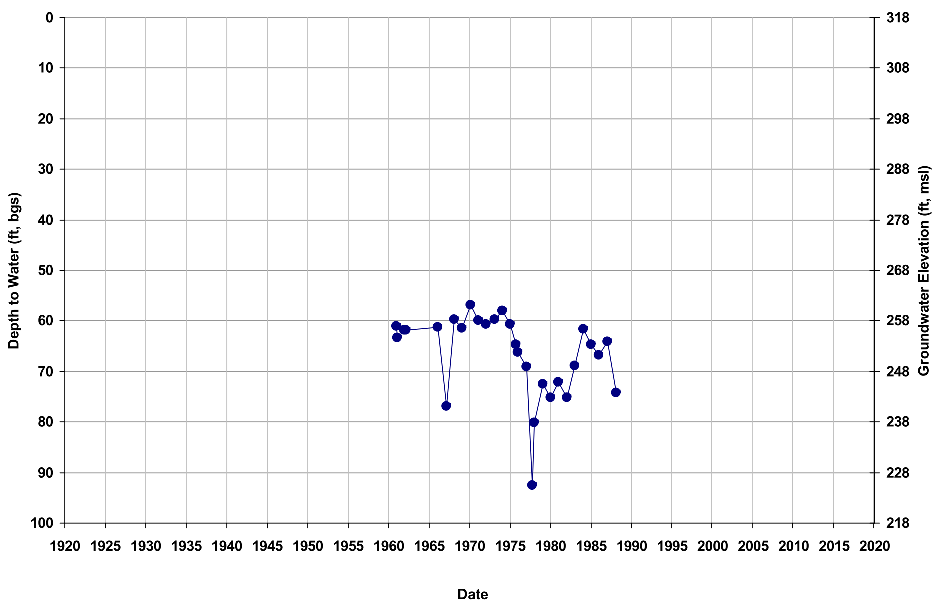
Well ID: 11S18E05G001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 314
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



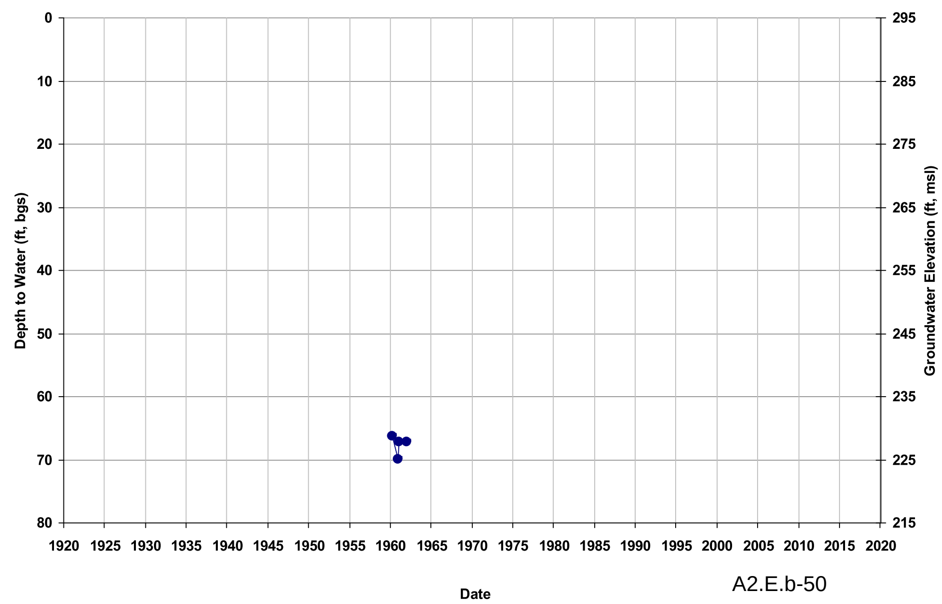
Well ID: 11S18E05J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

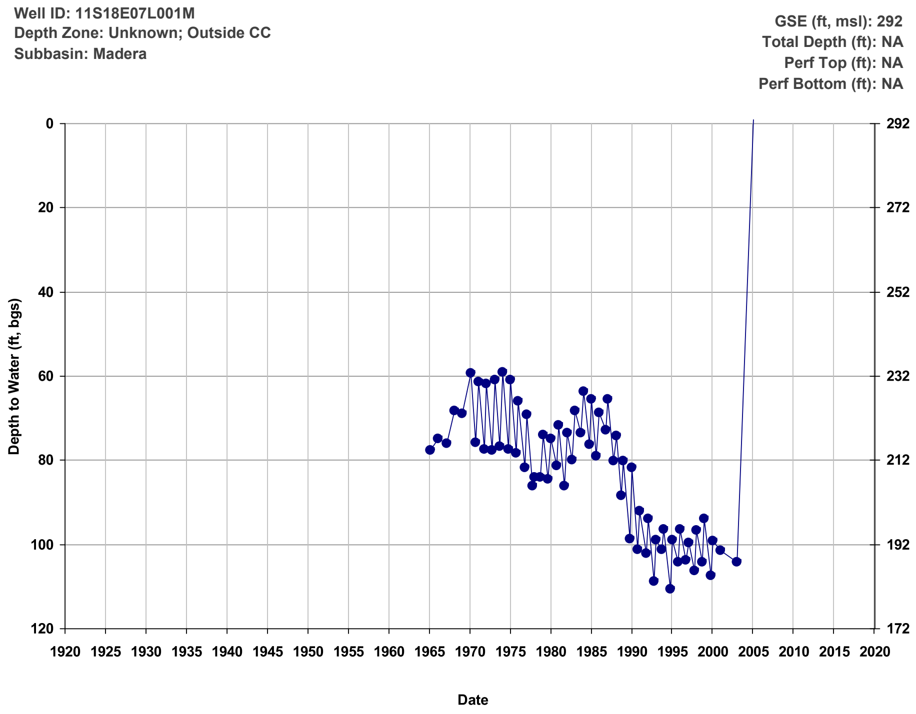
GSE (ft, msl): 318
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

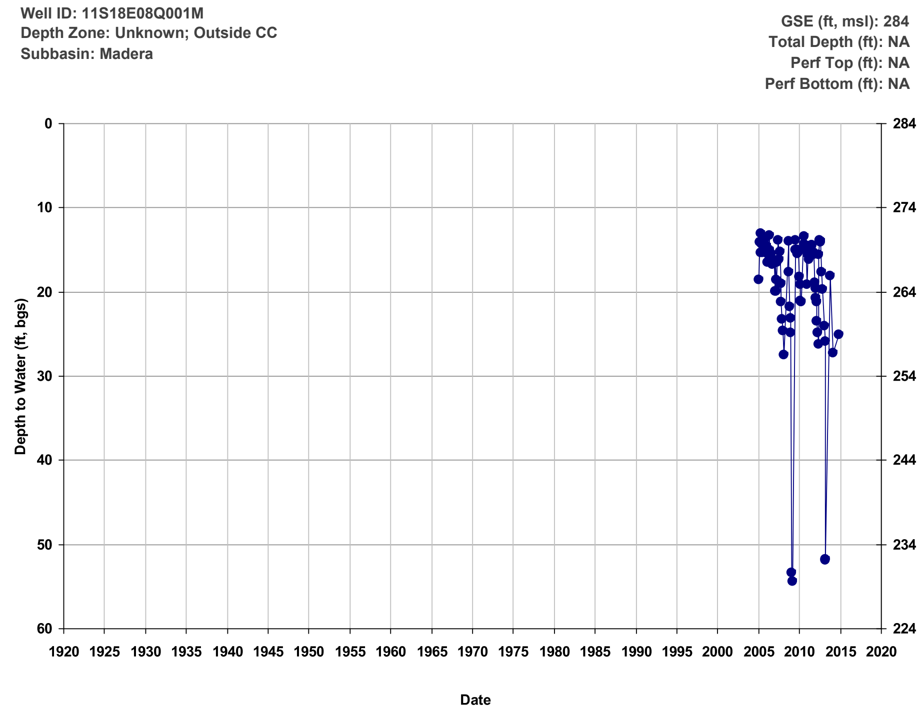


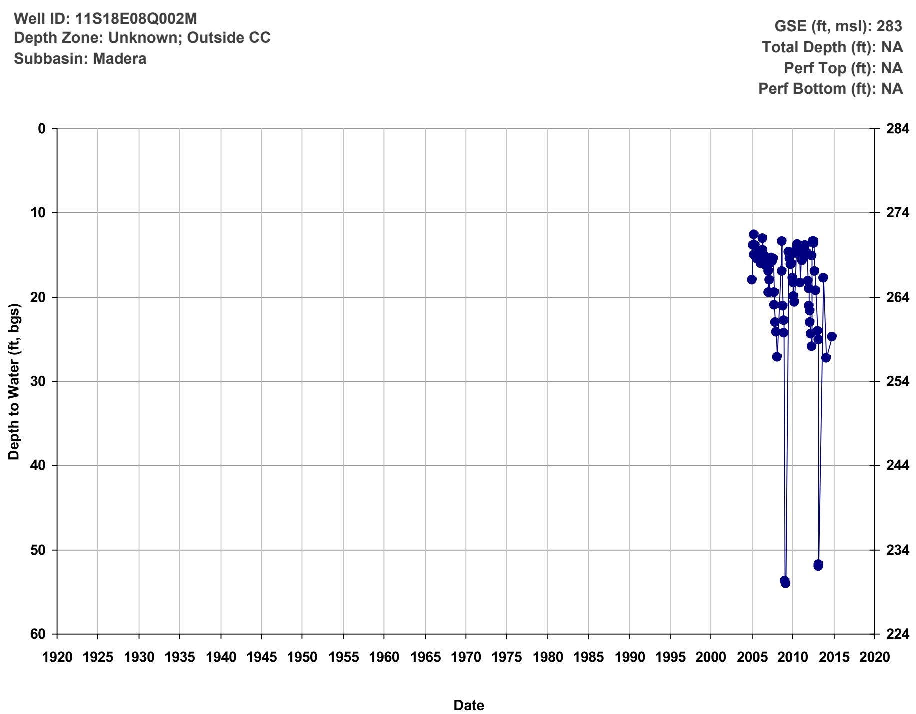
Well ID: 11S18E06P001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

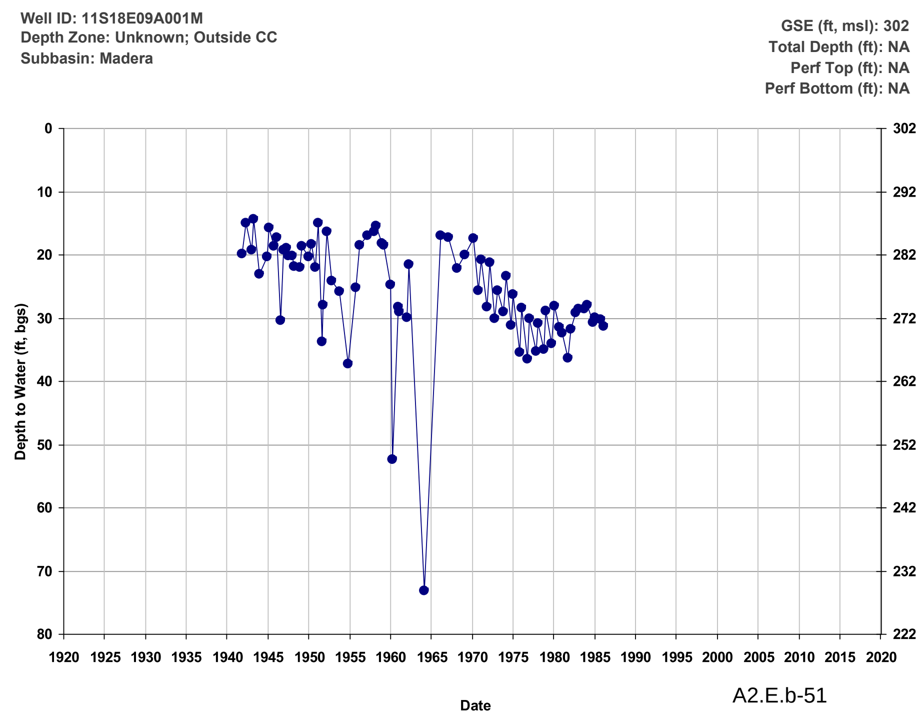
GSE (ft, msl): 295
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA




Well ID: 11S18E07L001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 292
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

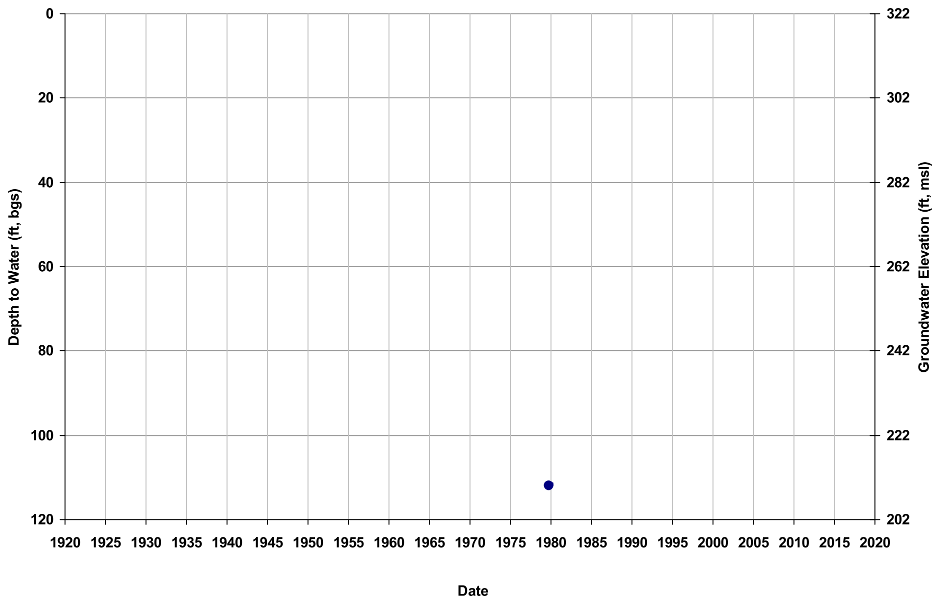

Well ID: 11S18E08Q001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 284
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 11S18E08Q002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 283
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 11S18E09A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 302
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

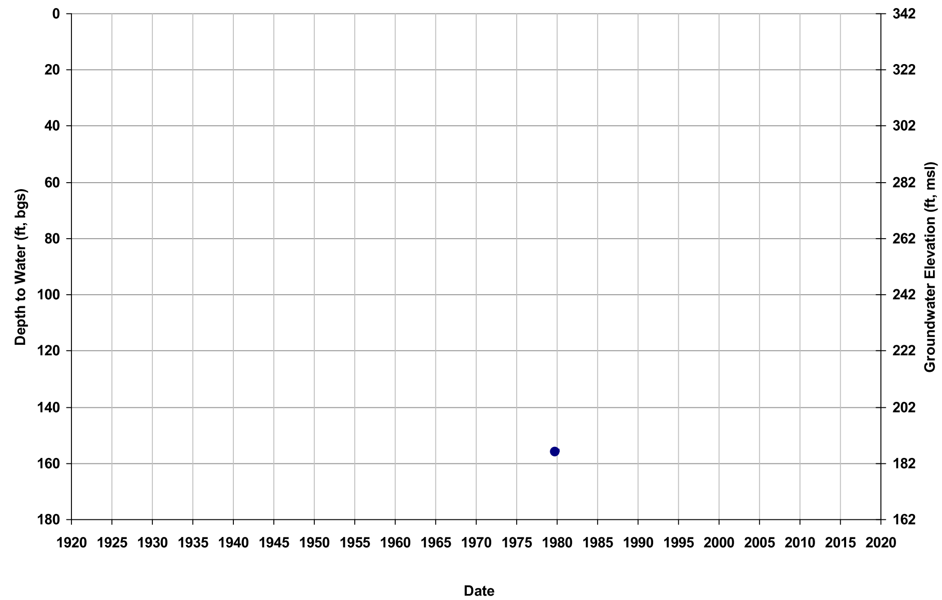
Well ID: 11S18E10H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 322
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



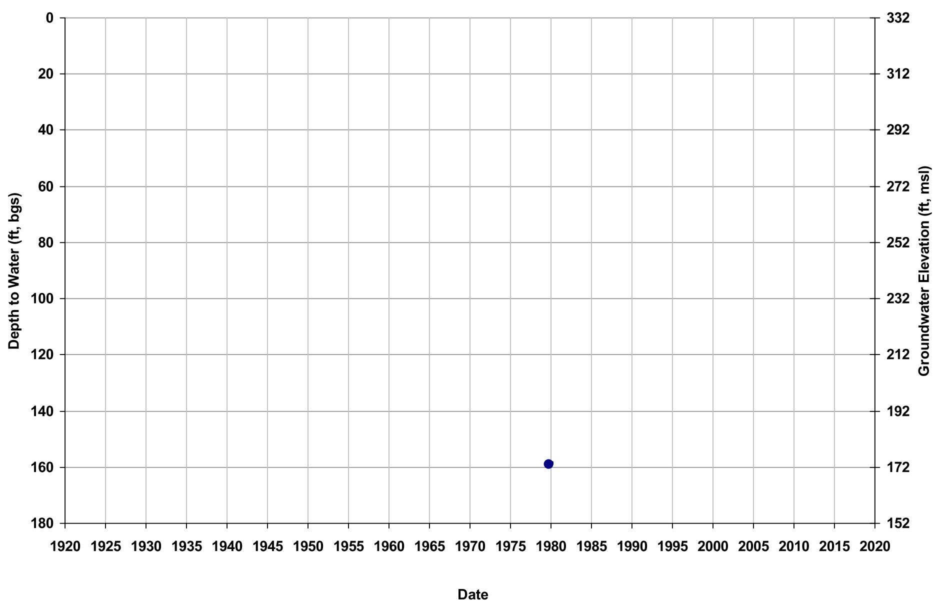
Well ID: 11S18E11A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 342
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



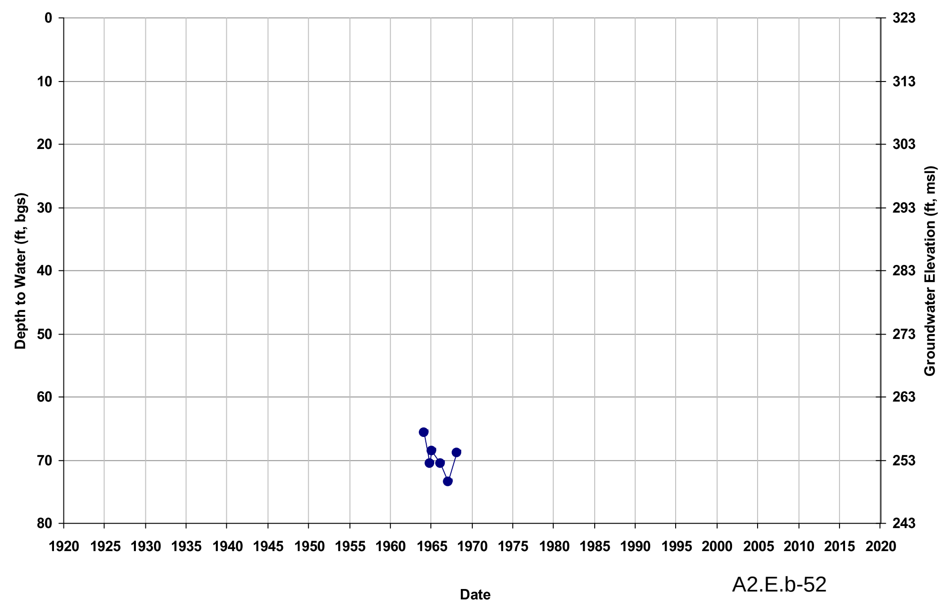
Well ID: 11S18E13C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 332
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



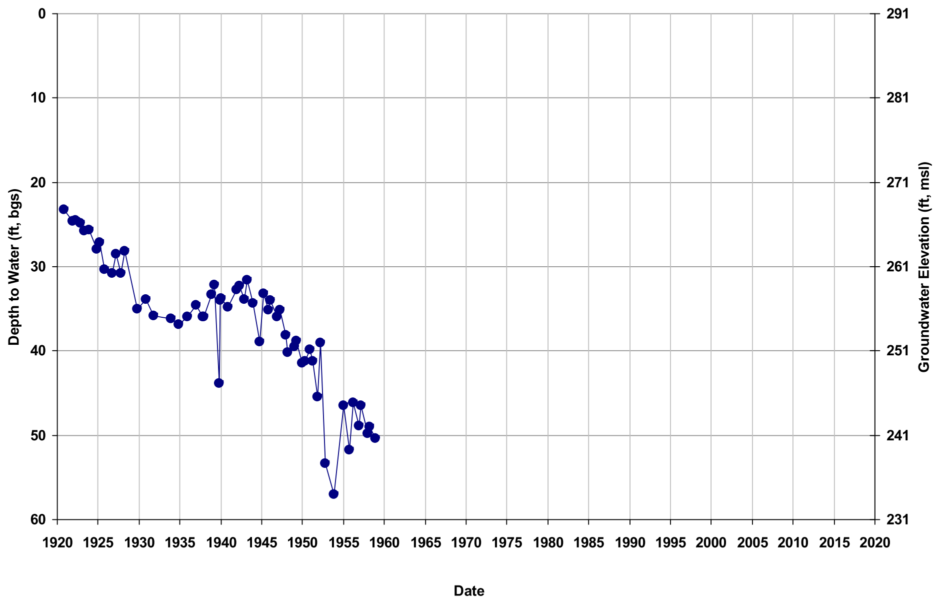
Well ID: 11S18E13P001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 323
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



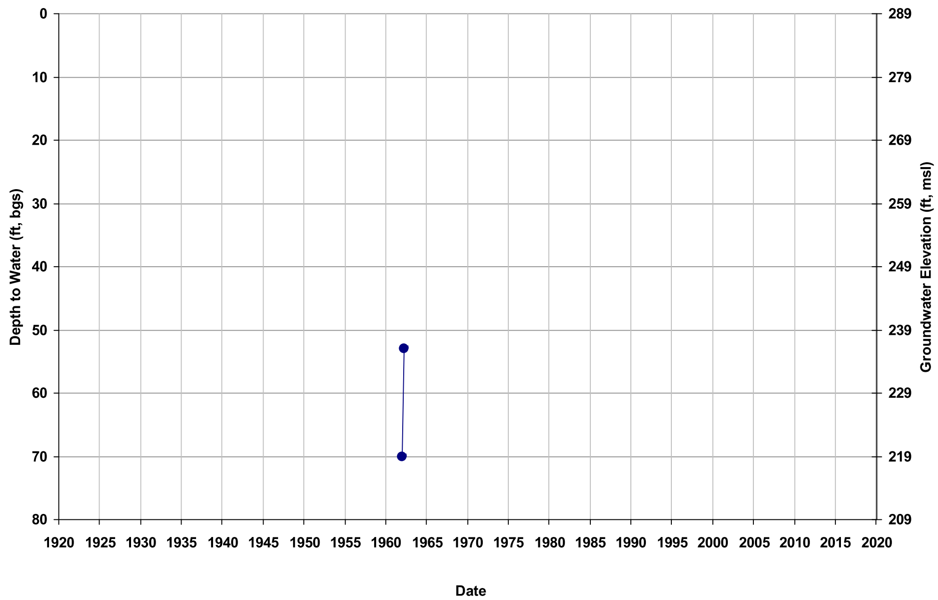
Well ID: 11S18E16K001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 291
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



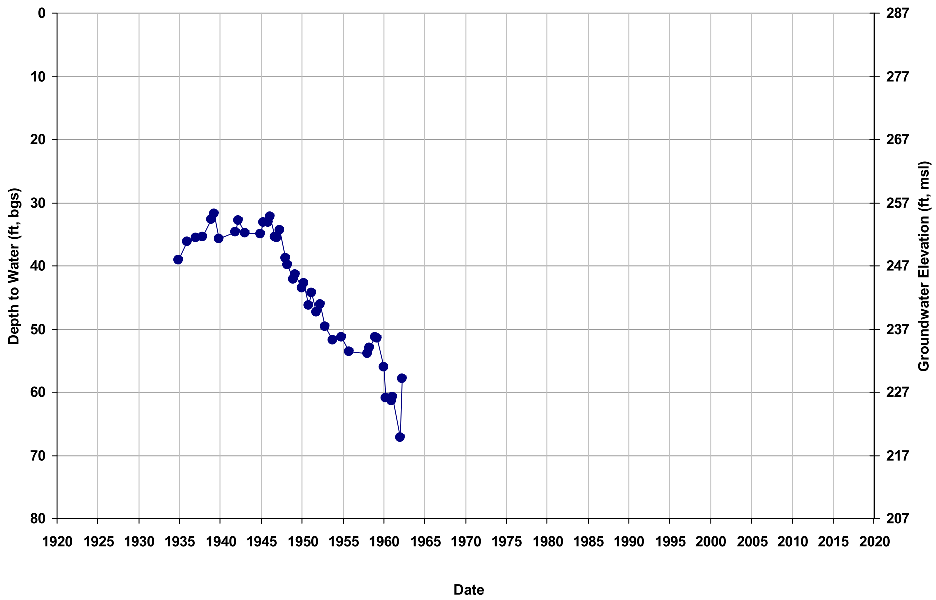
Well ID: 11S18E16L001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 289
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



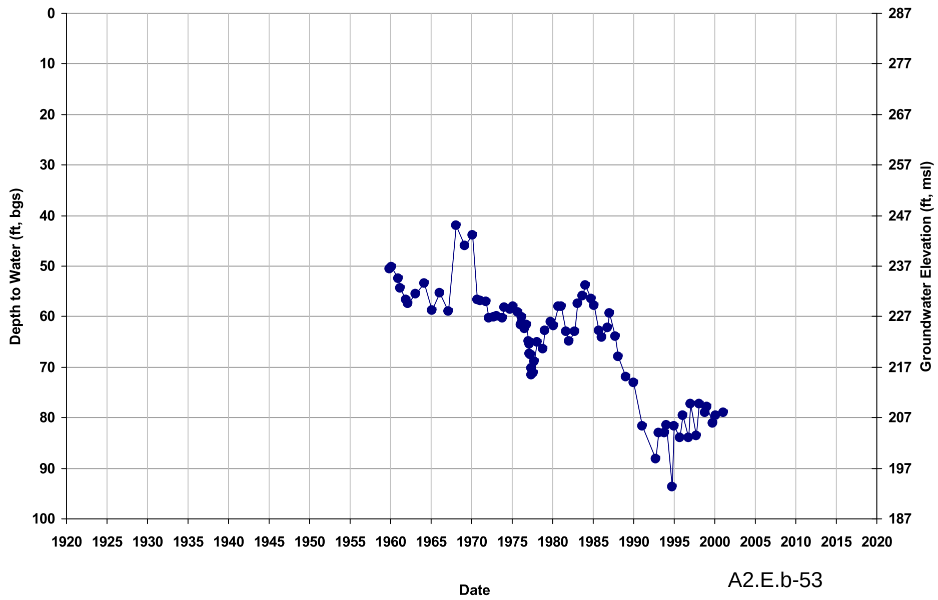
Well ID: 11S18E17L001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 287
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



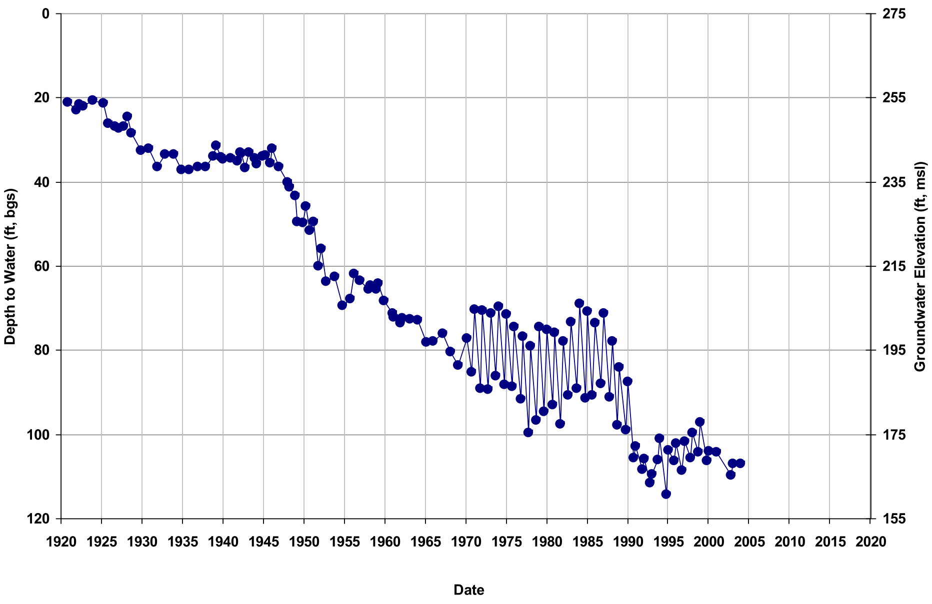
Well ID: 11S18E18A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 287
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



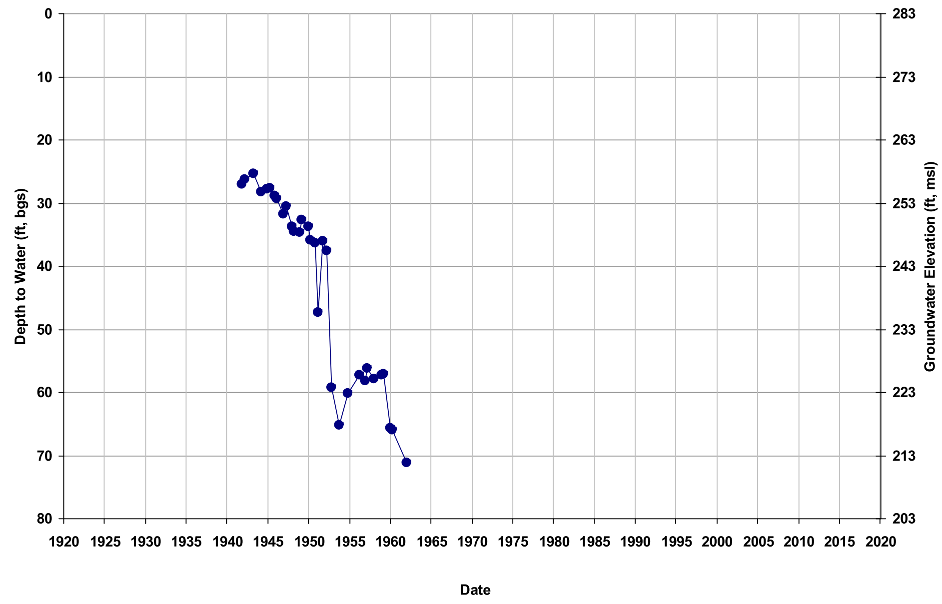
Well ID: 11S18E20N001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 274
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



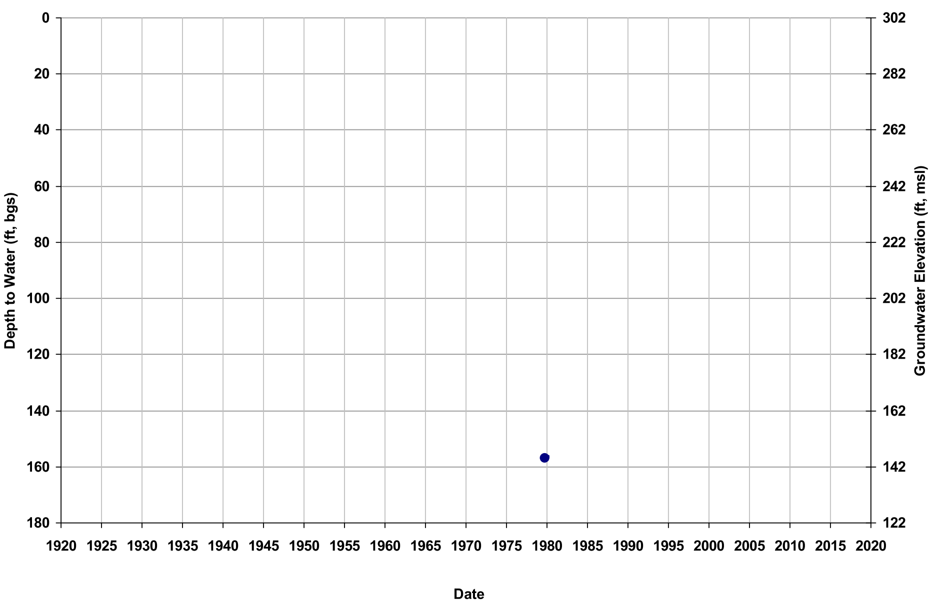
Well ID: 11S18E21E001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 282
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



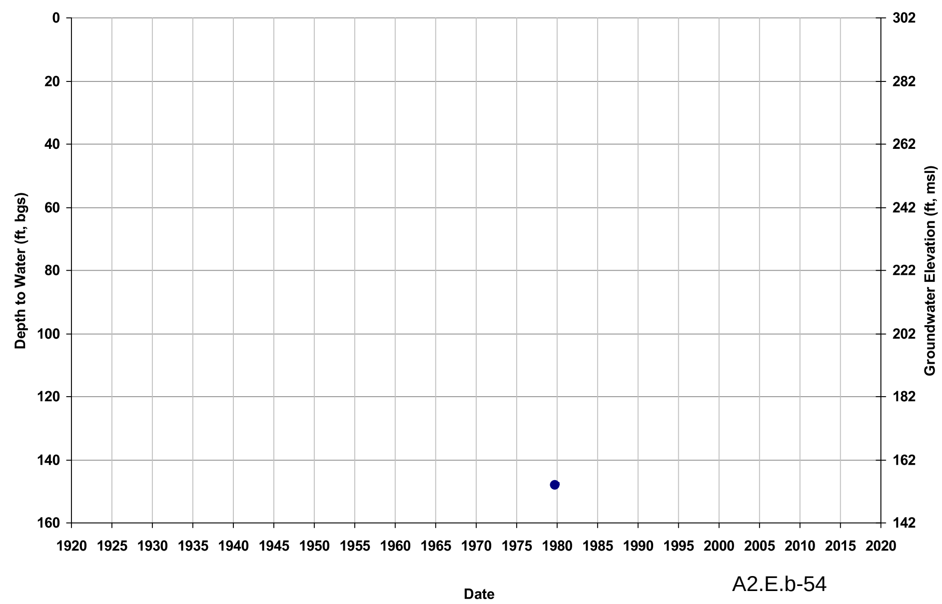
Well ID: 11S18E24G001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

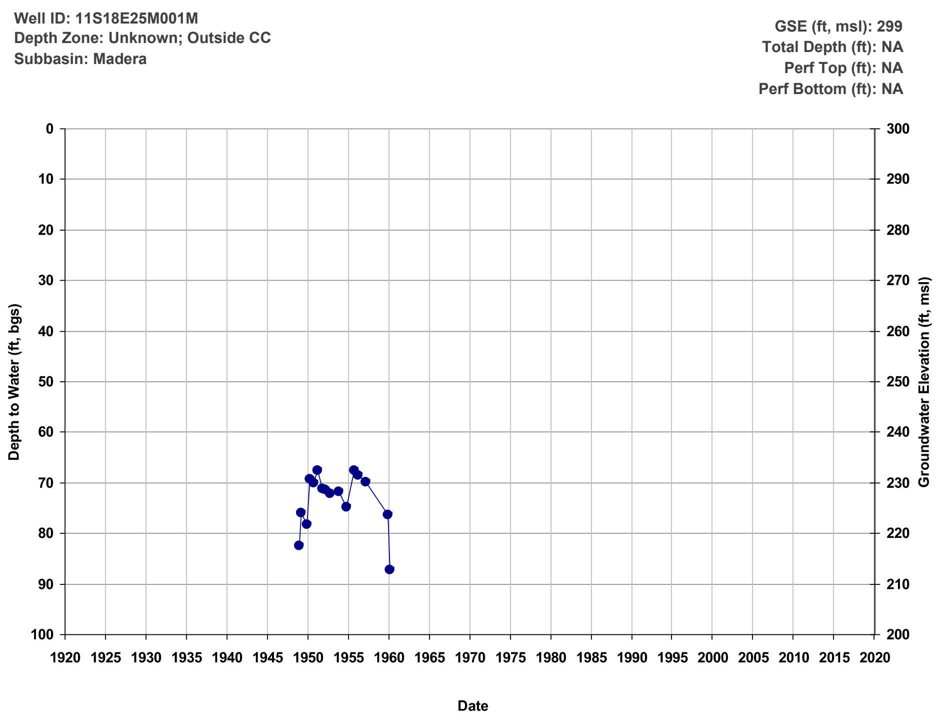
GSE (ft, msl): 302
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



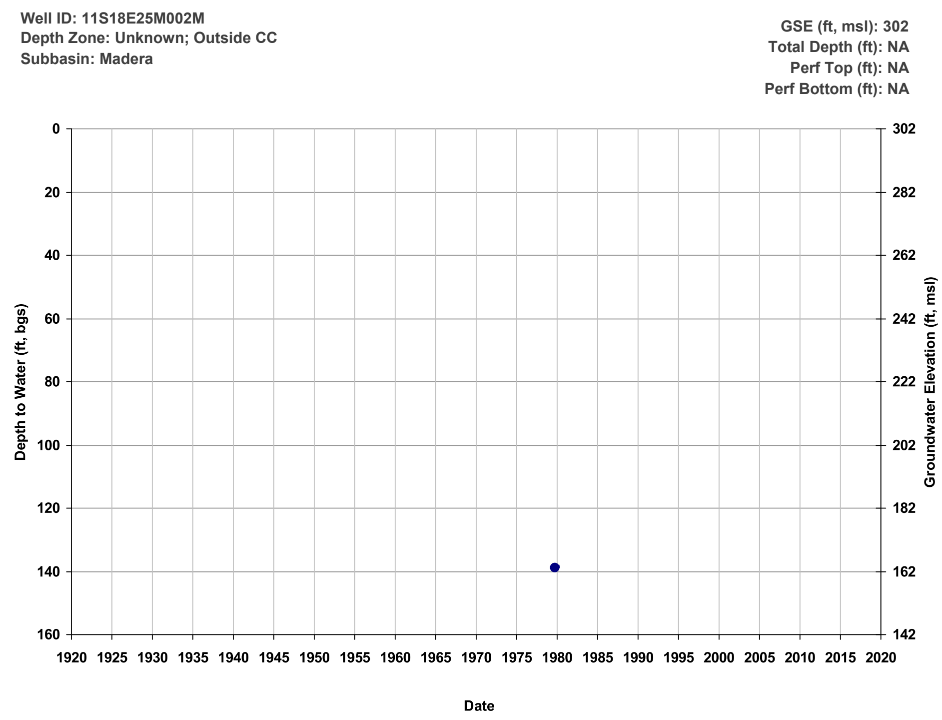
Well ID: 11S18E25D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 302
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

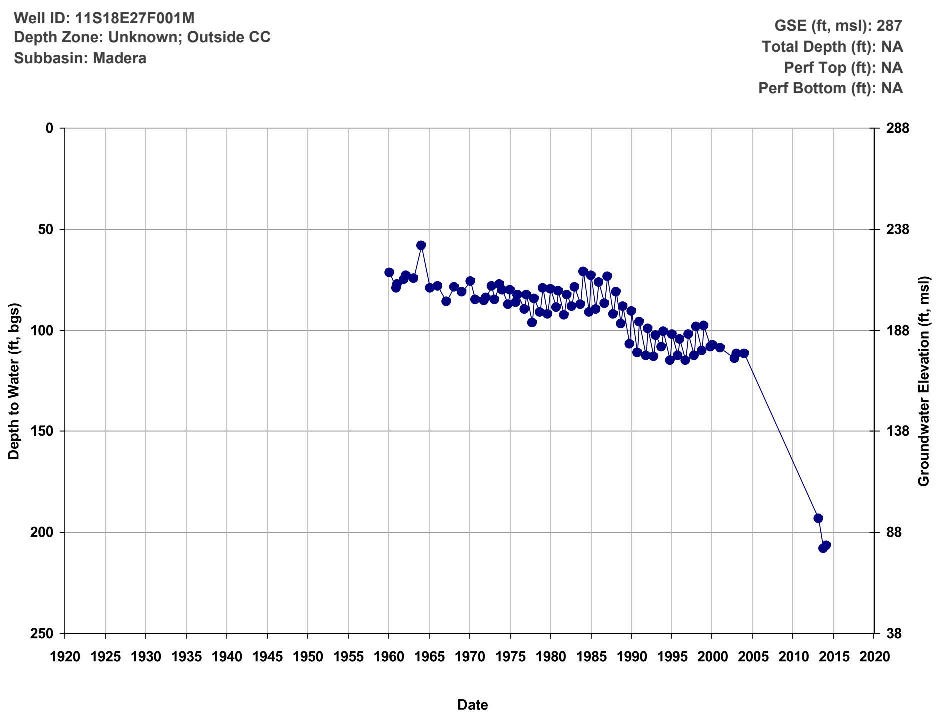




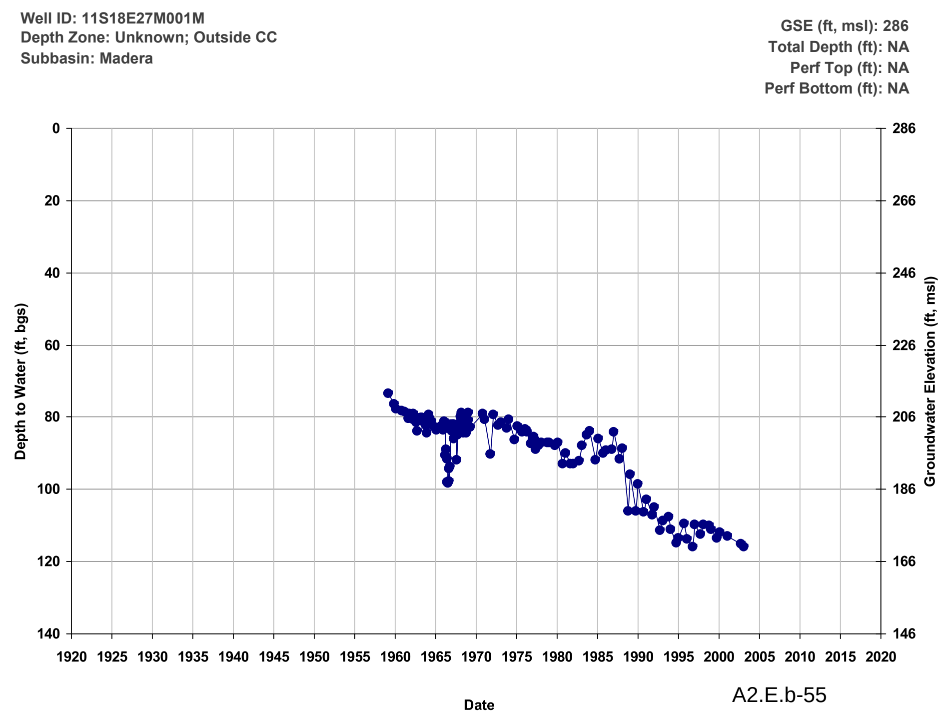
Well ID: 11S18E25M001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 299
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



Well ID: 11S18E25M002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 302
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



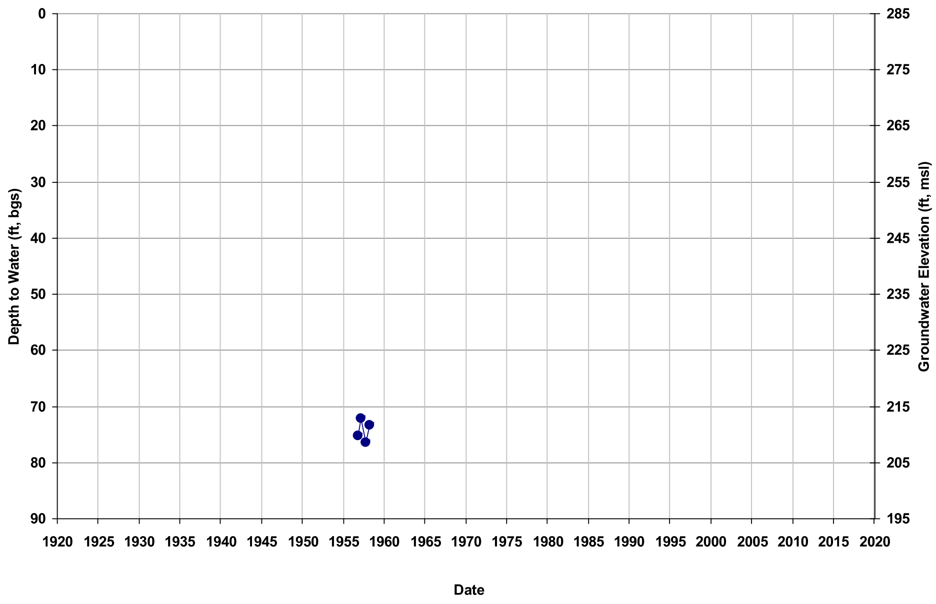
Well ID: 11S18E27F001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 287
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



Well ID: 11S18E27M001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 286
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

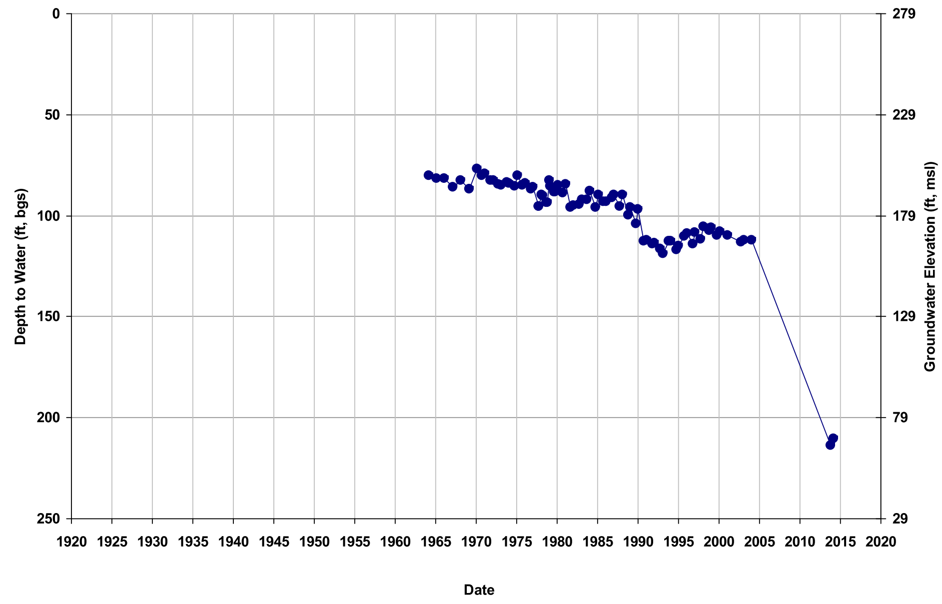
Well ID: 11S18E27N002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 285
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



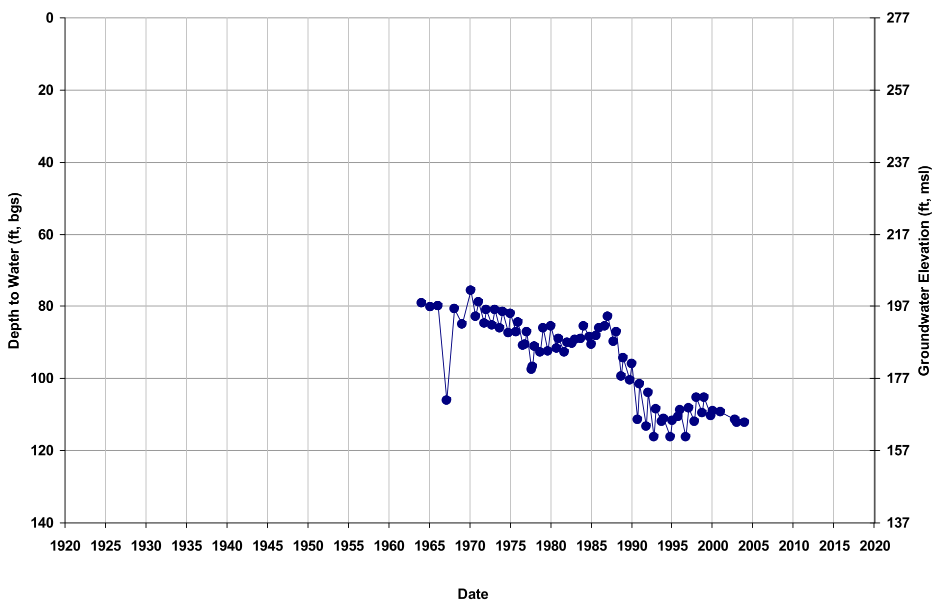
Well ID: 11S18E28P001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 278
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



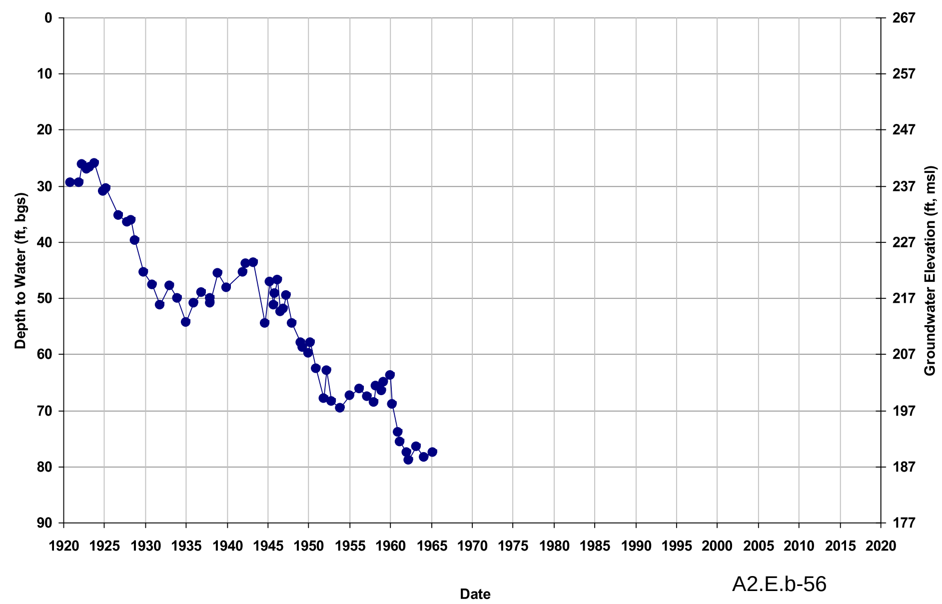
Well ID: 11S18E29H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 276
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



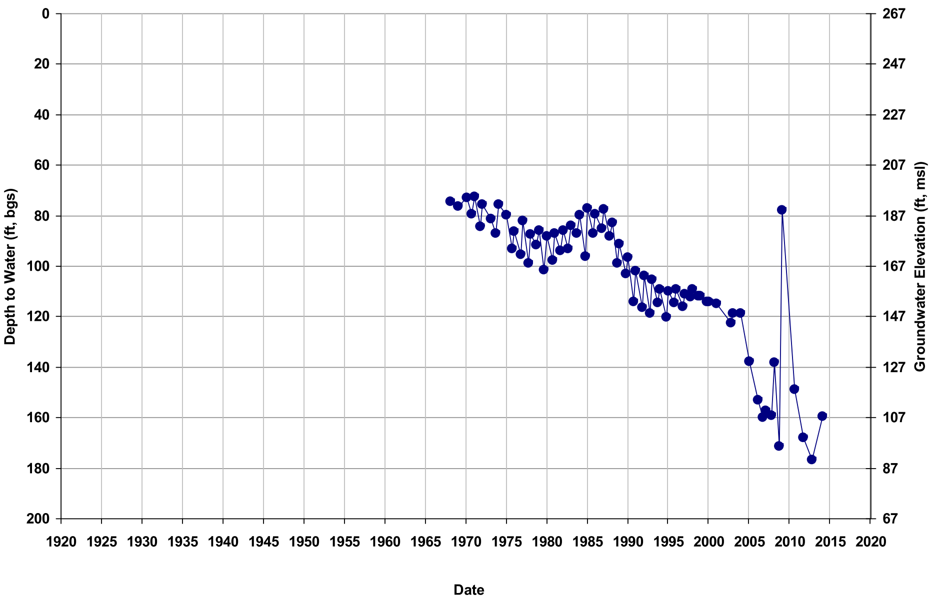
Well ID: 11S18E30R001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 266
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



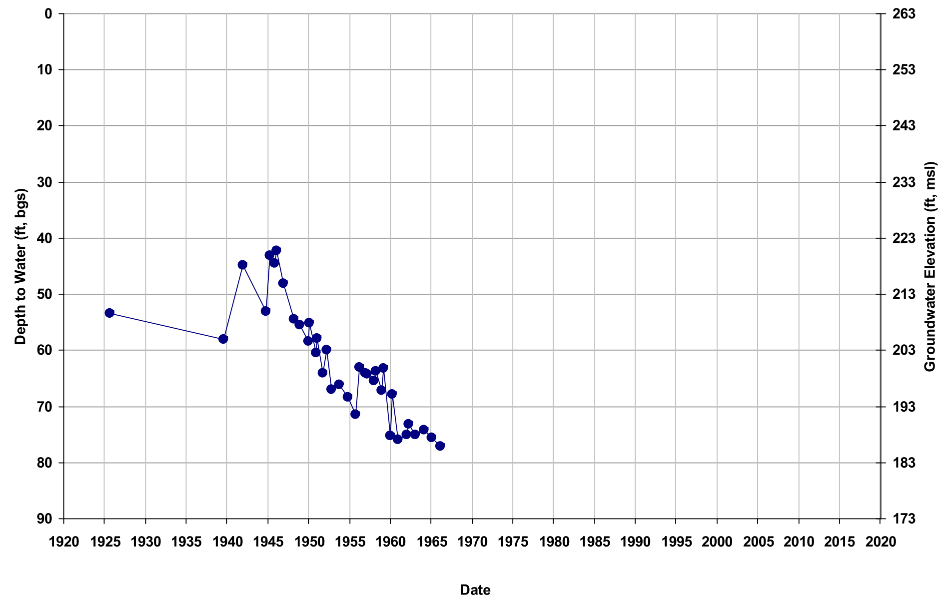
Well ID: 11S18E31A003M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 267
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



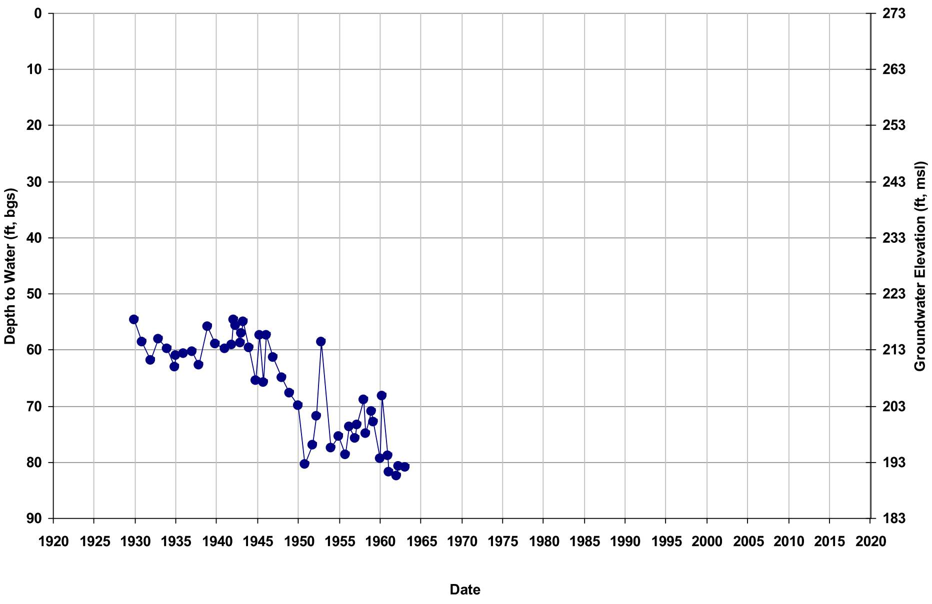
Well ID: 11S18E31C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 263
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



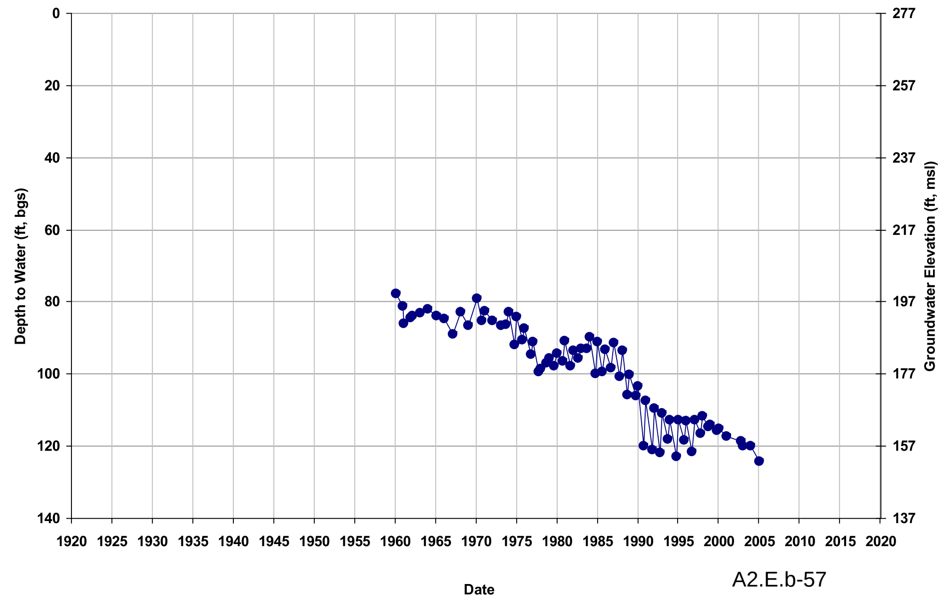
Well ID: 11S18E32J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 273
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



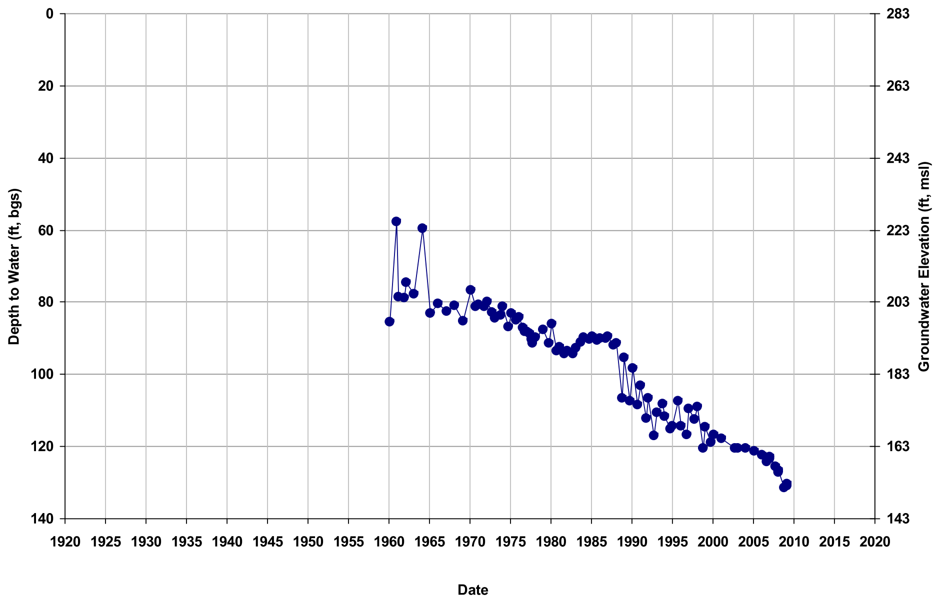
Well ID: 11S18E33D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 277
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



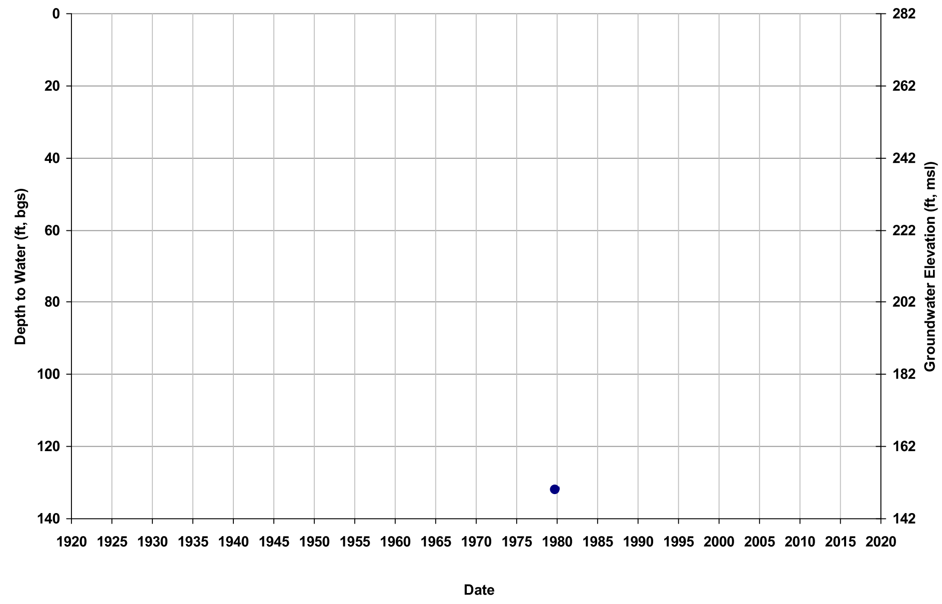
Well ID: 11S18E34B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 283
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



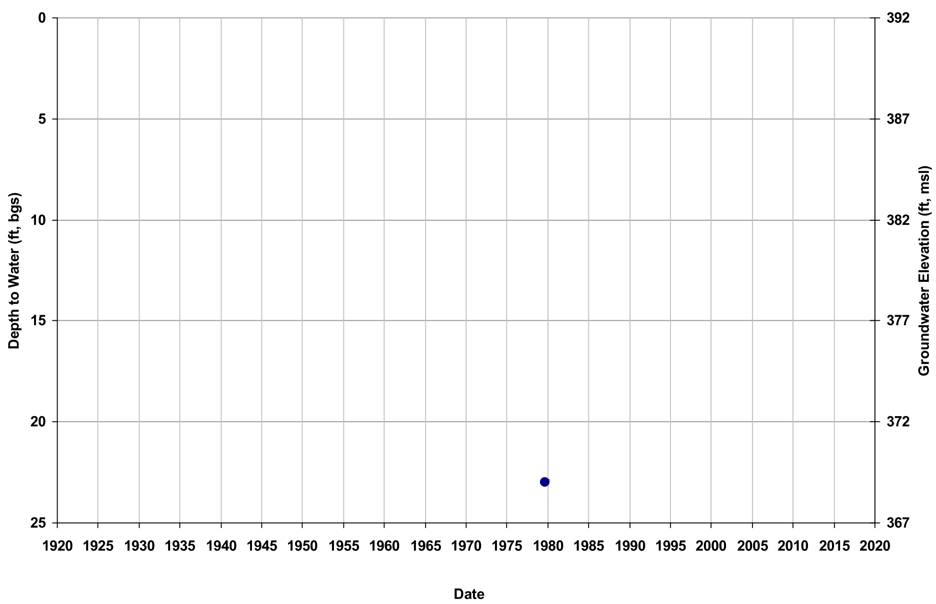
Well ID: 11S18E35C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 282
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



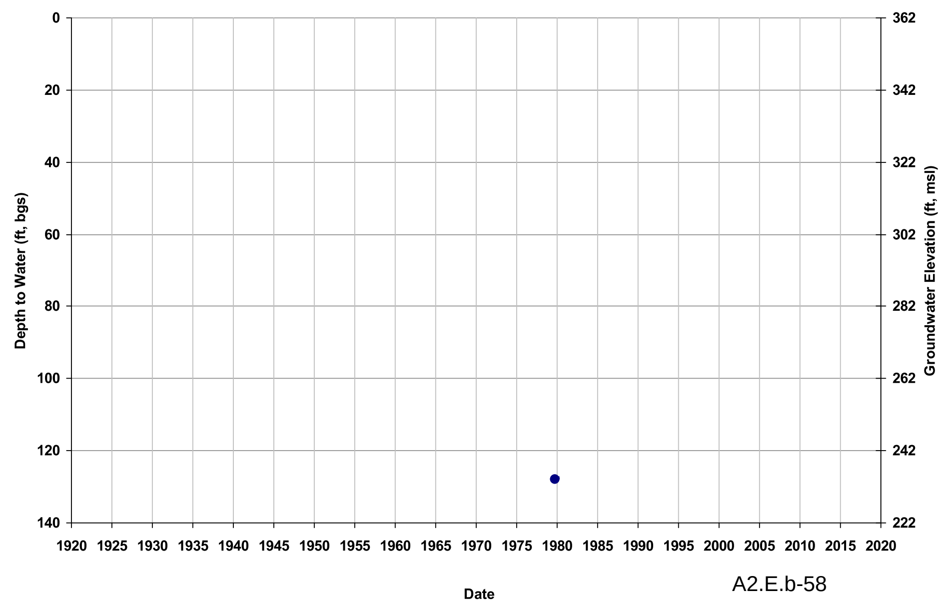
Well ID: 11S19E02M001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 392
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



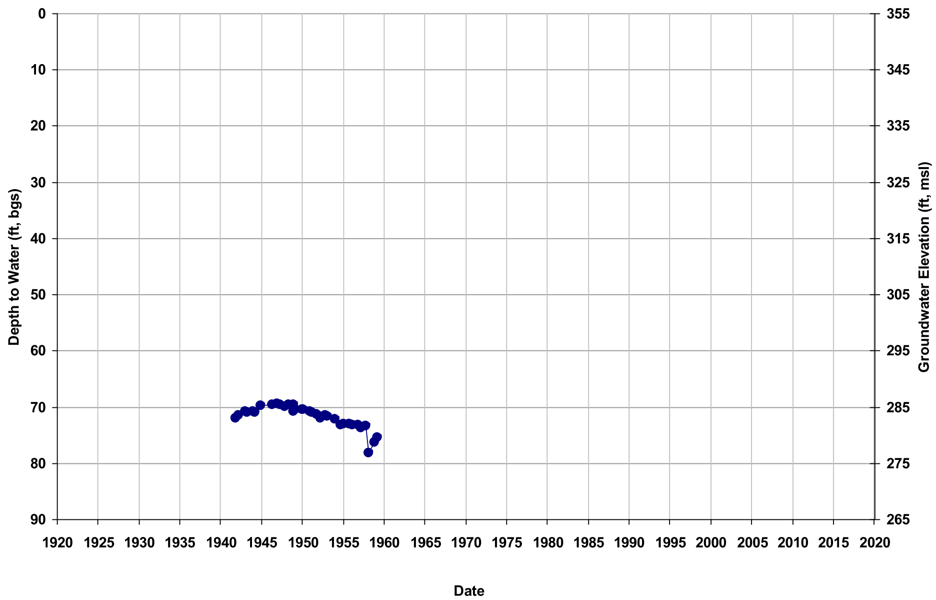
Well ID: 11S19E03N001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 362
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



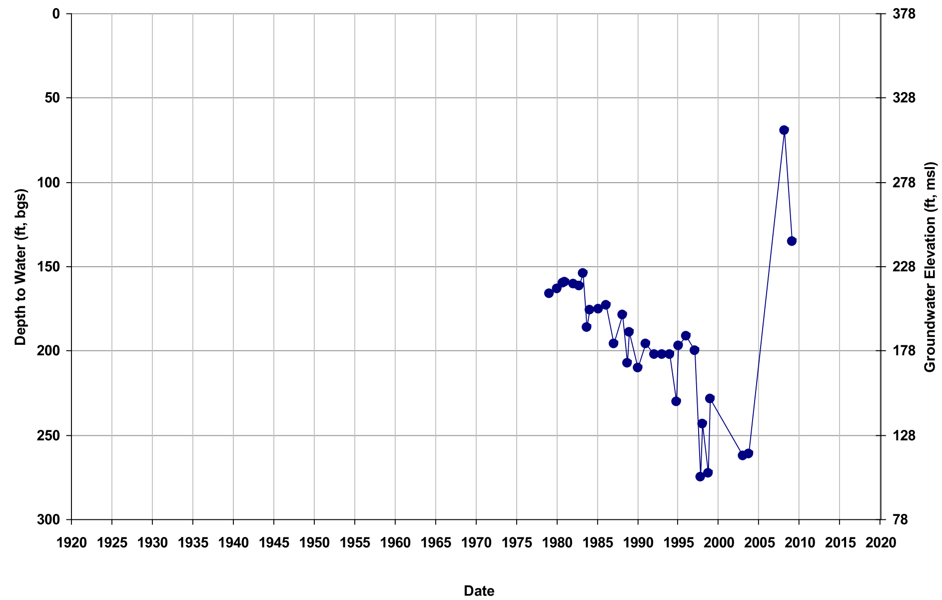
Well ID: 11S19E06F001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 355
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



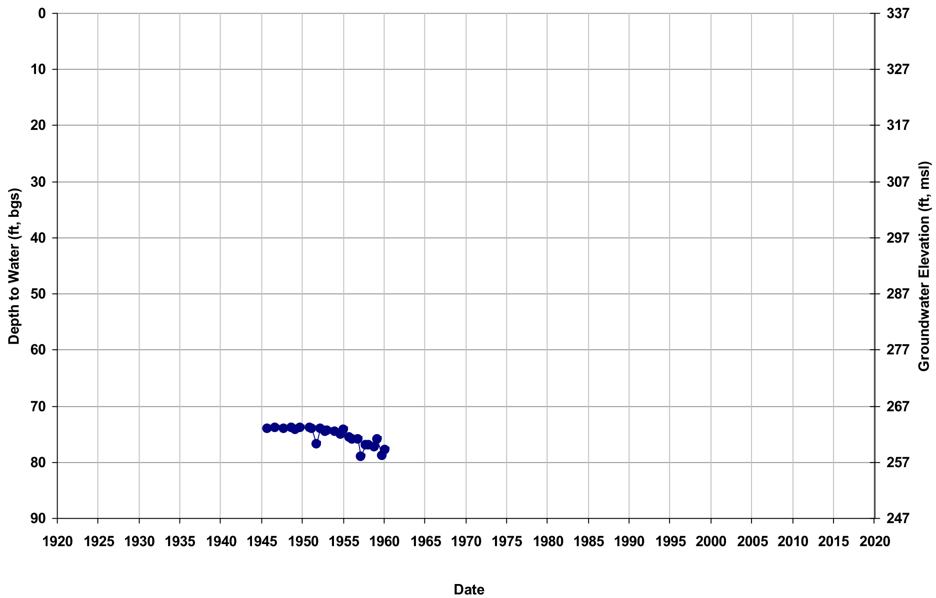
Well ID: 11S19E10J002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 378
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



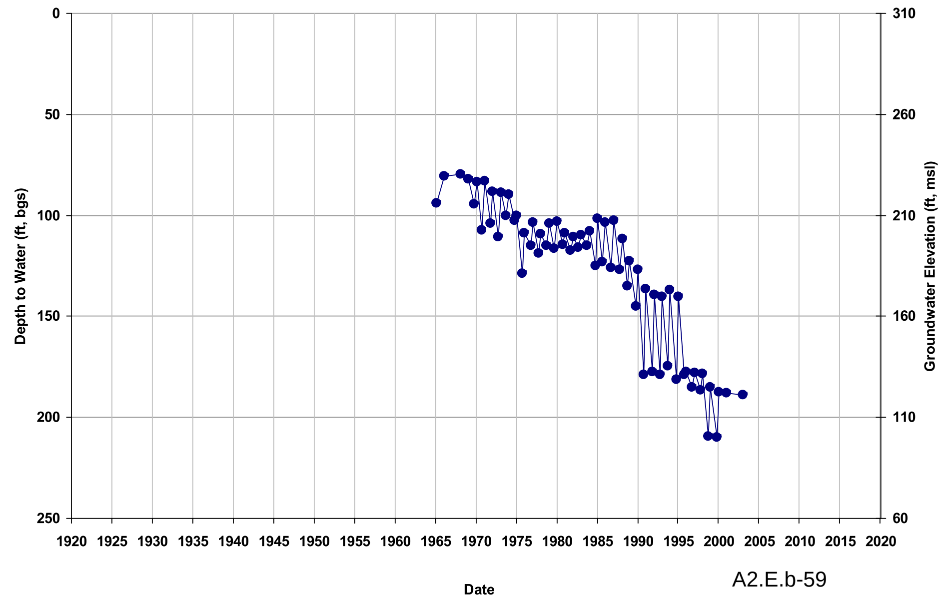
Well ID: 11S19E17Q001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 337
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



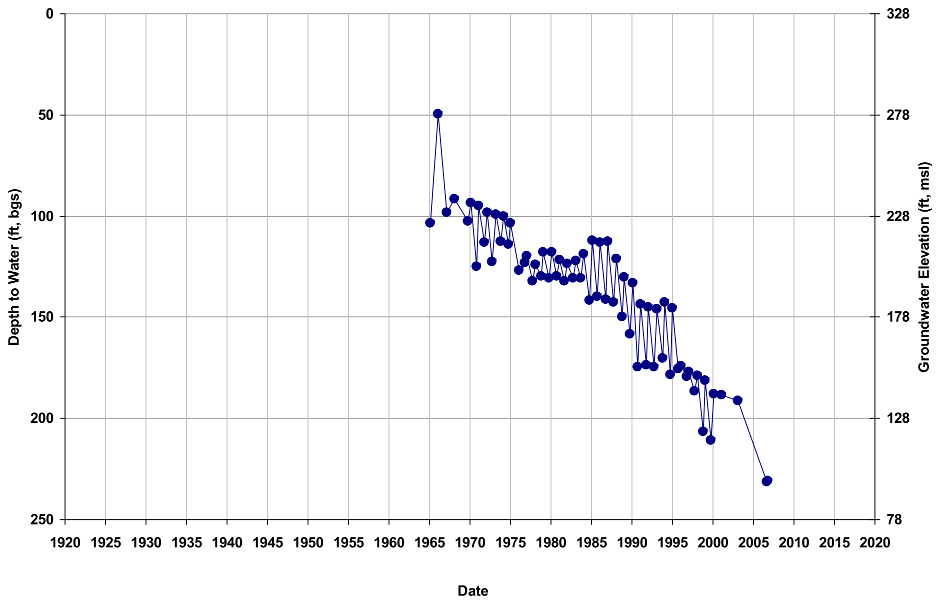
Well ID: 11S19E19F001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 310
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



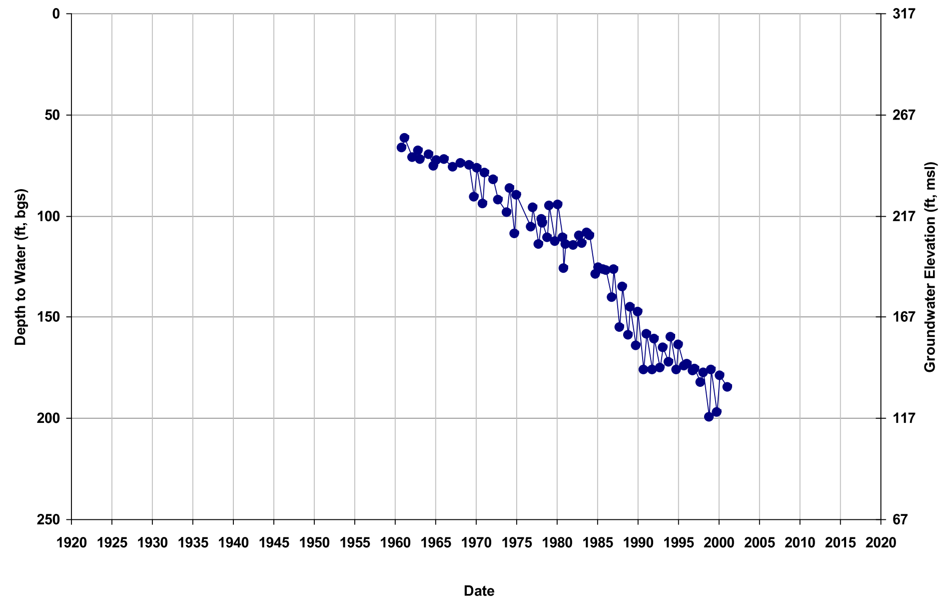
Well ID: 11S19E19N001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 327
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



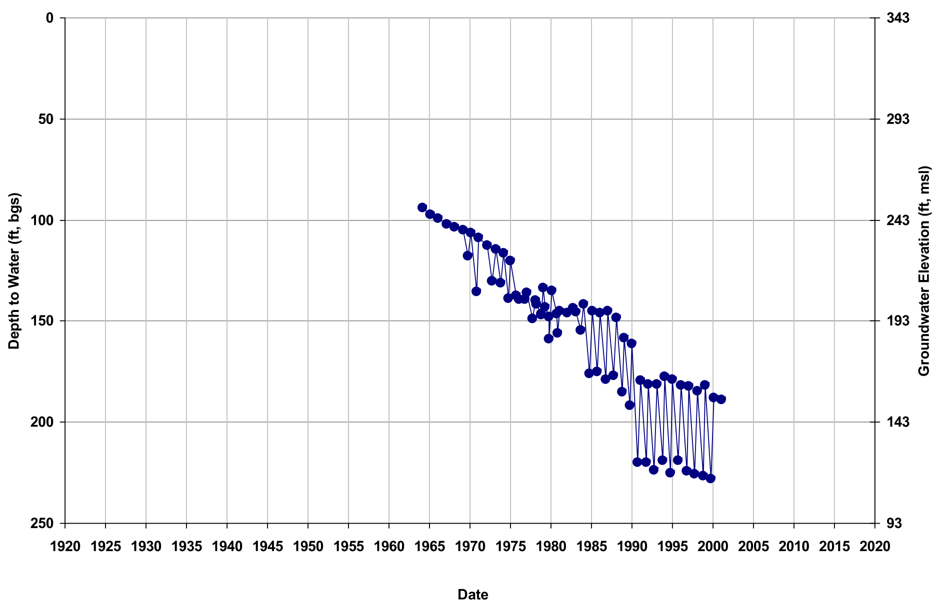
Well ID: 11S19E20G001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 317
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



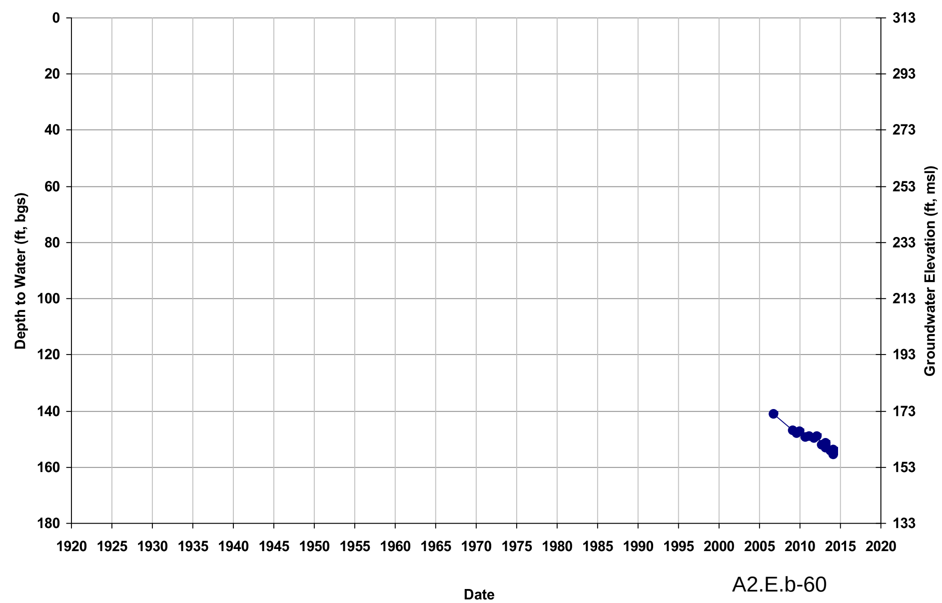
Well ID: 11S19E28F001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 343
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



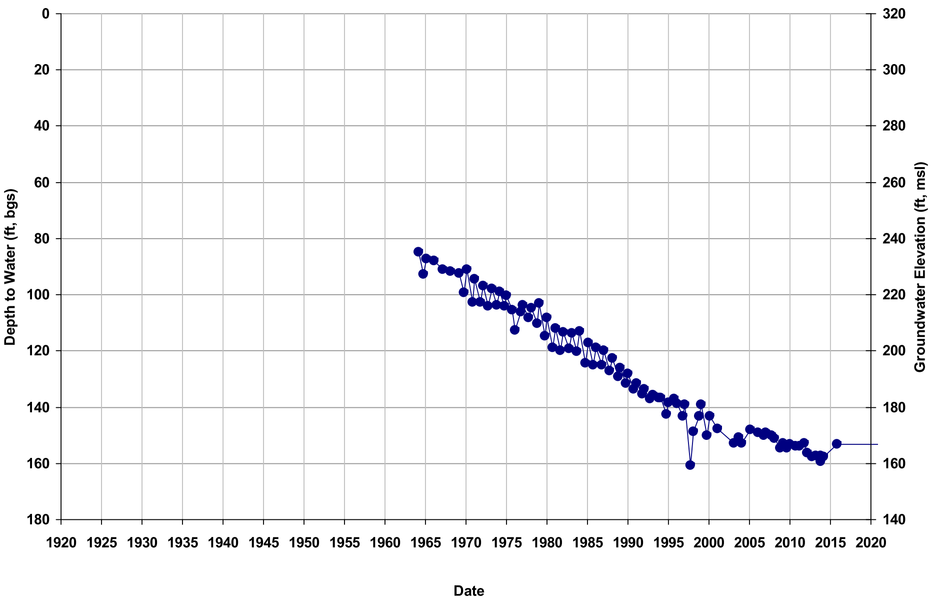
Well ID: 11S19E32P001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 312
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



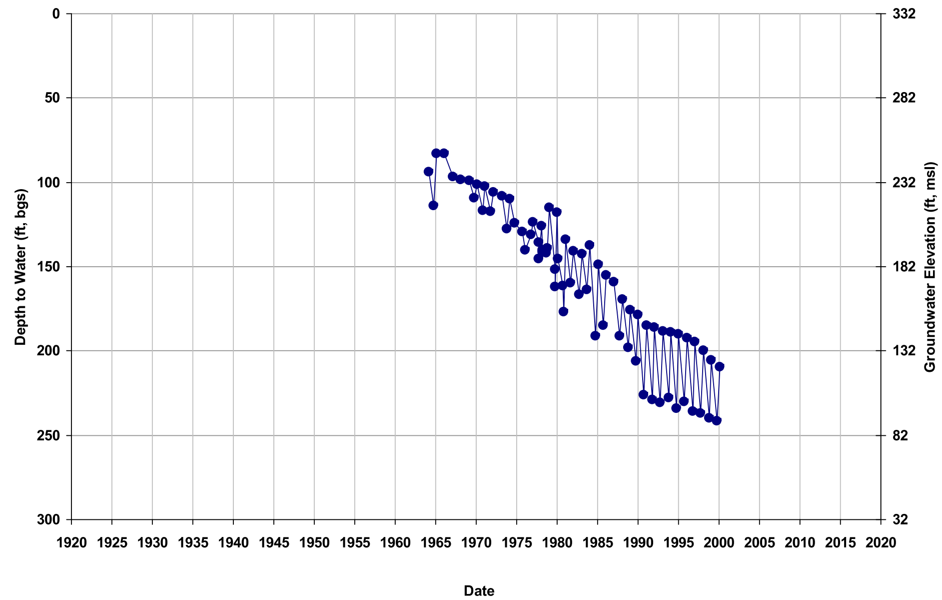
Well ID: 11S19E32R001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 320
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



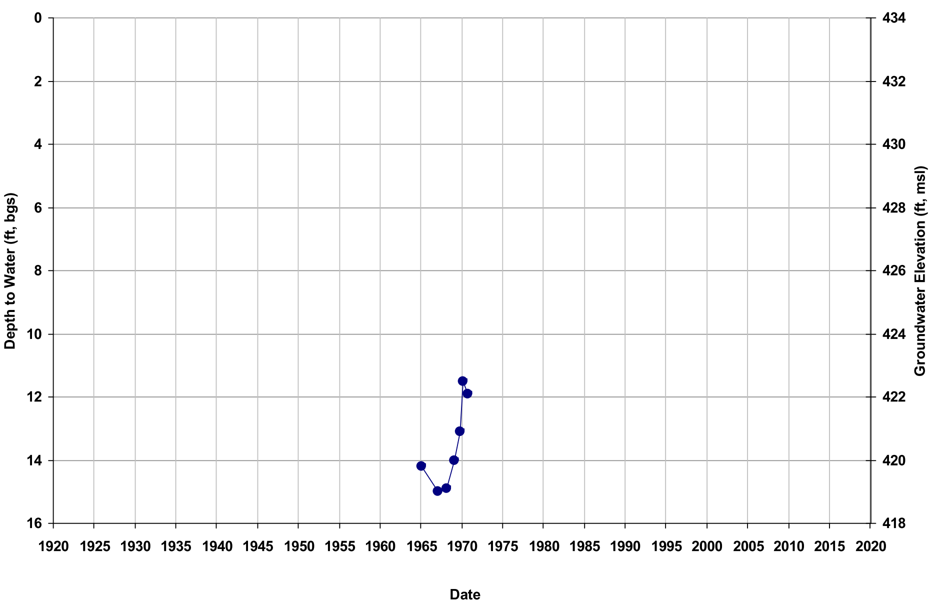
Well ID: 11S19E33J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 331
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



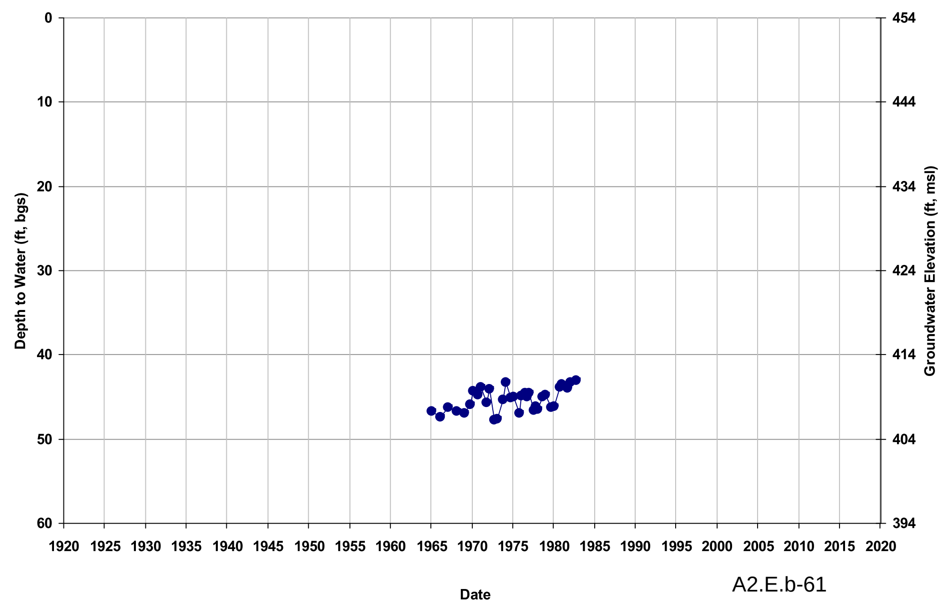
Well ID: 11S20E11G001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 434
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



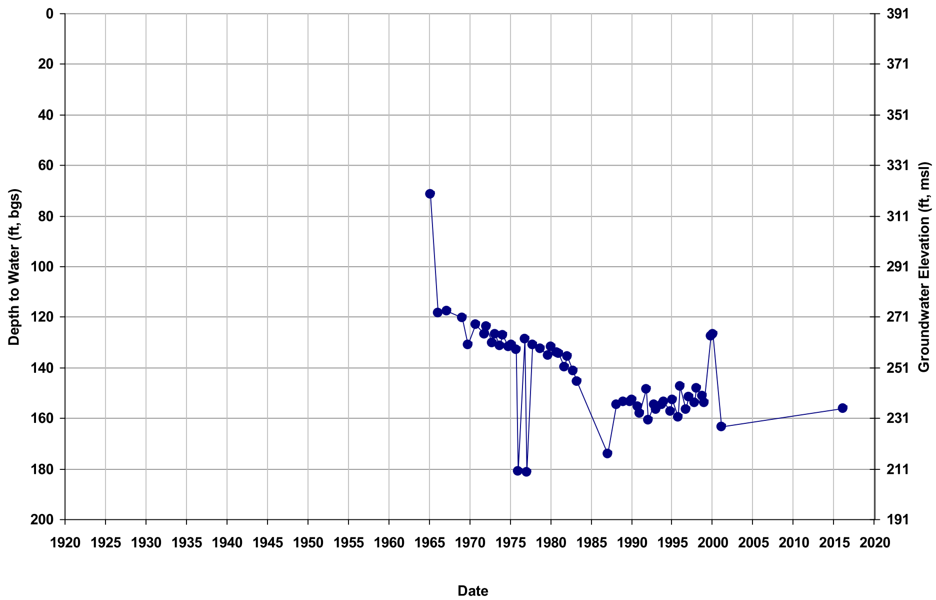
Well ID: 11S20E12E001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 454
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



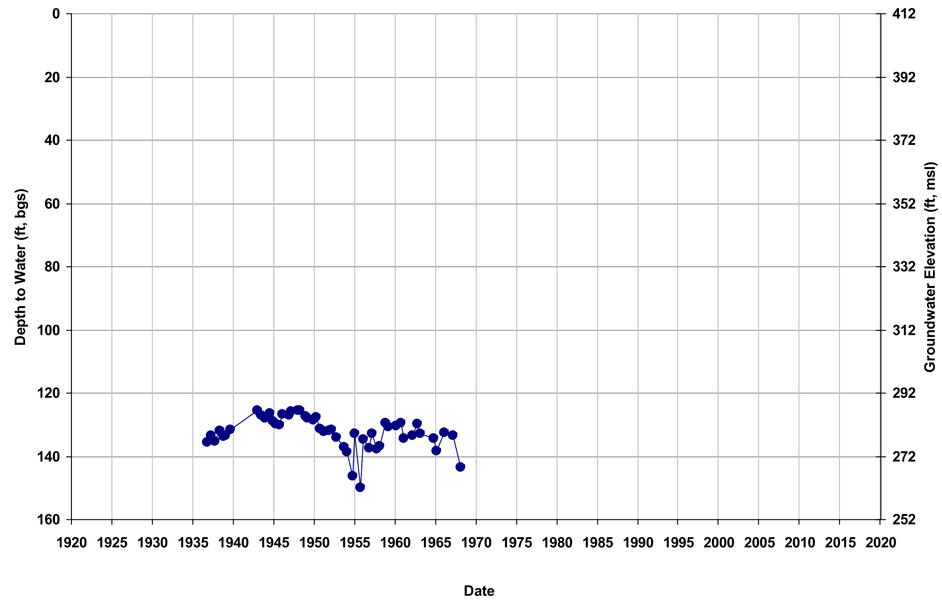
Well ID: 11S20E18L001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 391
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



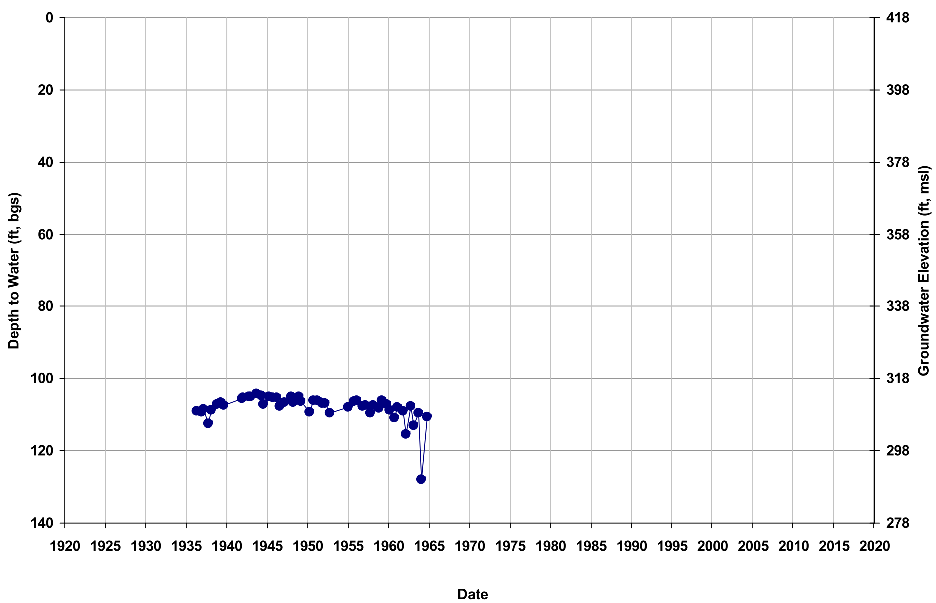
Well ID: 11S20E21P001M
Depth Zone: Composite or Lower; O
Subbasin: Madera

GSE (ft, msl): 412
Total Depth (ft): 320
Perf Top (ft): NA
Perf Bottom (ft): NA



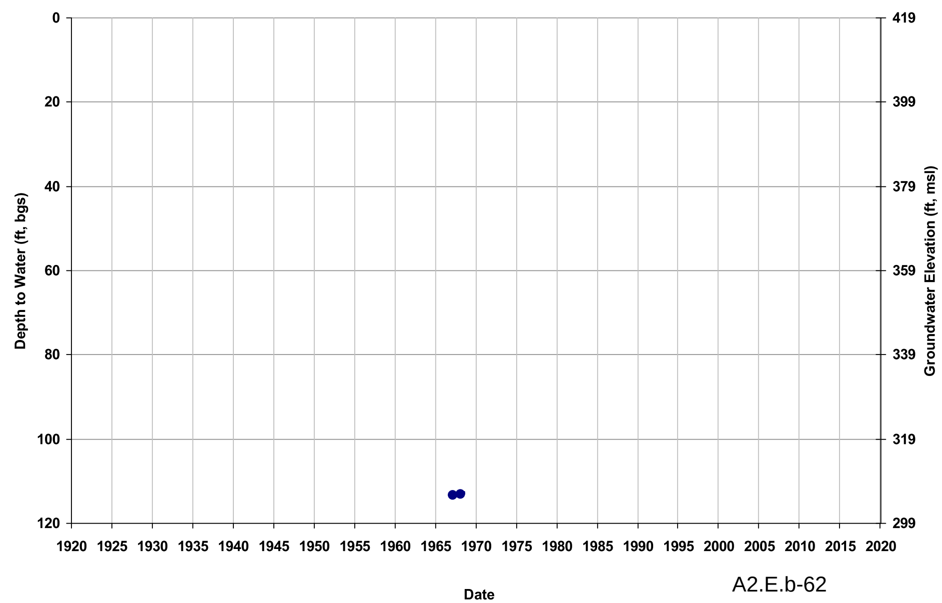
Well ID: 11S20E22M001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 418
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



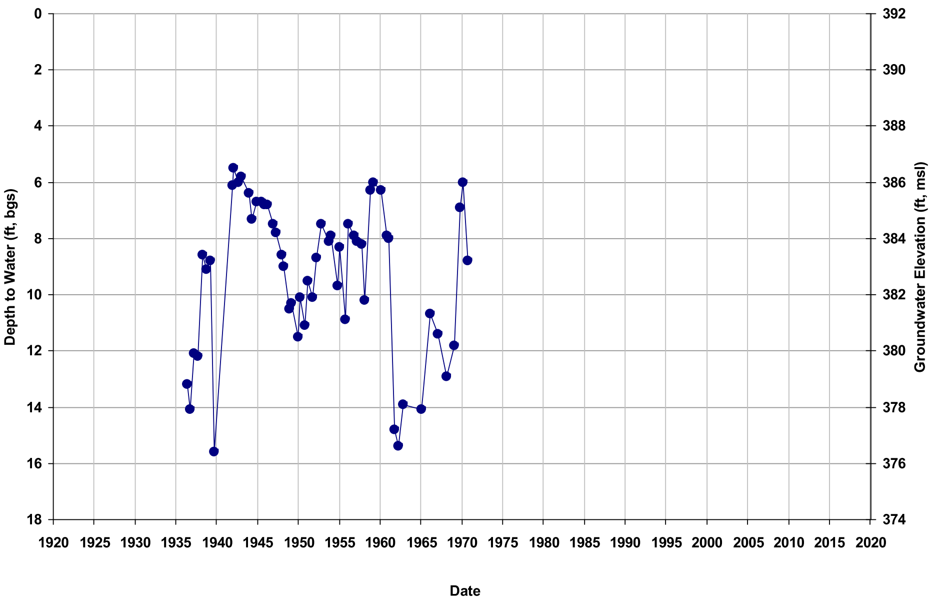
Well ID: 11S20E22M002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 419
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



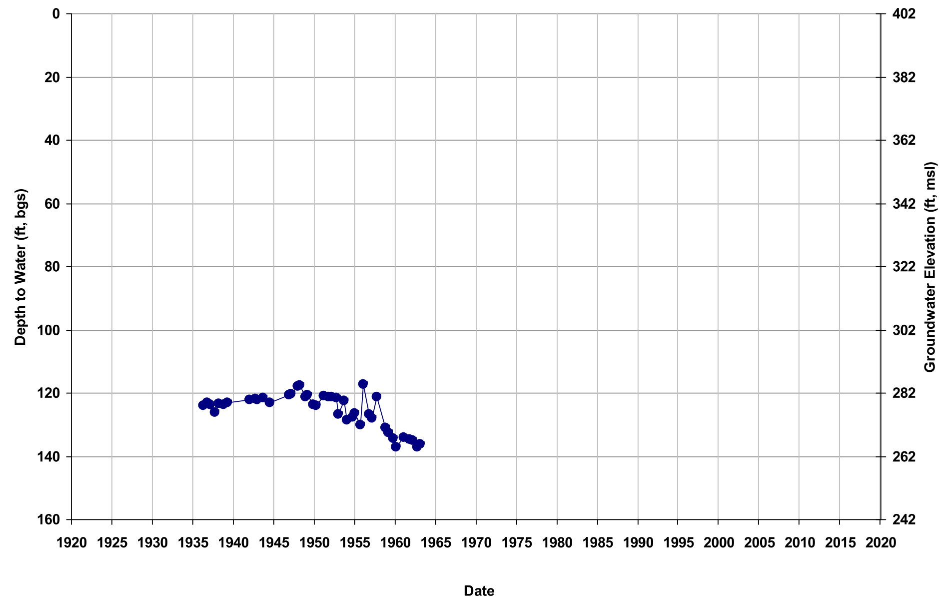
Well ID: 11S20E23M001M
Depth Zone: Upper, Shallow GW; Ou
Subbasin: Madera

GSE (ft, msl): 392
Total Depth (ft): 23
Perf Top (ft): NA
Perf Bottom (ft): NA



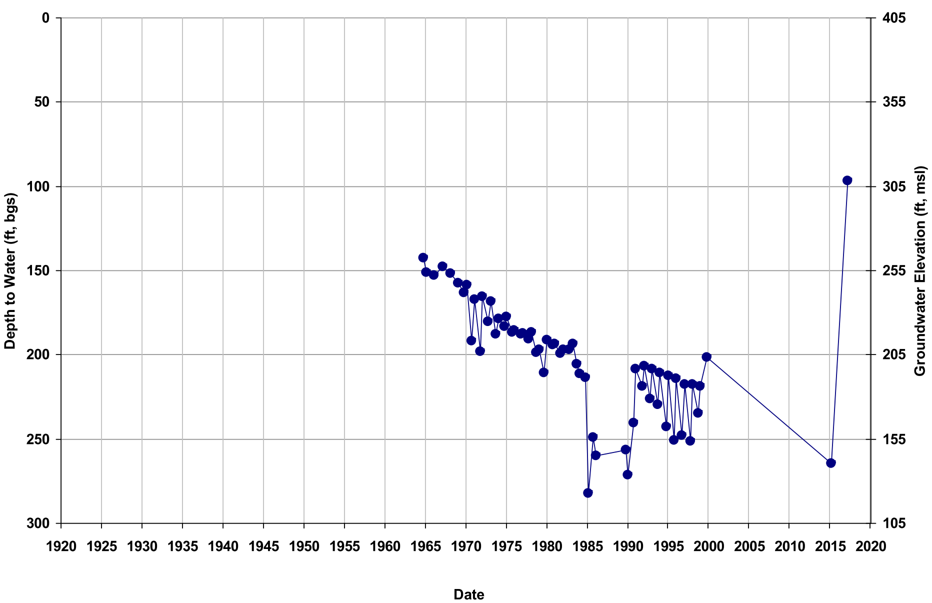
Well ID: 11S20E27N001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 402
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



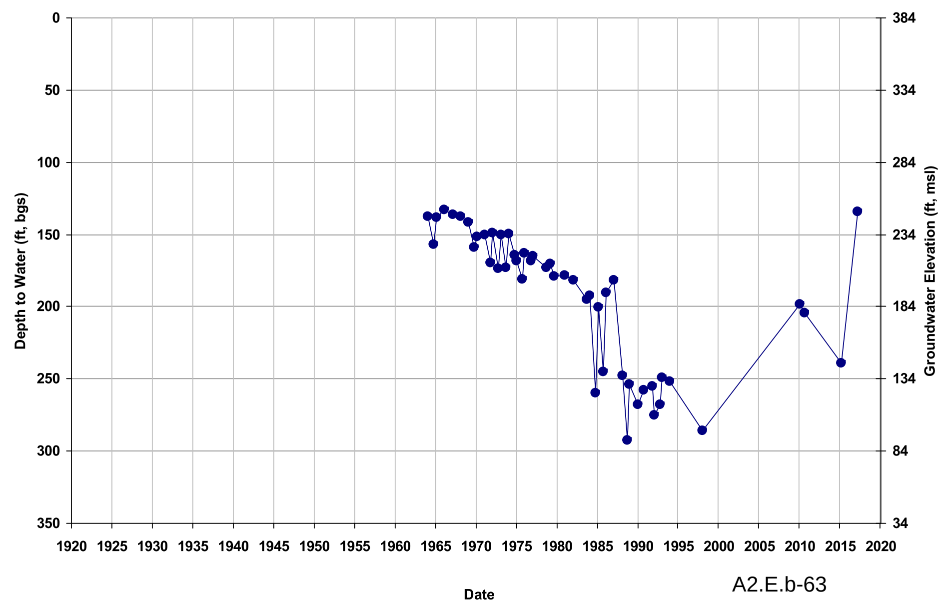
Well ID: 11S20E27N002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 404
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



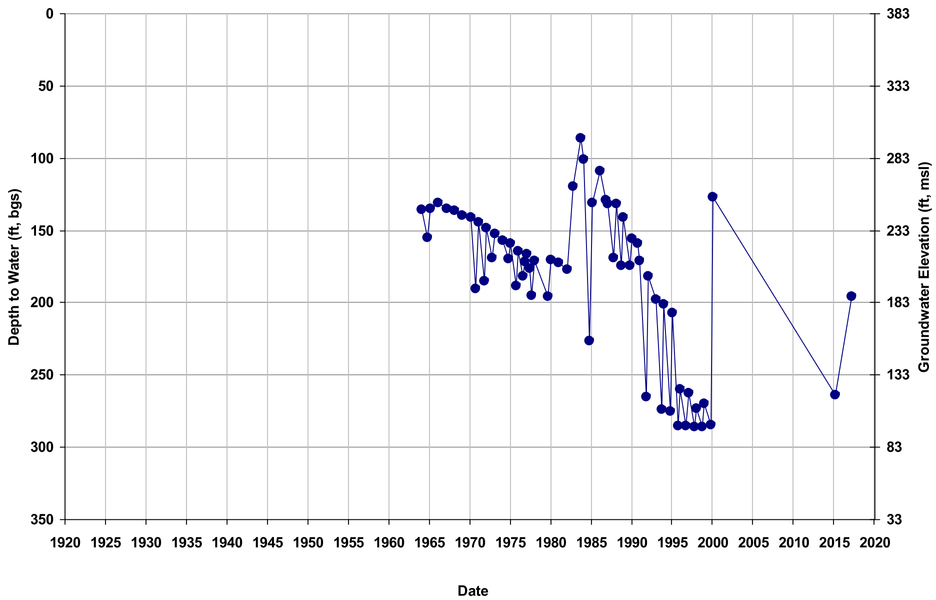
Well ID: 11S20E30F001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 384
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



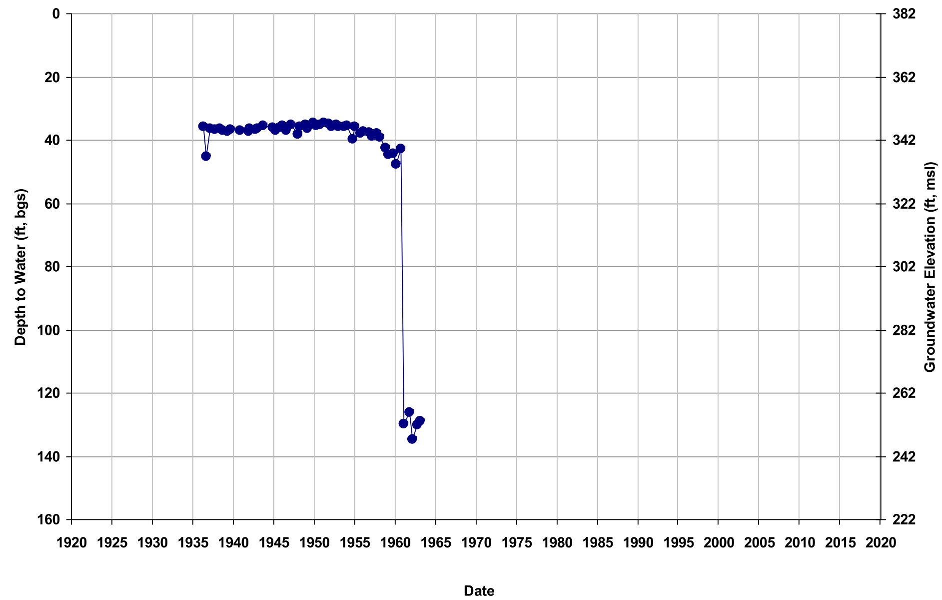
Well ID: 11S20E31P001M
Depth Zone: Composite or Lower; O
Subbasin: Madera

GSE (ft, msl): 383
Total Depth (ft): 340
Perf Top (ft): NA
Perf Bottom (ft): NA



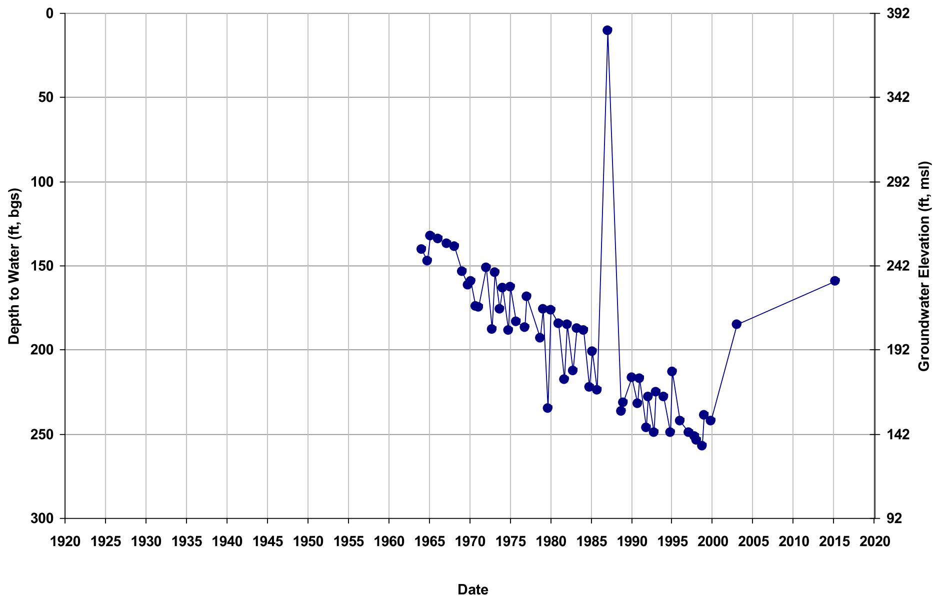
Well ID: 11S20E31R001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 382
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



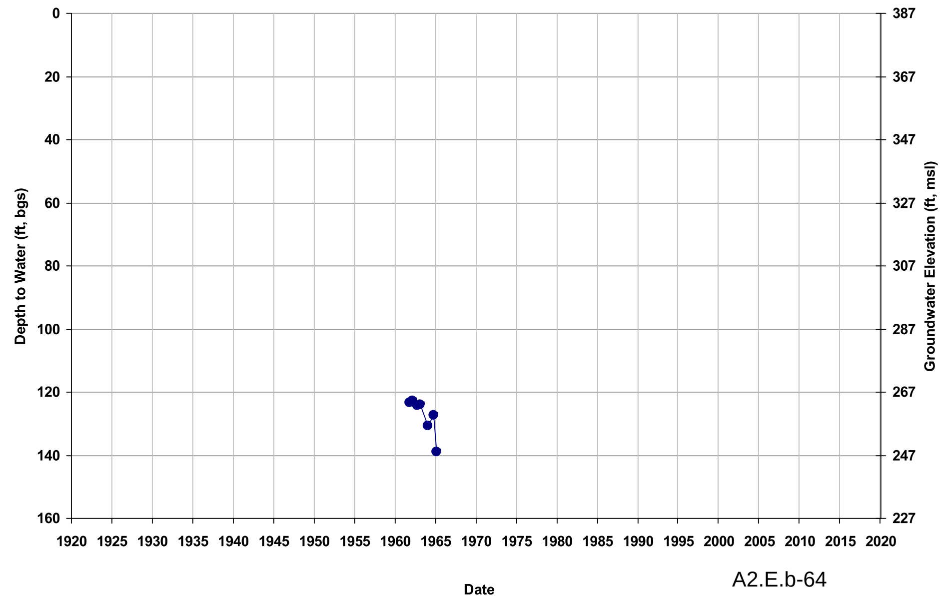
Well ID: 11S20E33K001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

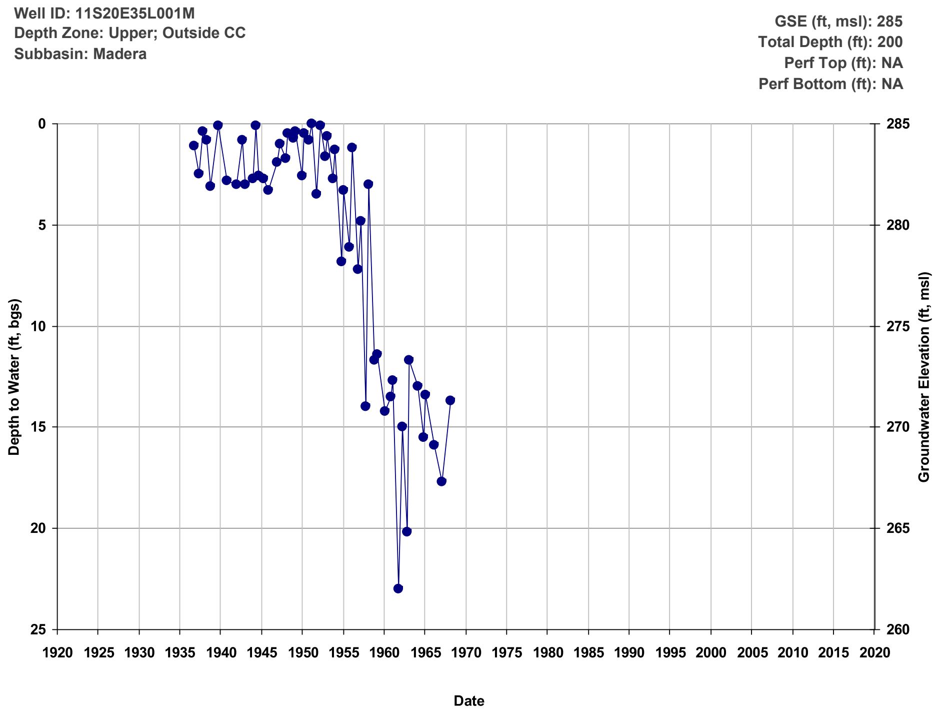
GSE (ft, msl): 392
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

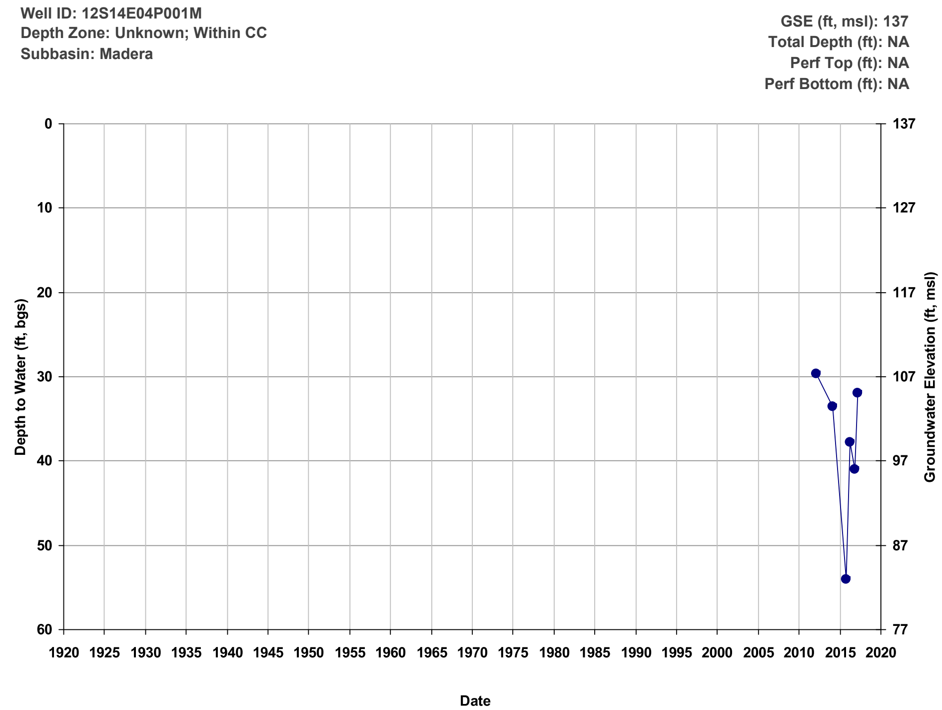


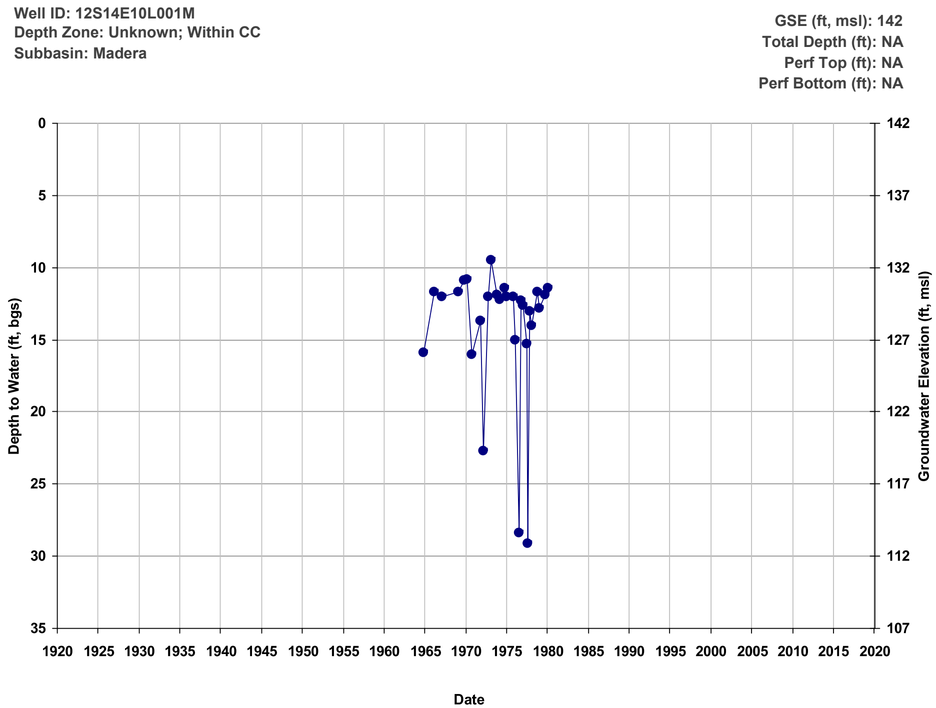
Well ID: 11S20E33Q001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

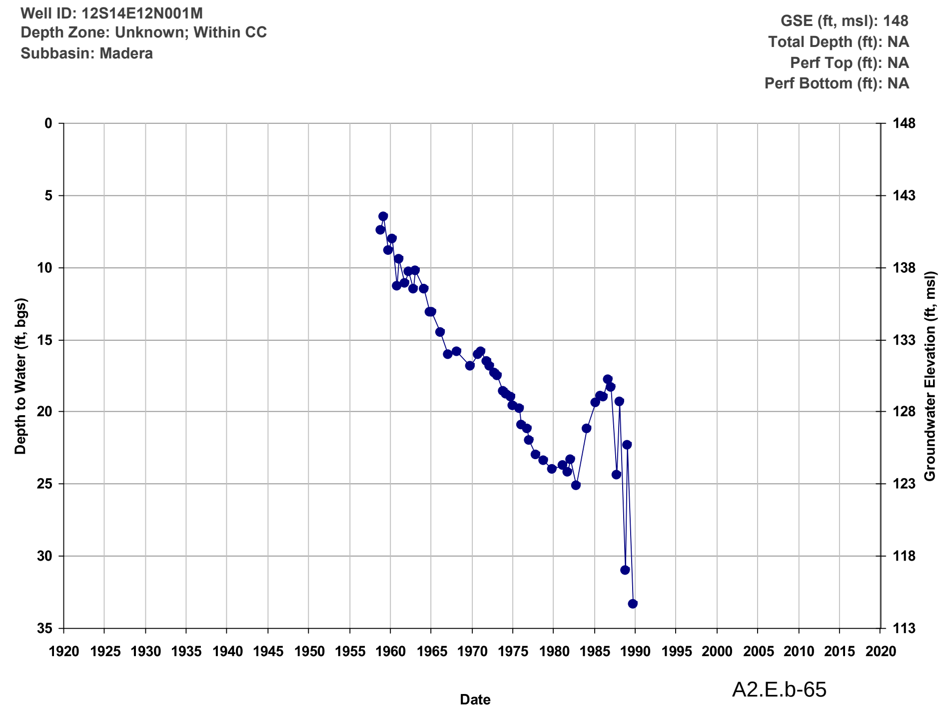
GSE (ft, msl): 387
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA




Well ID: 11S20E35L001M
Depth Zone: Upper; Outside CC
Subbasin: Madera
GSE (ft, msl): 285
Total Depth (ft): 200
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

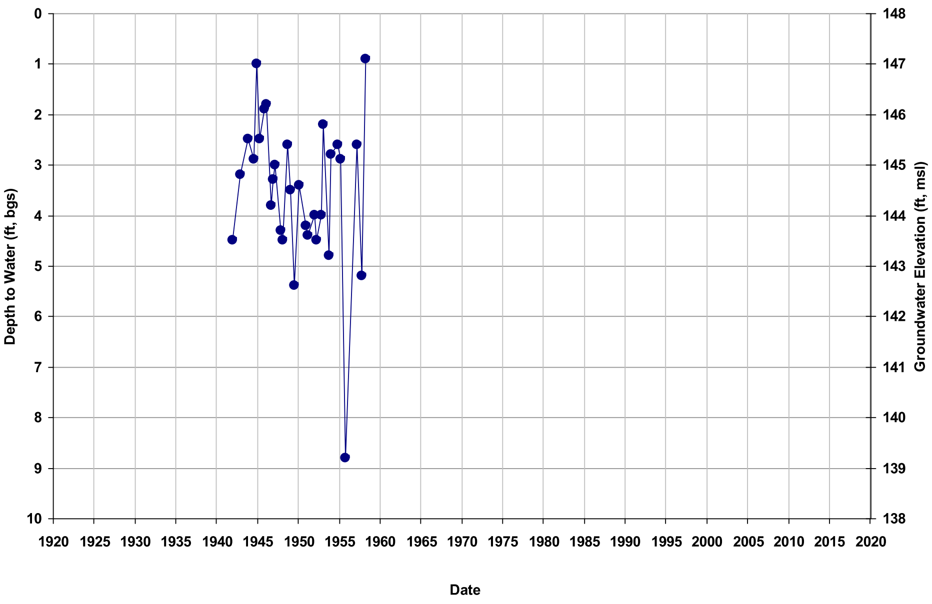

Well ID: 12S14E04P001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 137
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 12S14E10L001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 142
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 12S14E12N001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 148
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

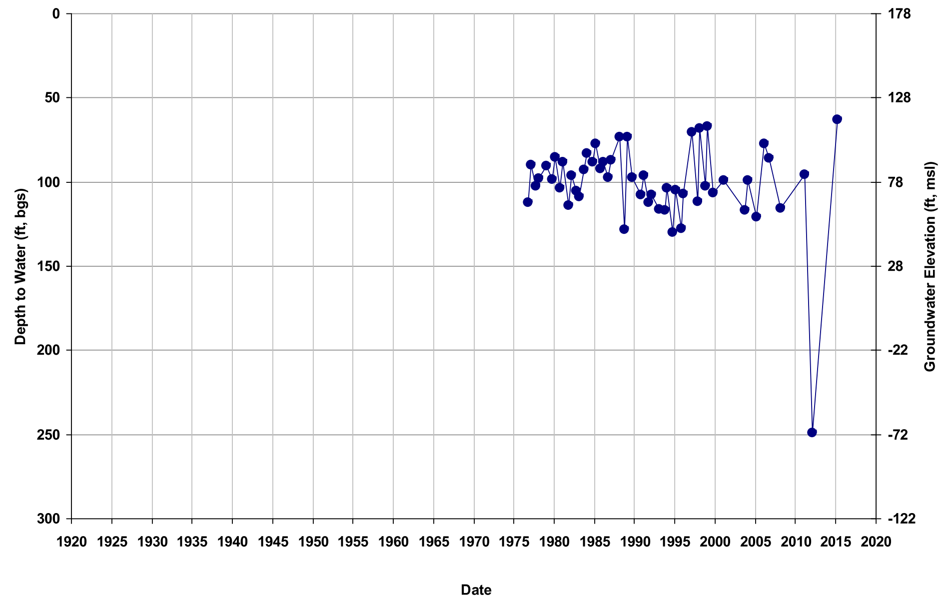
Well ID: 12S14E13P001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 147
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



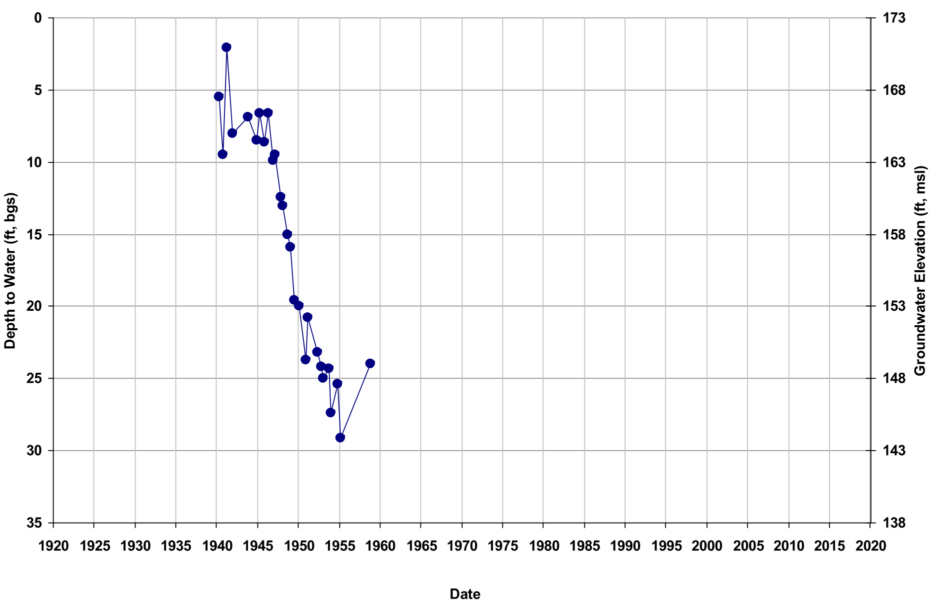
Well ID: 12S15E01R001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 177
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



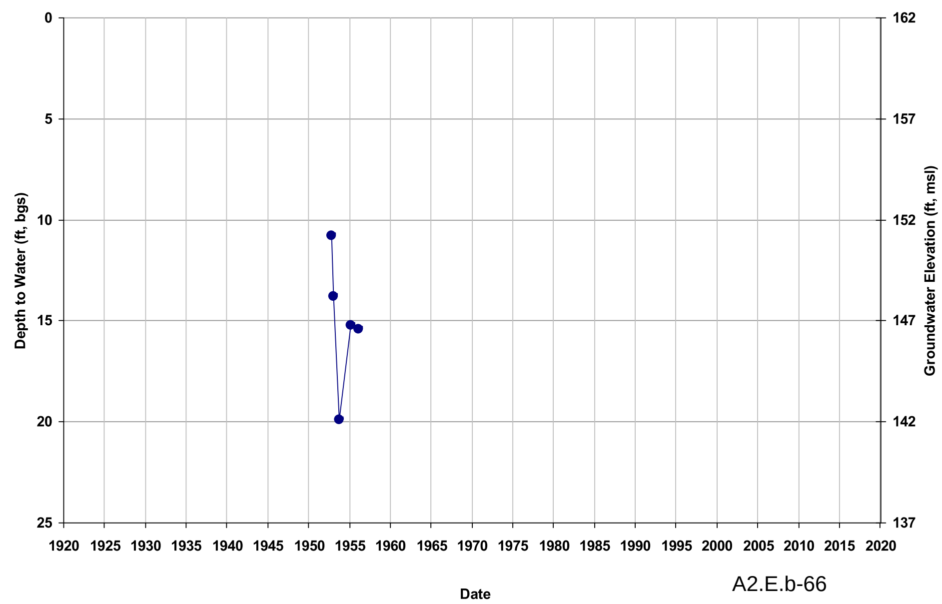
Well ID: 12S15E02A001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 172
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



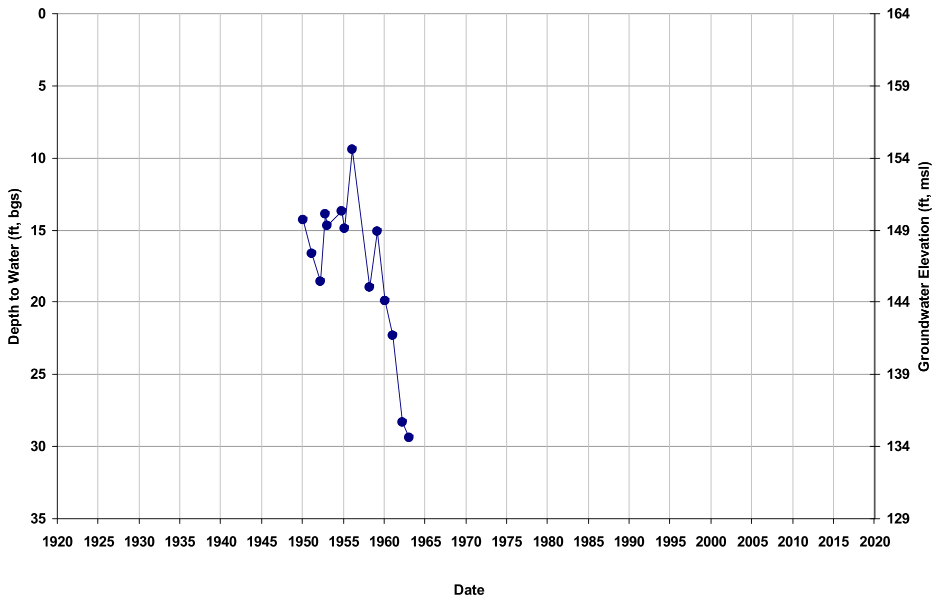
Well ID: 12S15E04Q001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 162
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



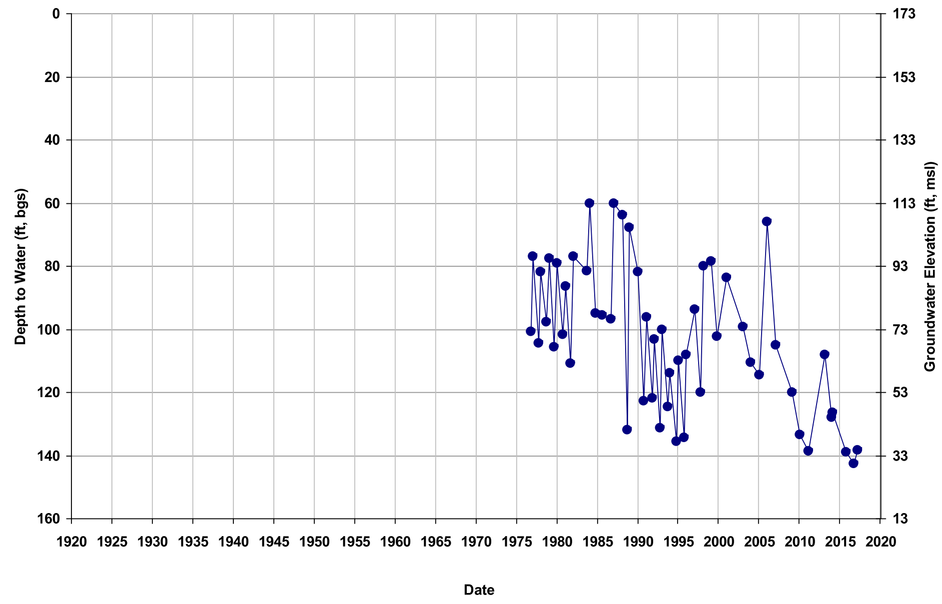
Well ID: 12S15E09J001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 163
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



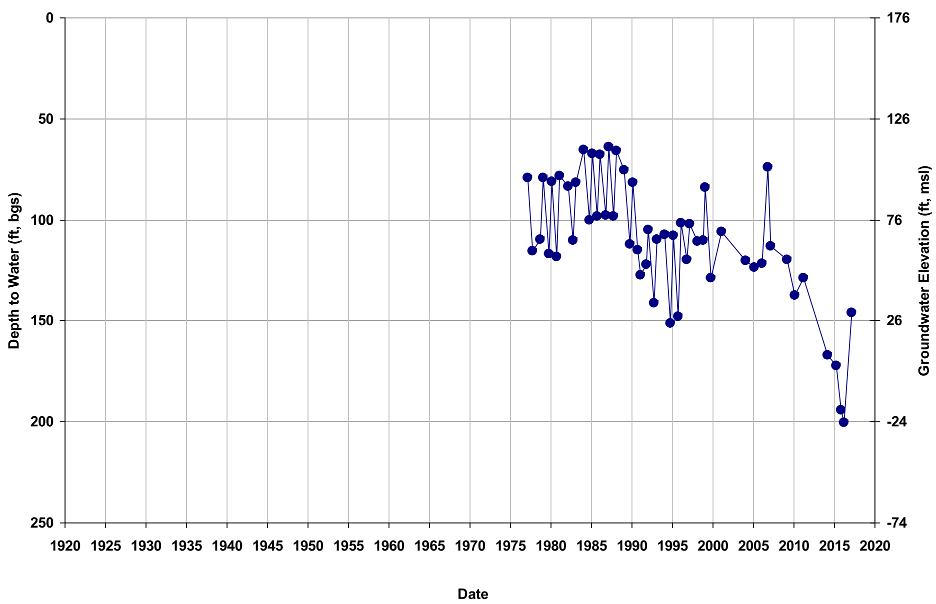
Well ID: 12S15E11R001M
Depth Zone: Upper; Within CC
Subbasin: Madera

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



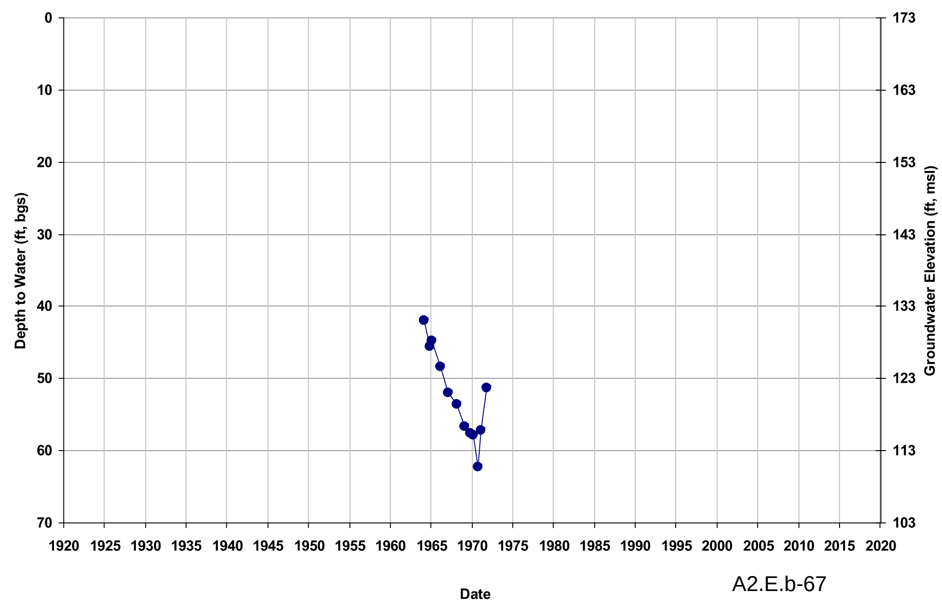
Well ID: 12S15E13R001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

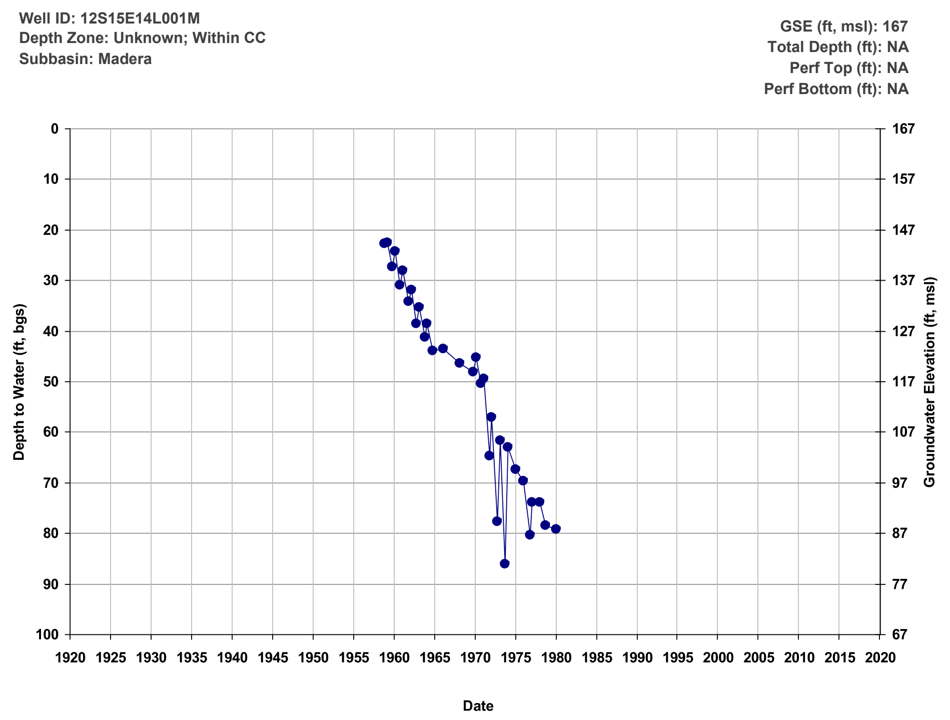
GSE (ft, msl): 176
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

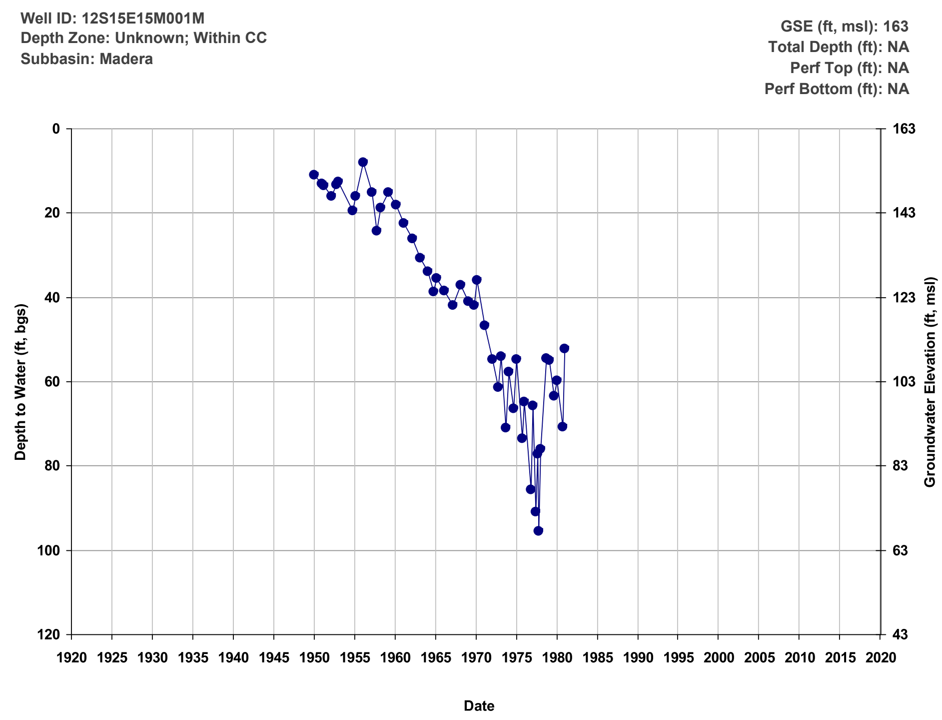


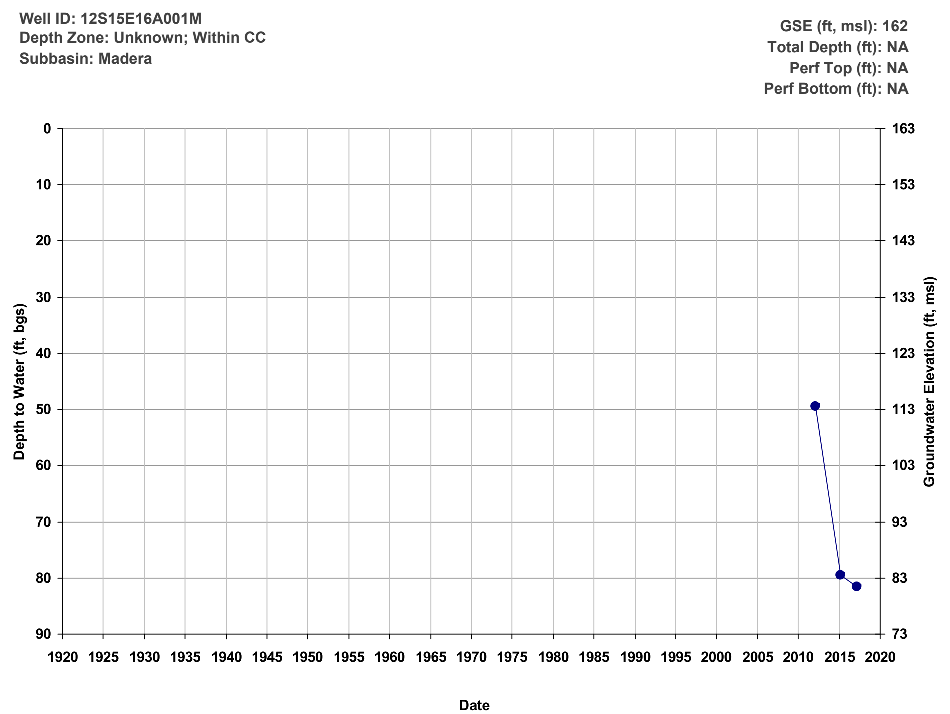
Well ID: 12S15E14A001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

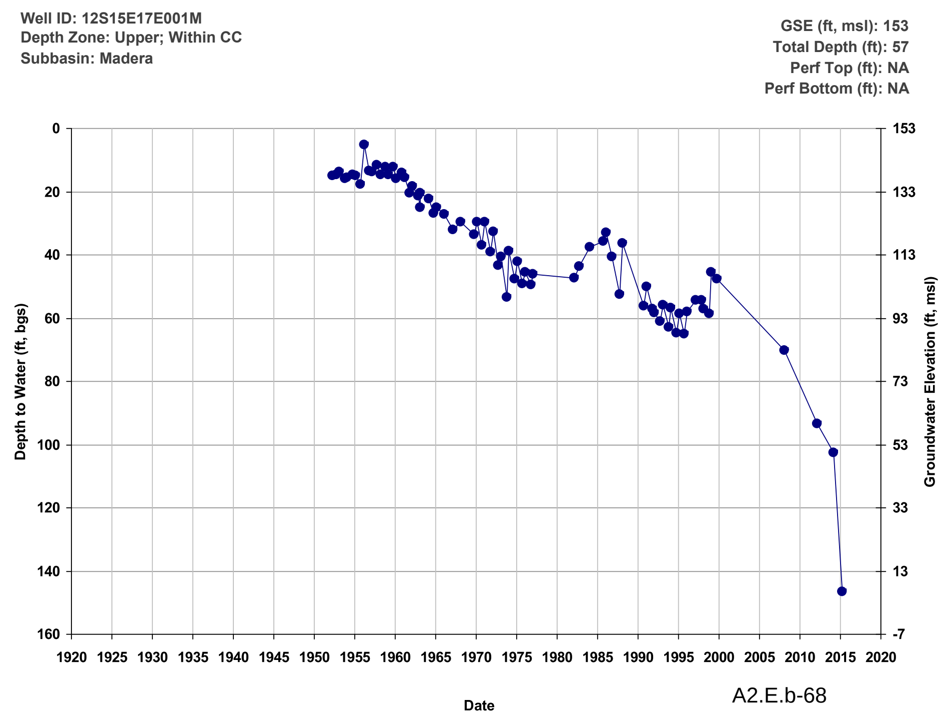
GSE (ft, msl): 173
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

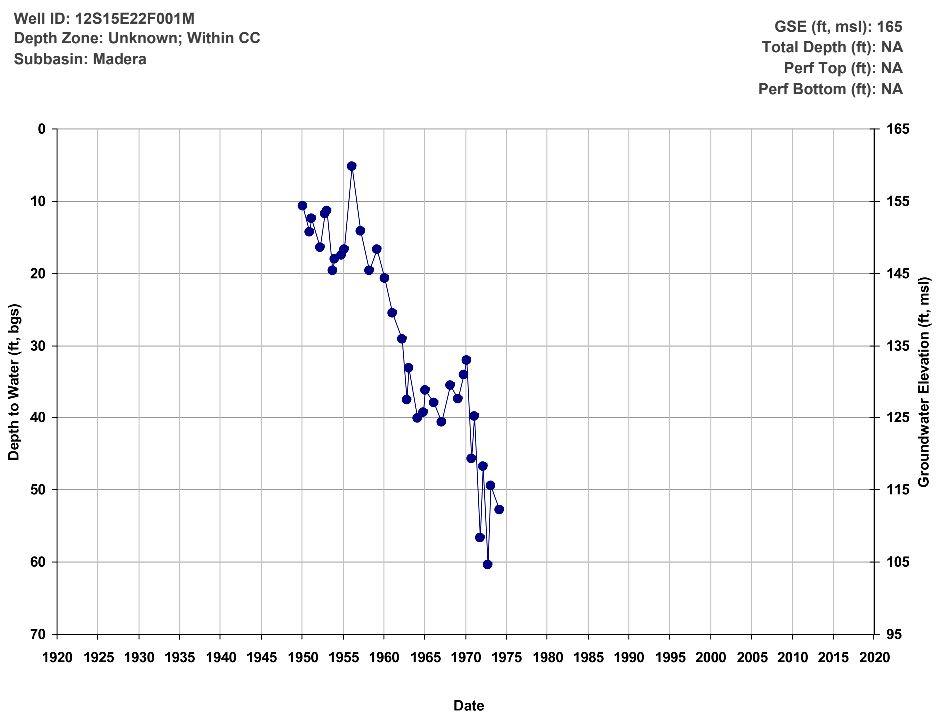


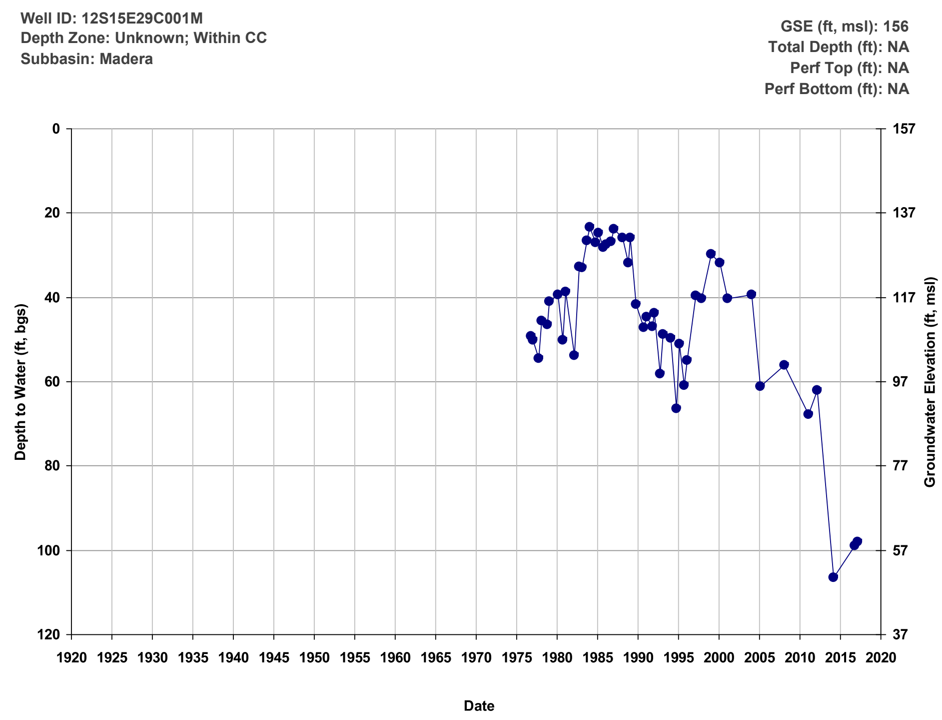

Well ID: 12S15E14L001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 167
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

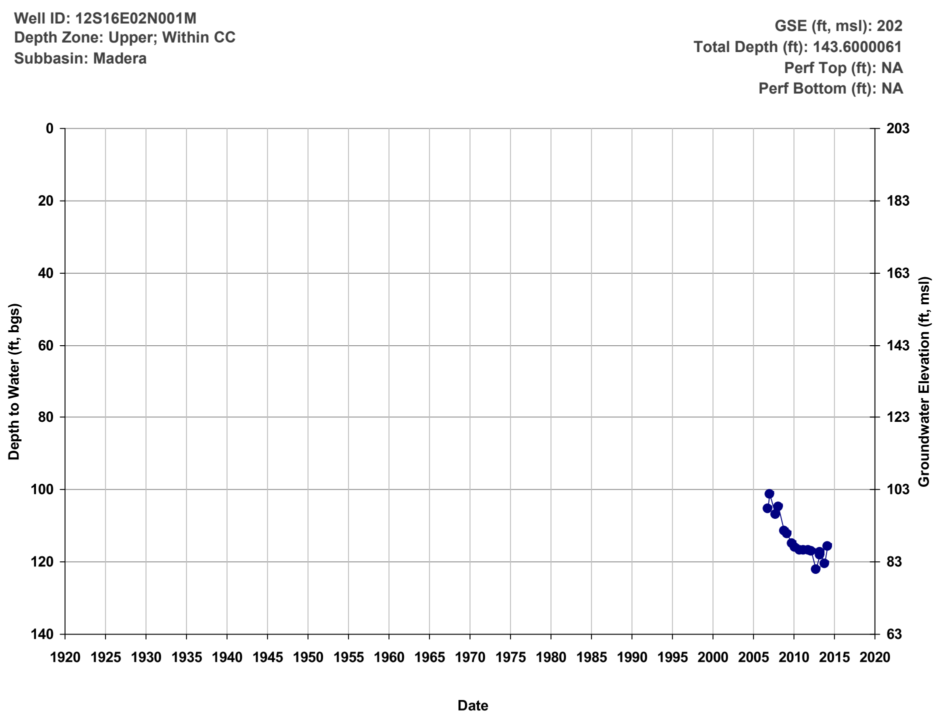

Well ID: 12S15E15M001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 163
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

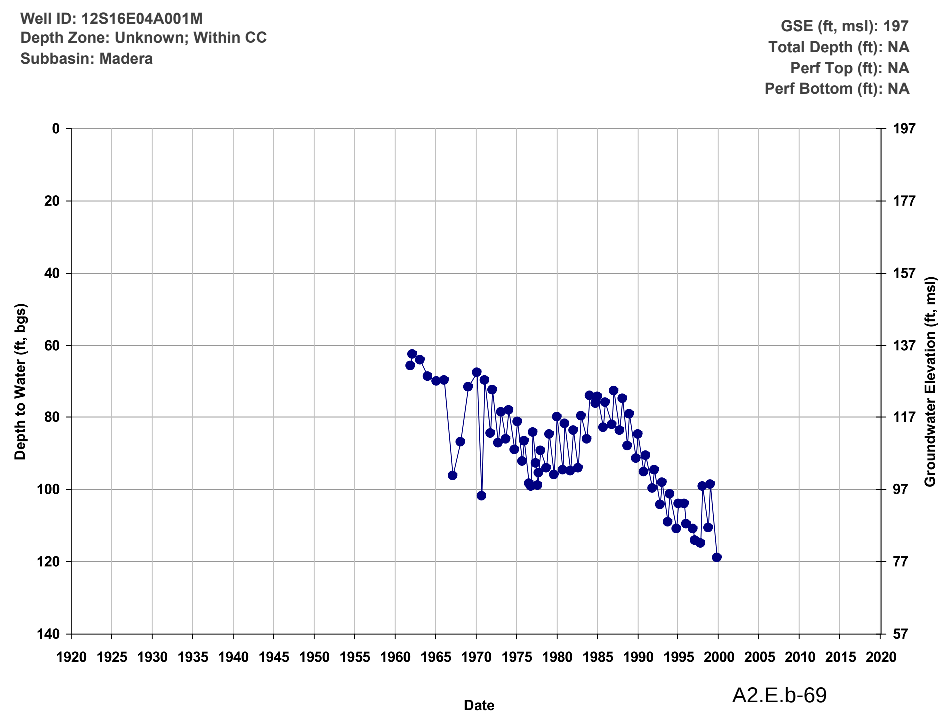

Well ID: 12S15E16A001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 162
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

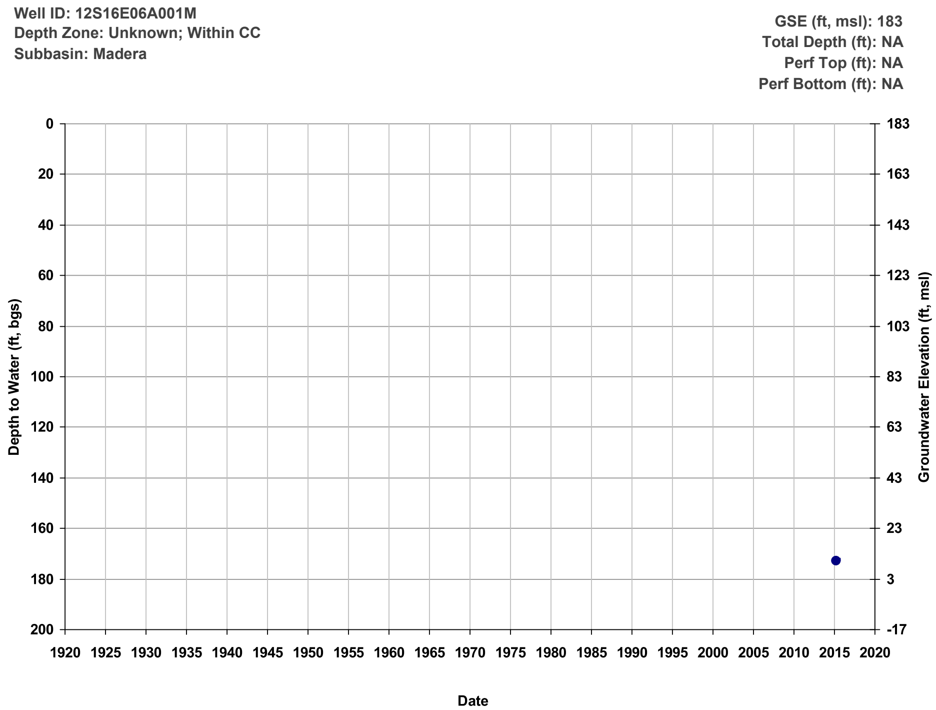

Well ID: 12S15E17E001M
Depth Zone: Upper; Within CC
Subbasin: Madera
GSE (ft, msl): 153
Total Depth (ft): 57
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

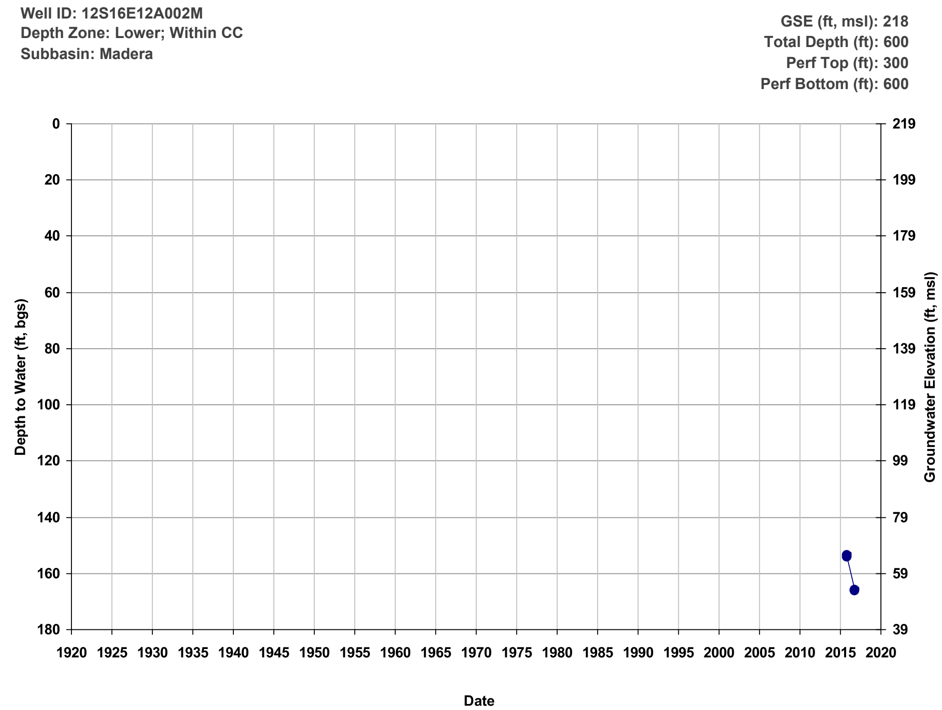

Well ID: 12S15E22F001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 165
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

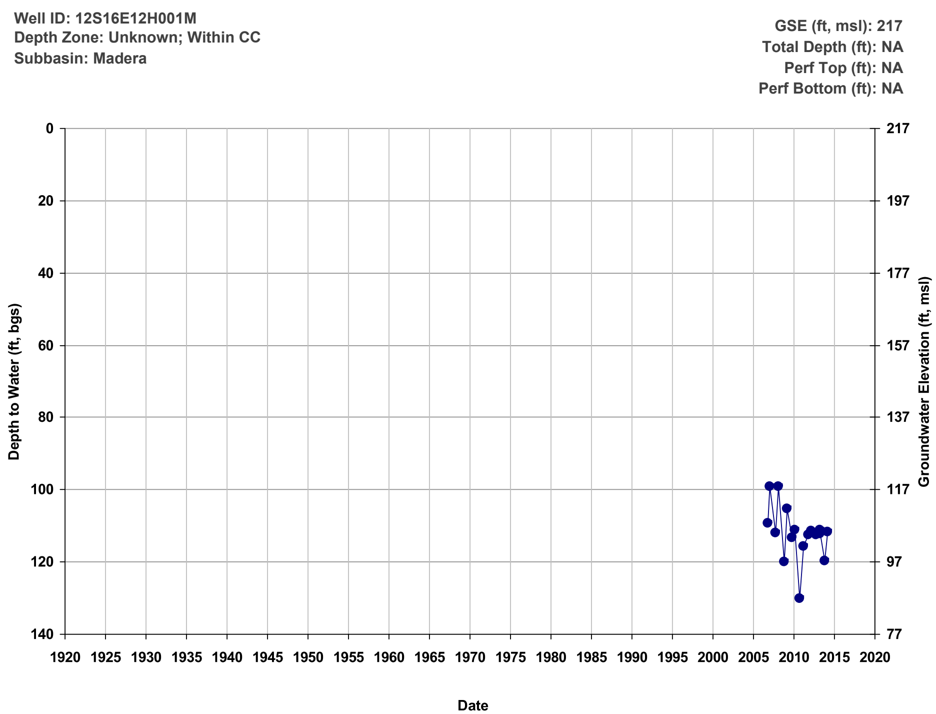

Well ID: 12S15E29C001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 156
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

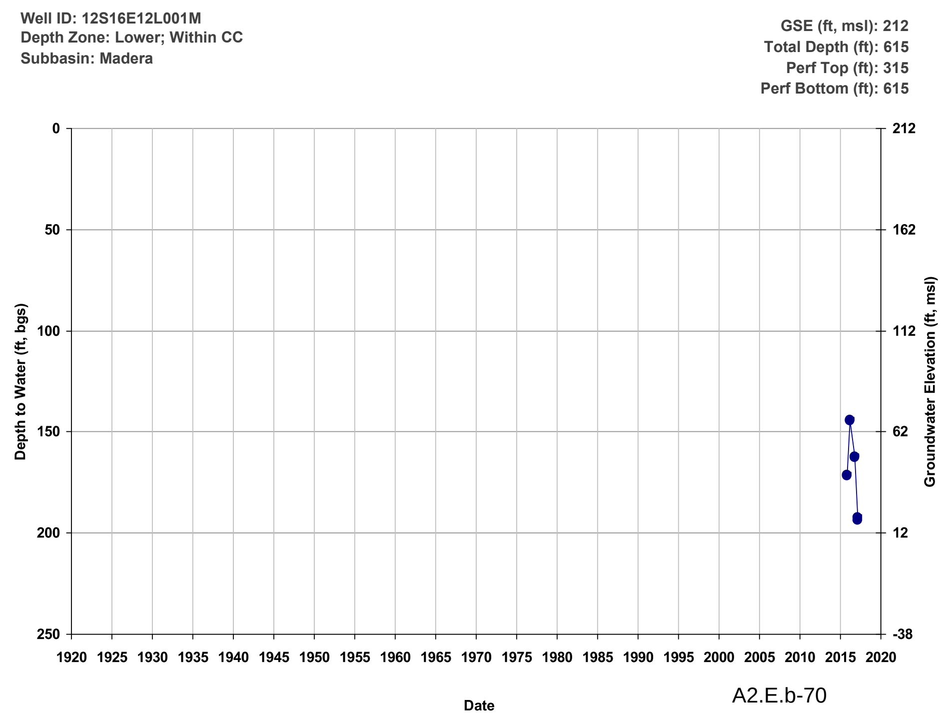

Well ID: 12S16E02N001M
Depth Zone: Upper; Within CC
Subbasin: Madera
GSE (ft, msl): 202
Total Depth (ft): 143.6000061
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

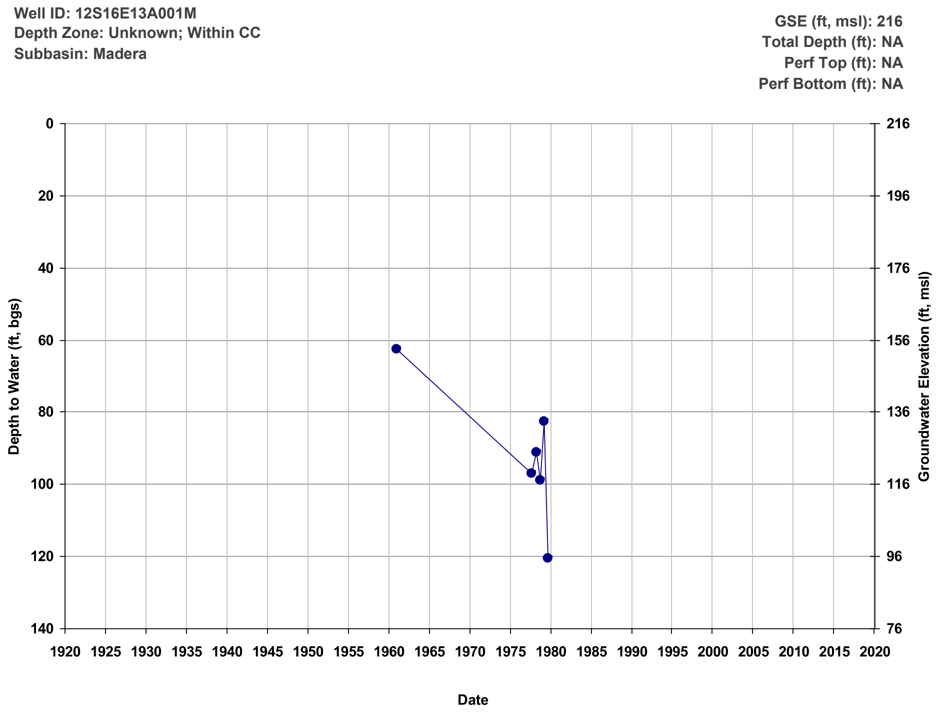

Well ID: 12S16E04A001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 197
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

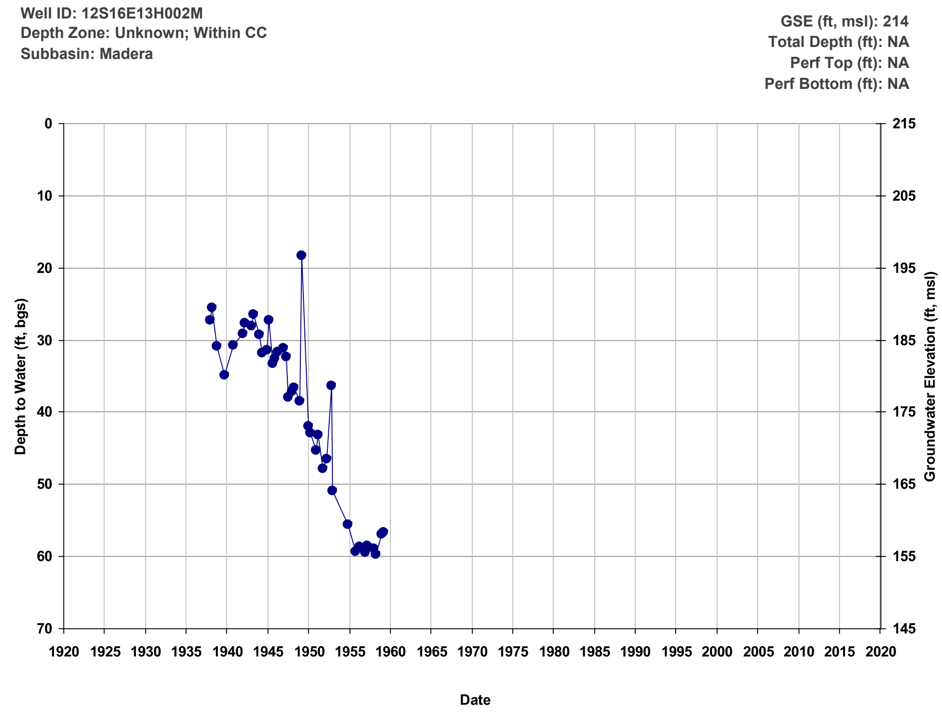

Well ID: 12S16E06A001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 183
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

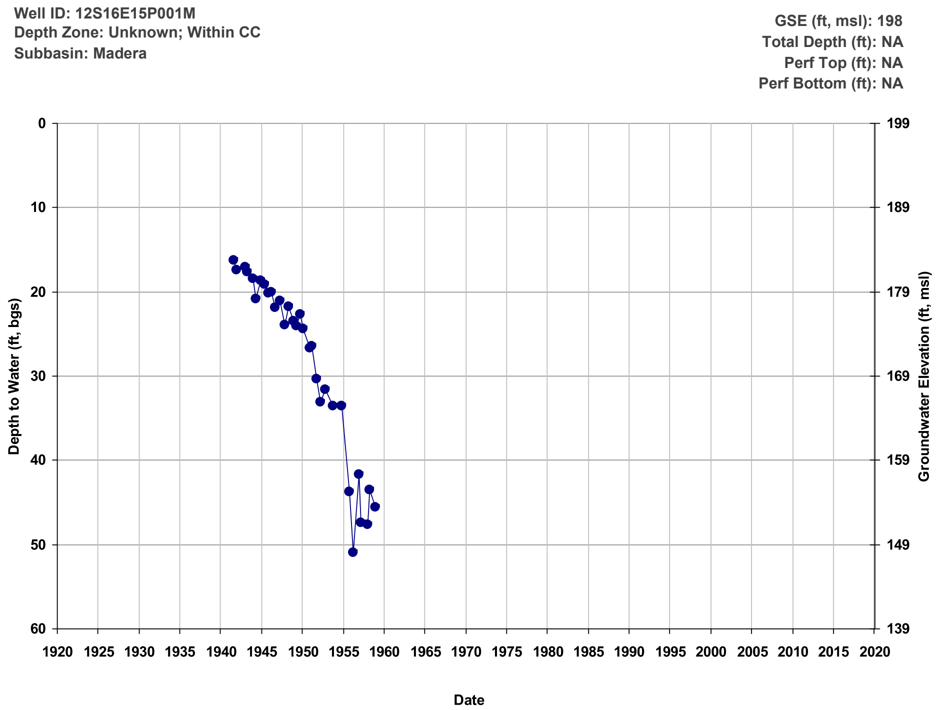

Well ID: 12S16E12A002M
Depth Zone: Lower; Within CC
Subbasin: Madera
GSE (ft, msl): 218
Total Depth (ft): 600
Perf Top (ft): 300
Perf Bottom (ft): 600
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

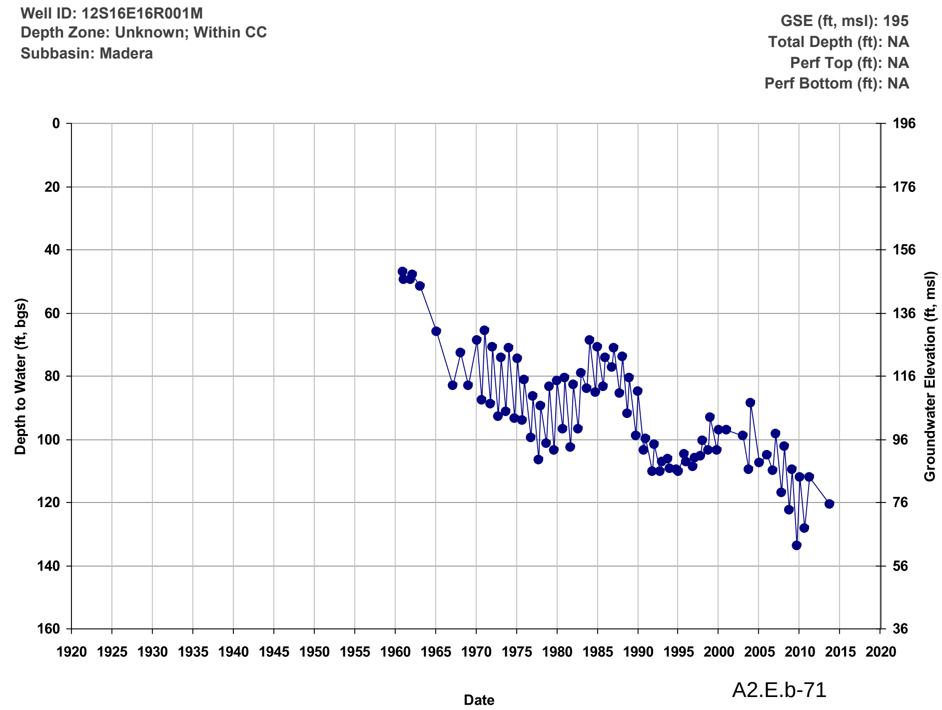

Well ID: 12S16E12H001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 217
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

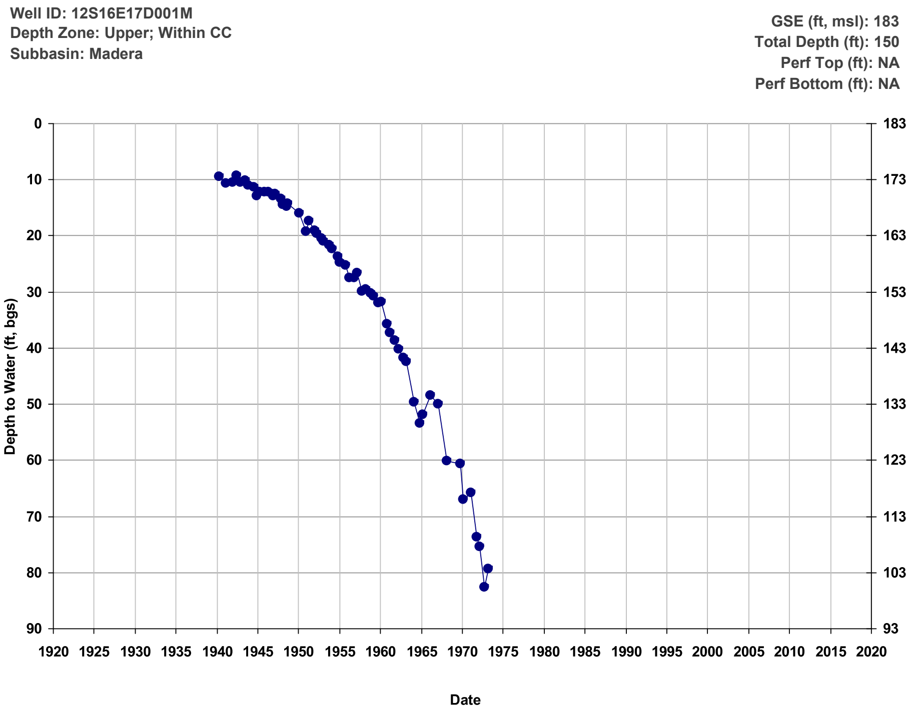

Well ID: 12S16E12L001M
Depth Zone: Lower; Within CC
Subbasin: Madera
GSE (ft, msl): 212
Total Depth (ft): 615
Perf Top (ft): 315
Perf Bottom (ft): 615
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 12S16E13A001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 216
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

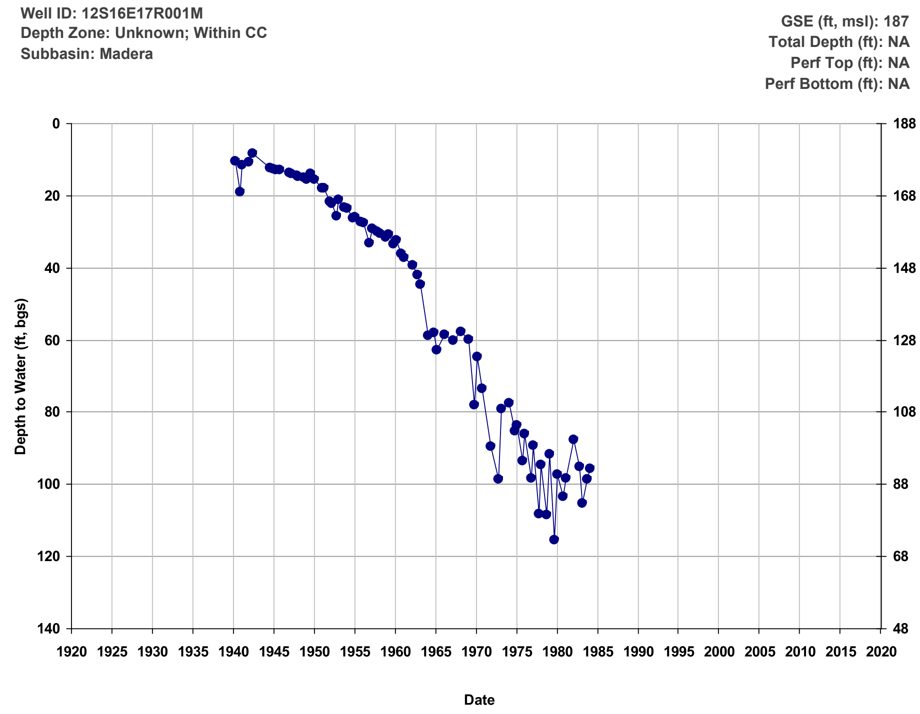

Well ID: 12S16E13H002M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 214
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 12S16E15P001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 198
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

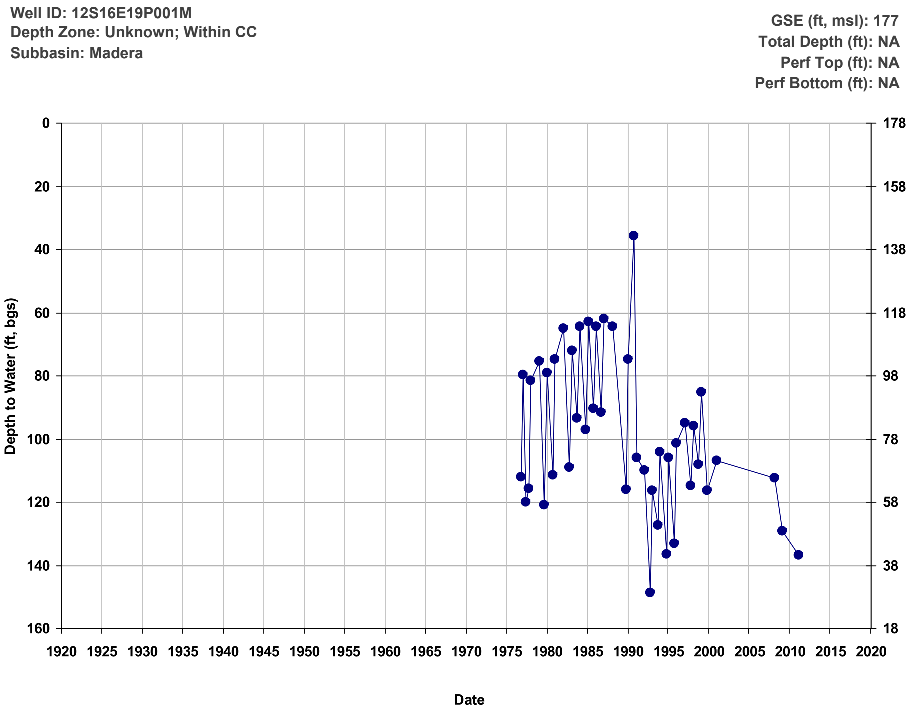

Well ID: 12S16E16R001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 195
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



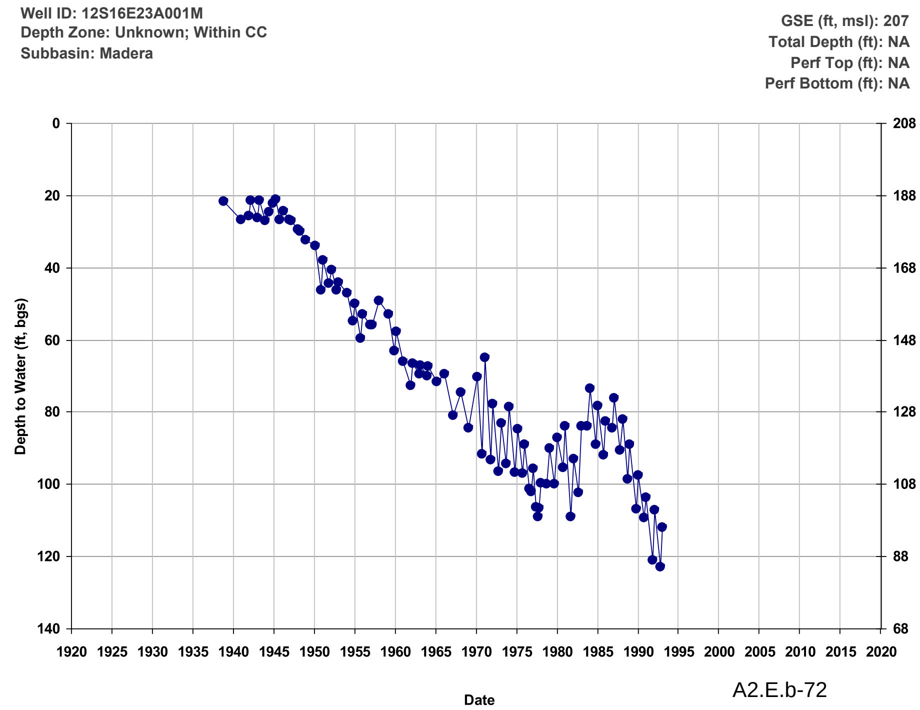
Well ID: 12S16E17D001M
Depth Zone: Upper; Within CC
Subbasin: Madera
GSE (ft, msl): 183
Total Depth (ft): 150
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



Well ID: 12S16E17R001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 187
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



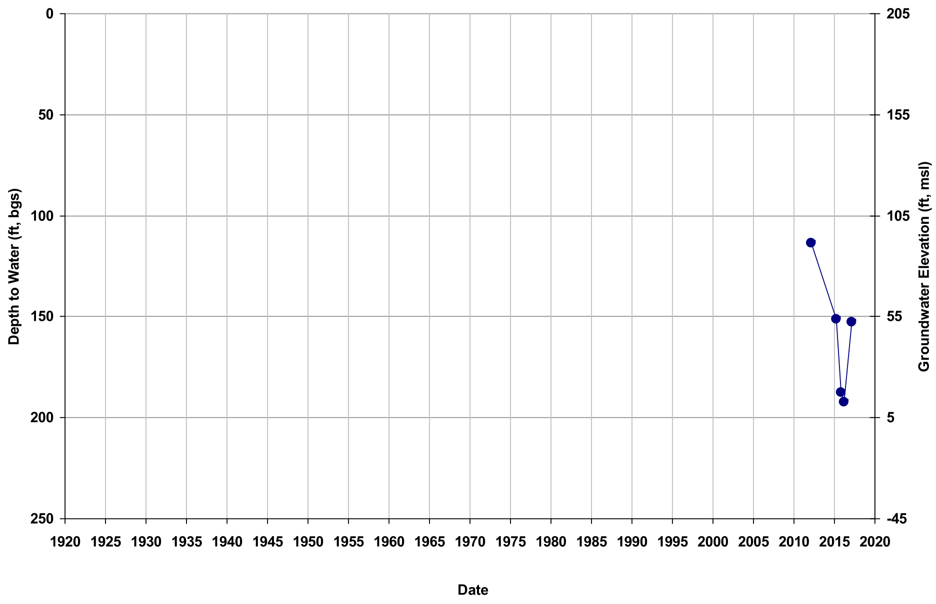
Well ID: 12S16E19P001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 177
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



Well ID: 12S16E23A001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 207
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

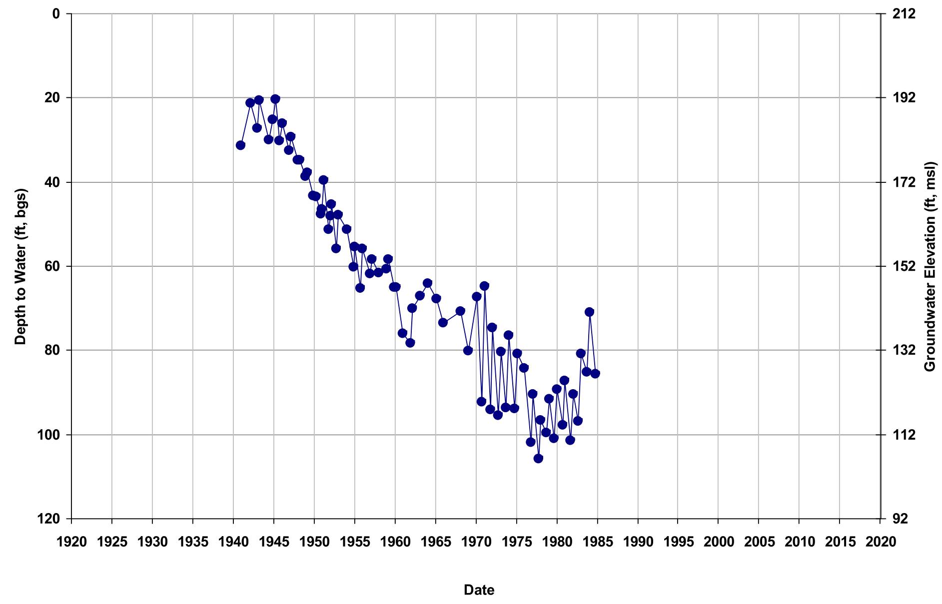
Well ID: 12S16E23H001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 204
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



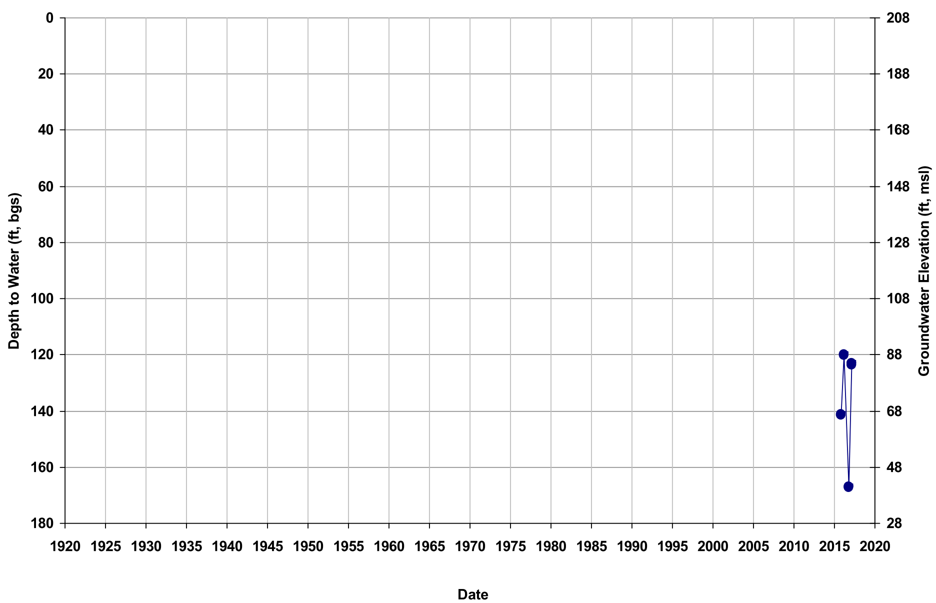
Well ID: 12S16E24A002M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 211
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



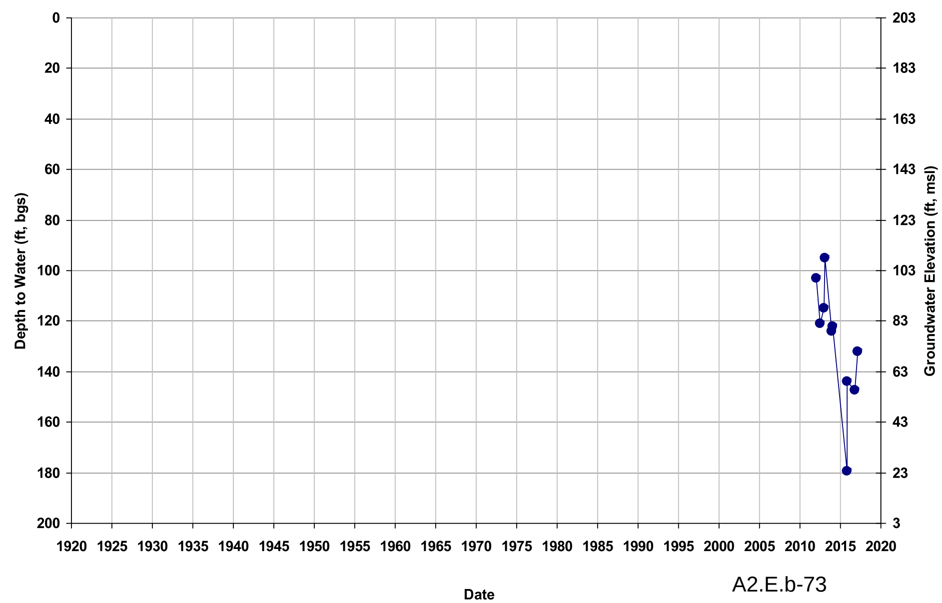
Well ID: 12S16E25R001M
Depth Zone: Composite; Within CC
Subbasin: Madera

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



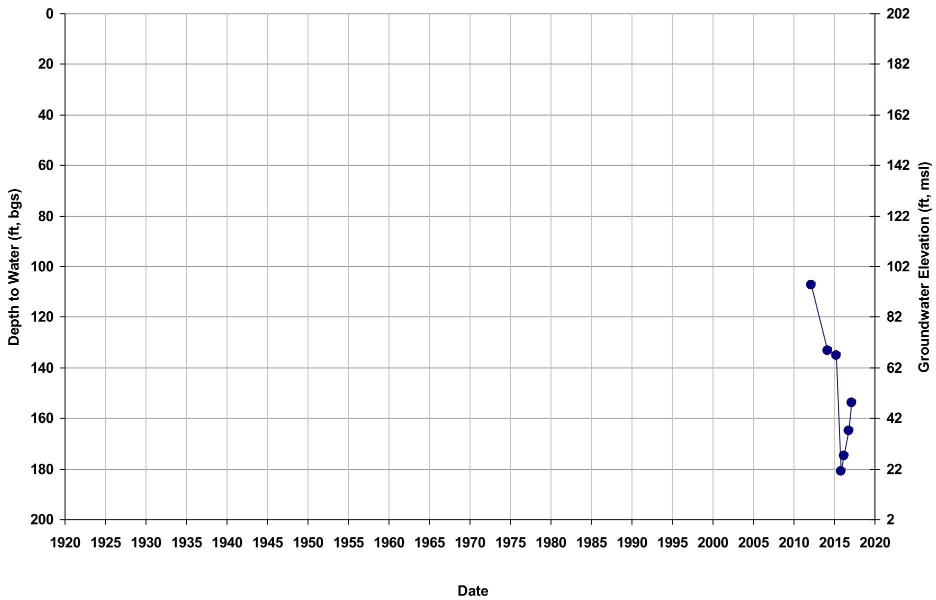
Well ID: 12S16E26H001M
Depth Zone: Upper; Within CC
Subbasin: Madera

GSE (ft, msl): 203
Total Depth (ft): 286
Perf Top (ft): 228
Perf Bottom (ft): 284



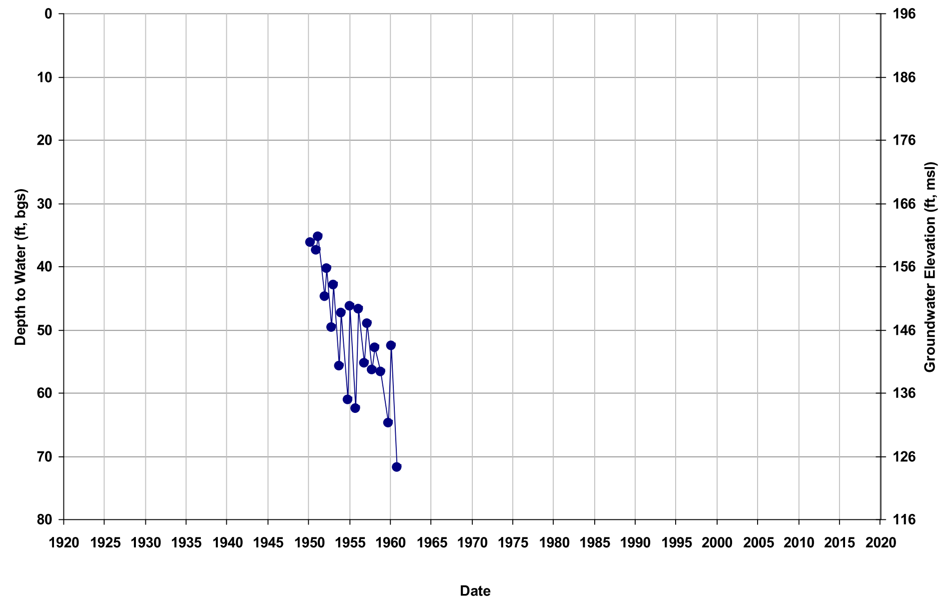
Well ID: 12S16E26R001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 202
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



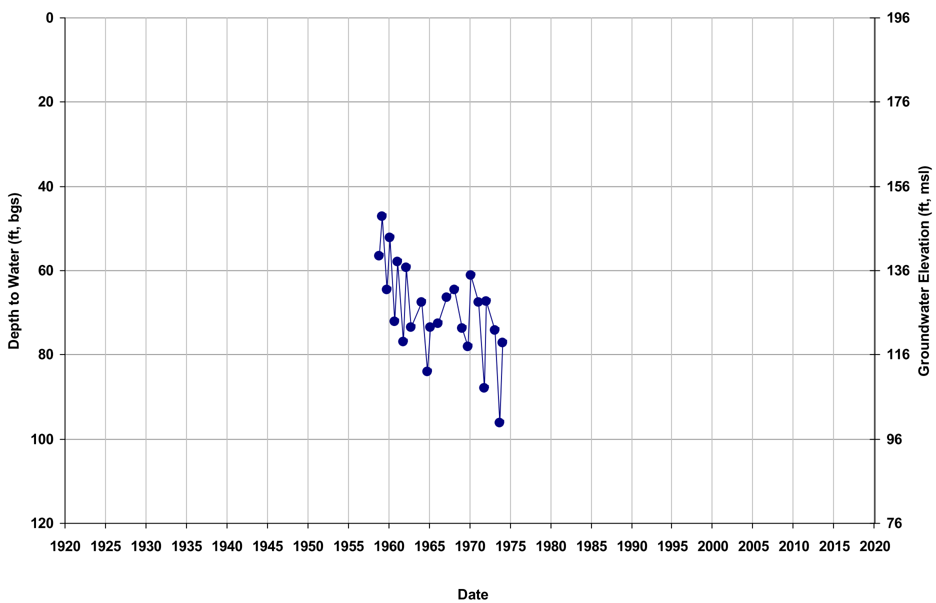
Well ID: 12S16E27R001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 196
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



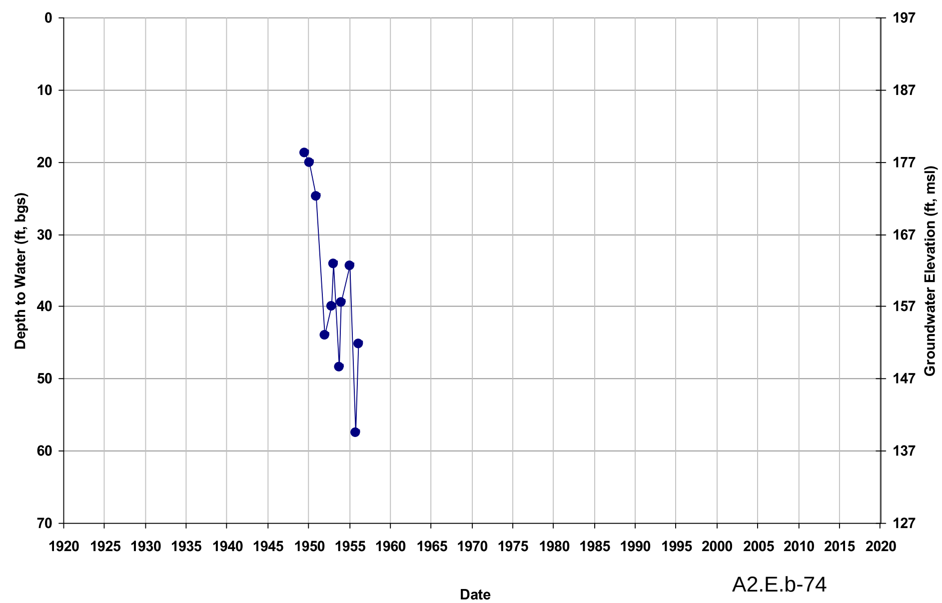
Well ID: 12S16E27R002M
Depth Zone: Unknown; Within CC
Subbasin: Madera

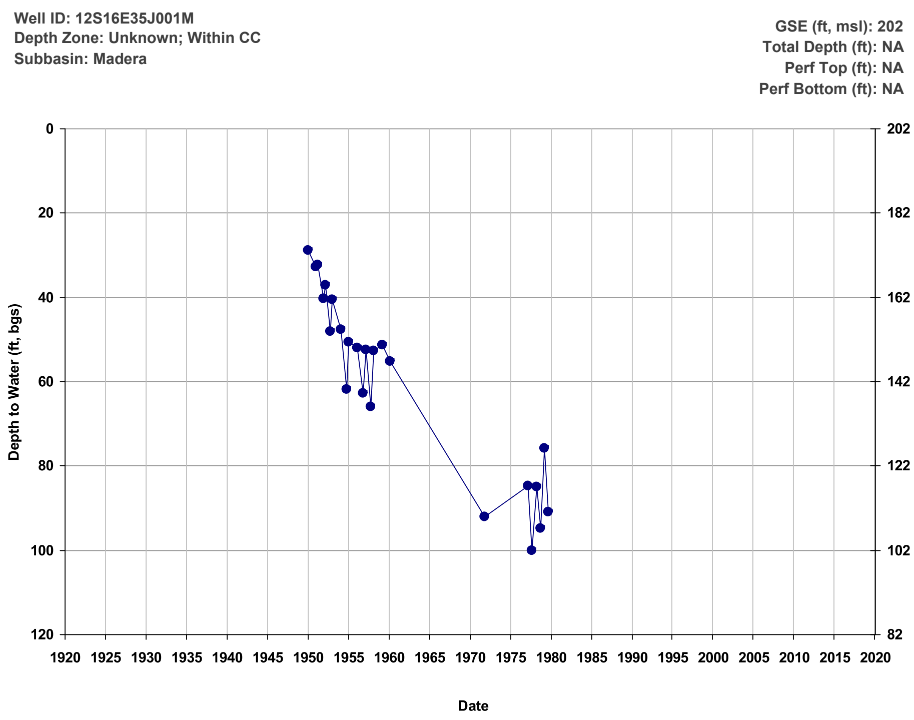
GSE (ft, msl): 196
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



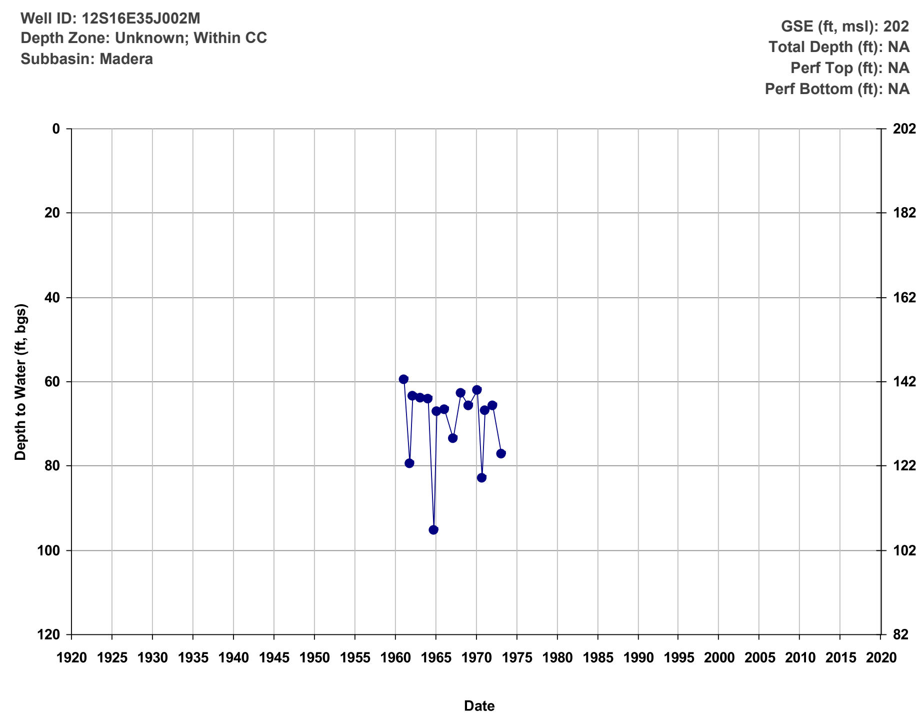
Well ID: 12S16E34J001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 196
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

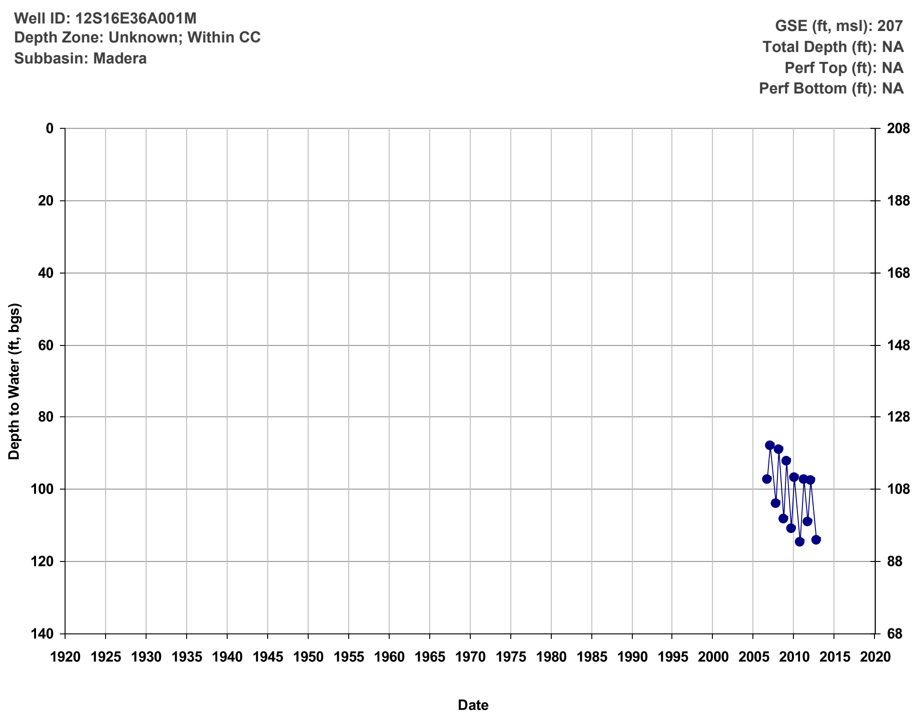




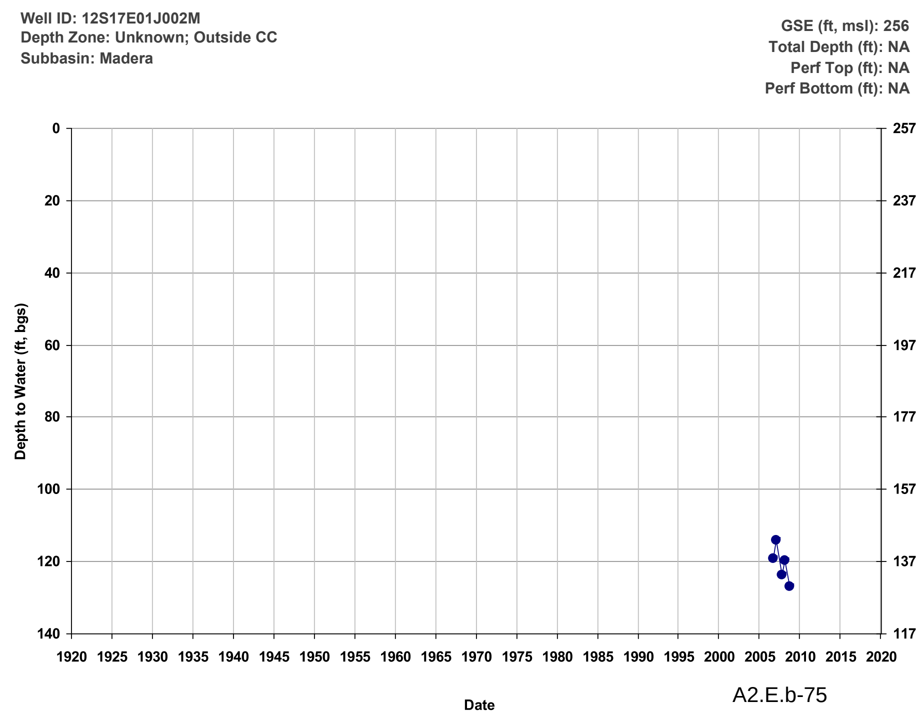
Well ID: 12S16E35J001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 202
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



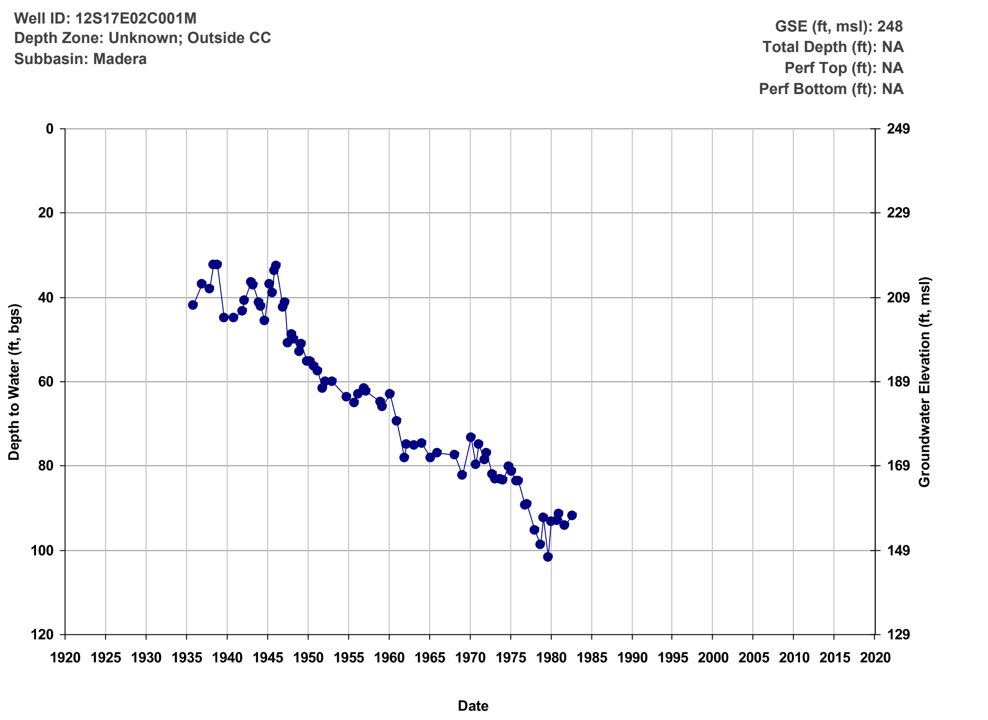
Well ID: 12S16E35J002M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 202
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

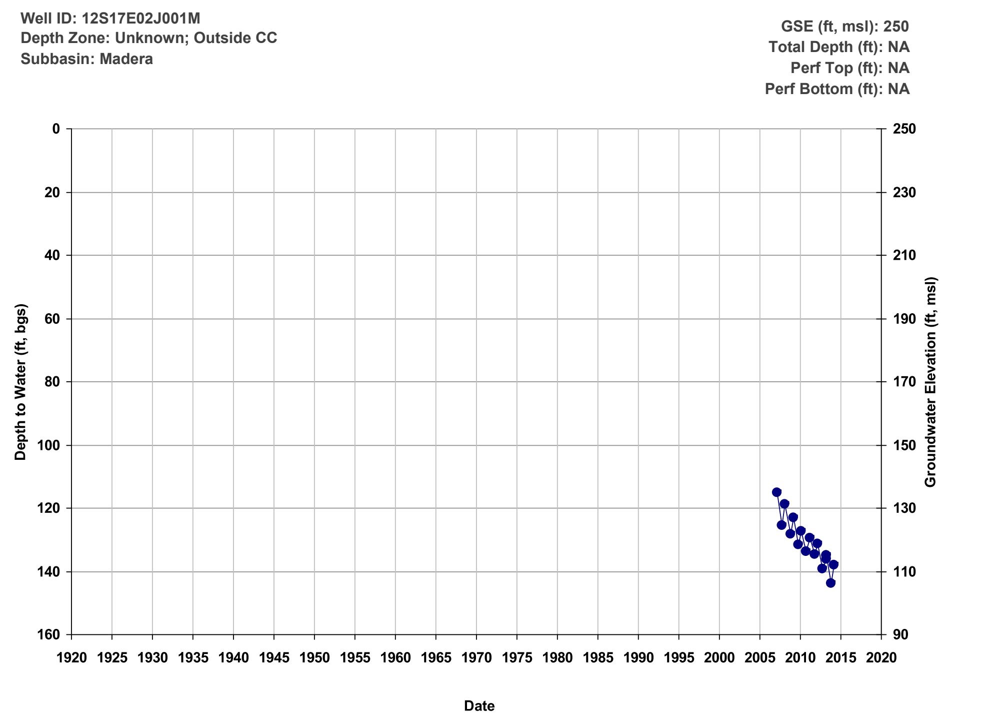


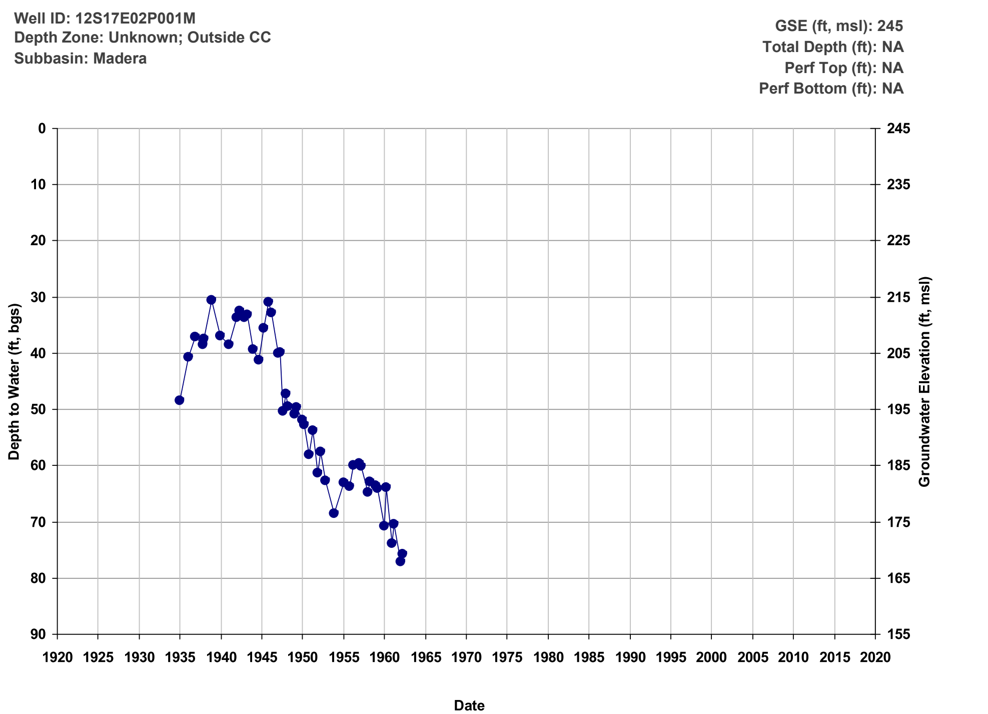
Well ID: 12S16E36A001M
Depth Zone: Unknown; Within CC
Subbasin: Madera
GSE (ft, msl): 207
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

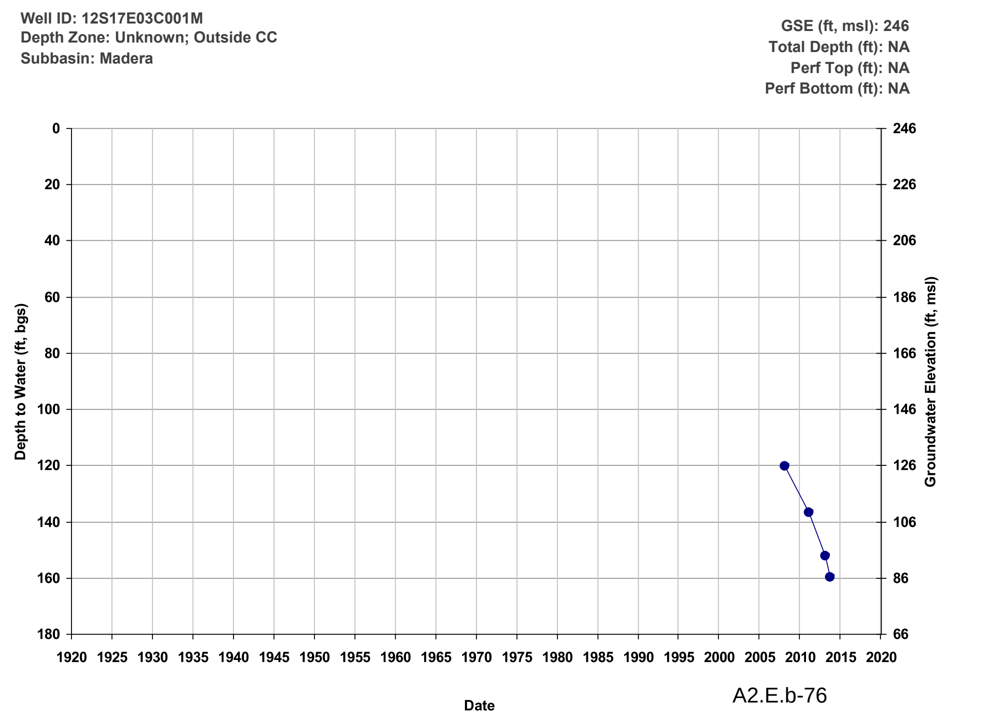


Well ID: 12S17E01J002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 256
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 12S17E02C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 248
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

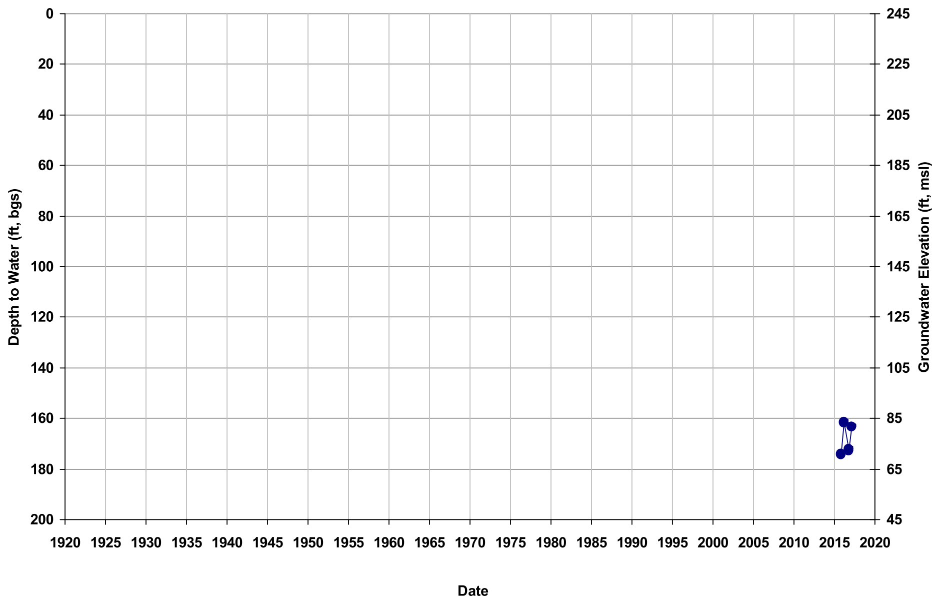

Well ID: 12S17E02J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 250
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 12S17E02P001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 245
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 12S17E03C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 246
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

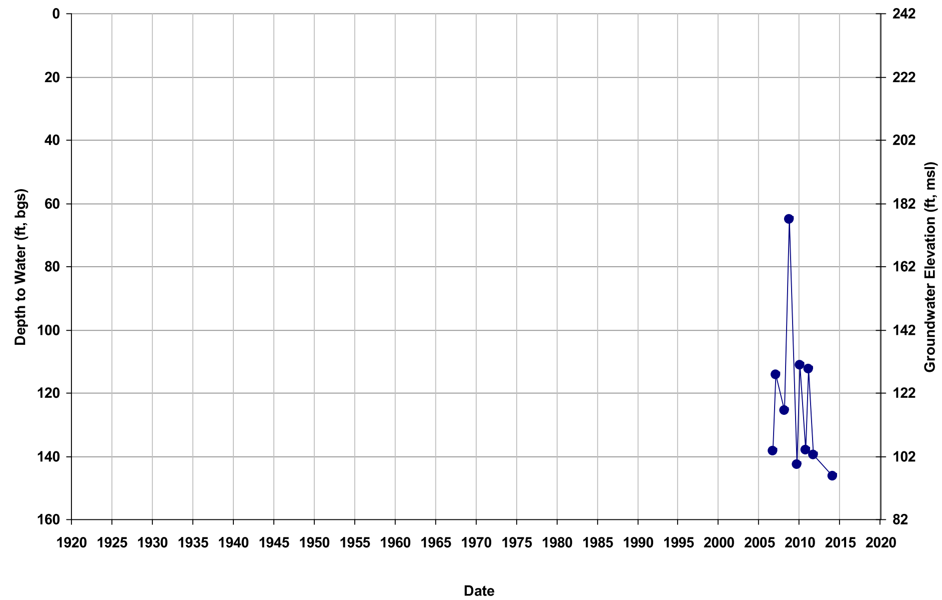
Well ID: 12S17E03D001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 245
Total Depth (ft): 644
Perf Top (ft): 308
Perf Bottom (ft): 596



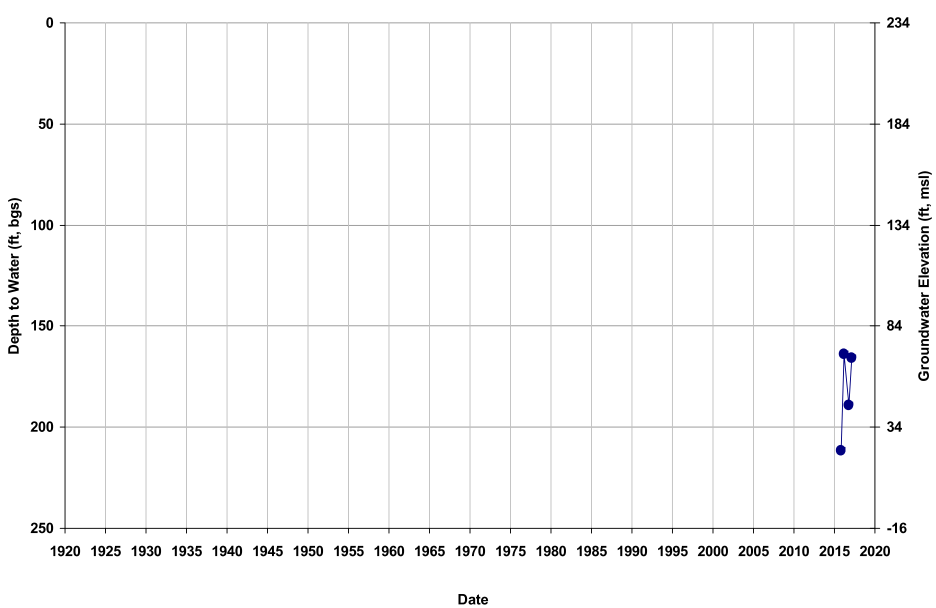
Well ID: 12S17E03F001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 242
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



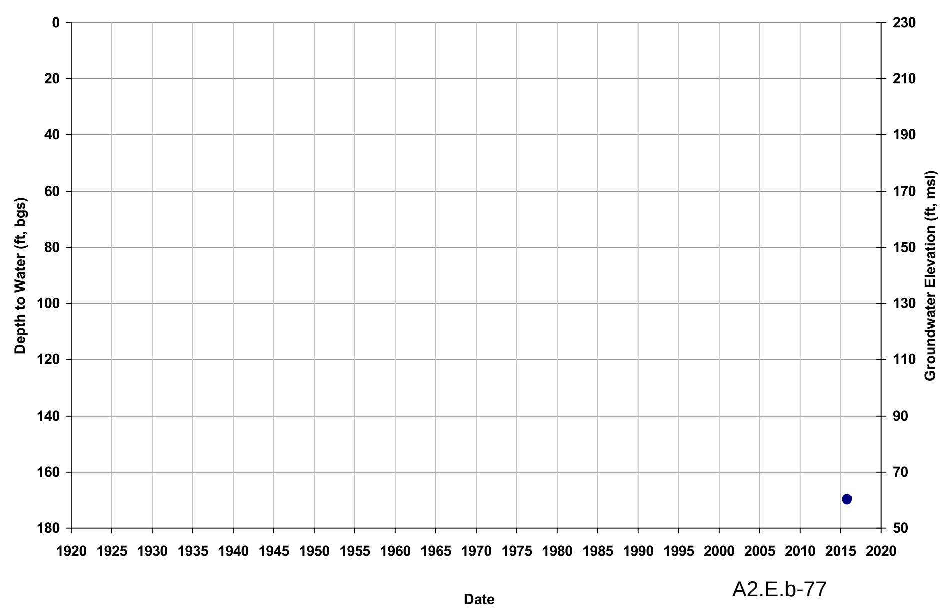
Well ID: 12S17E05B001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 234
Total Depth (ft): 724
Perf Top (ft): 430
Perf Bottom (ft): 715



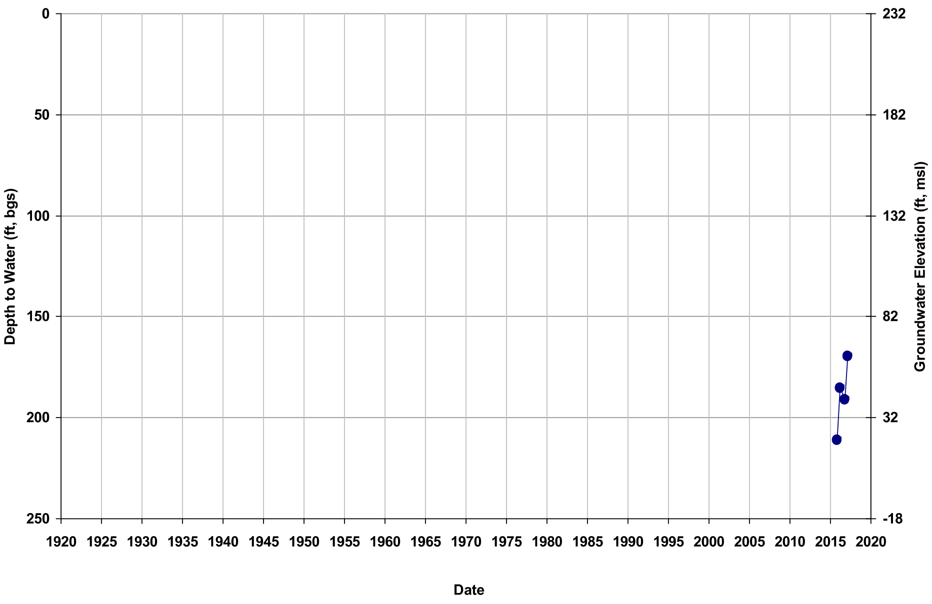
Well ID: 12S17E05N001M
Depth Zone: Lower; Within CC
Subbasin: Madera

GSE (ft, msl): 230
Total Depth (ft): 625
Perf Top (ft): 200
Perf Bottom (ft): 546



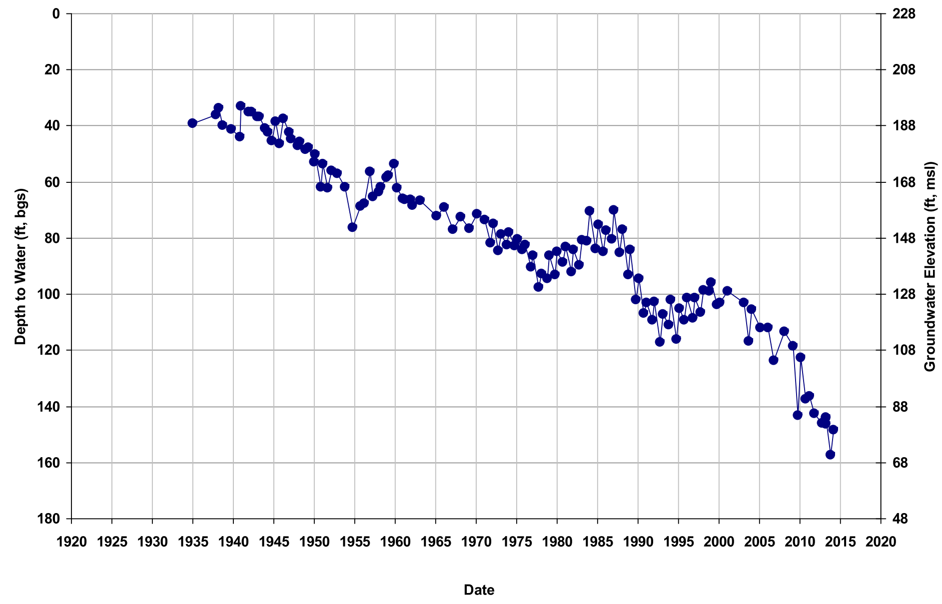
Well ID: 12S17E05P001M
Depth Zone: Lower; Within CC
Subbasin: Madera

GSE (ft, msl): 232
Total Depth (ft): 680
Perf Top (ft): 300
Perf Bottom (ft): 680



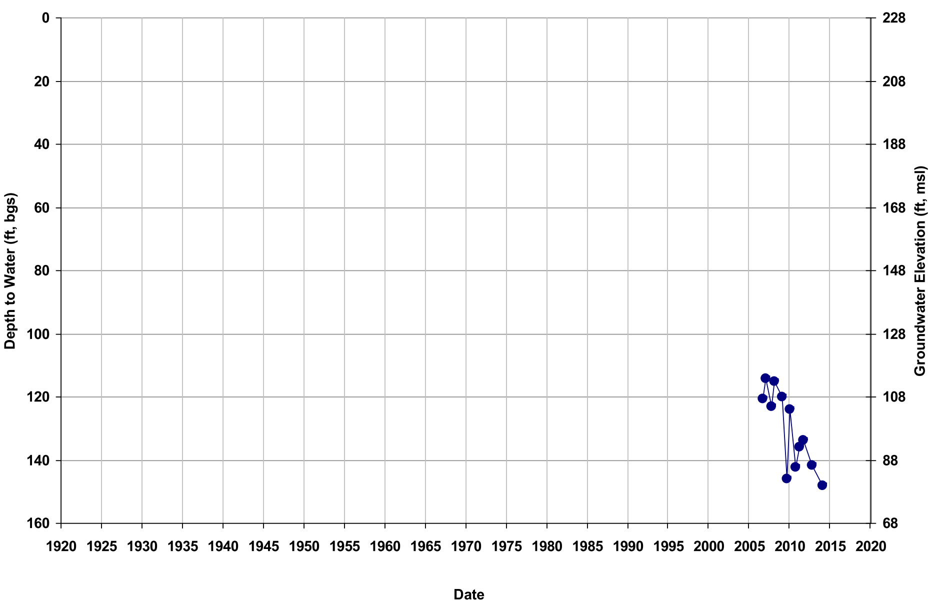
Well ID: 12S17E06A003M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 227
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



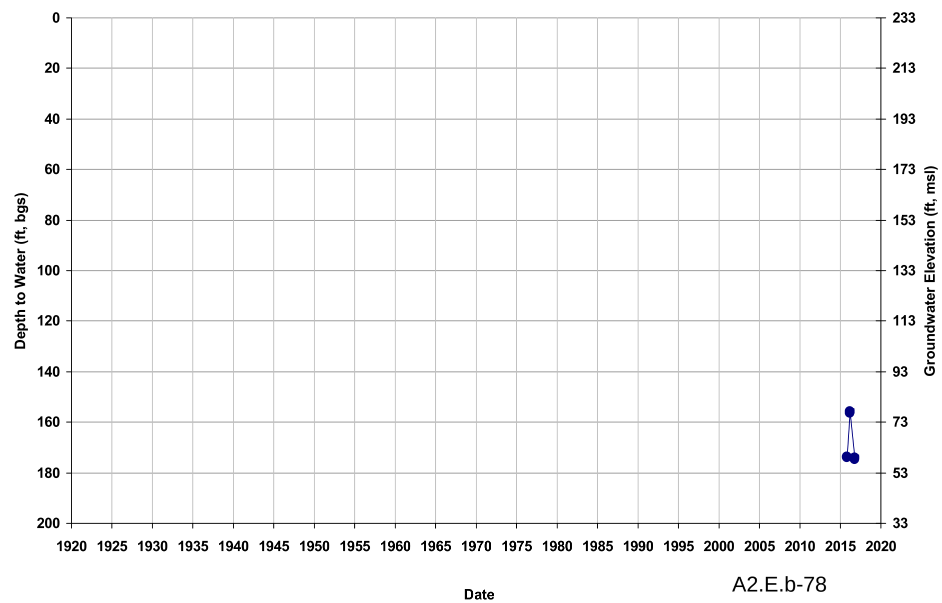
Well ID: 12S17E06R001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 227
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



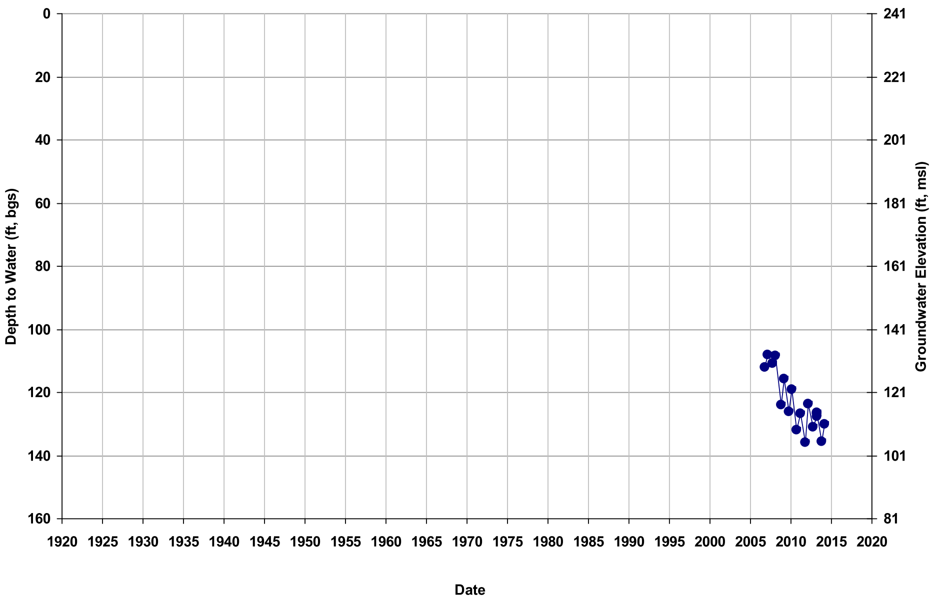
Well ID: 12S17E08B001M
Depth Zone: Lower; Within CC
Subbasin: Madera

GSE (ft, msl): 233
Total Depth (ft): 612
Perf Top (ft): 220
Perf Bottom (ft): 548



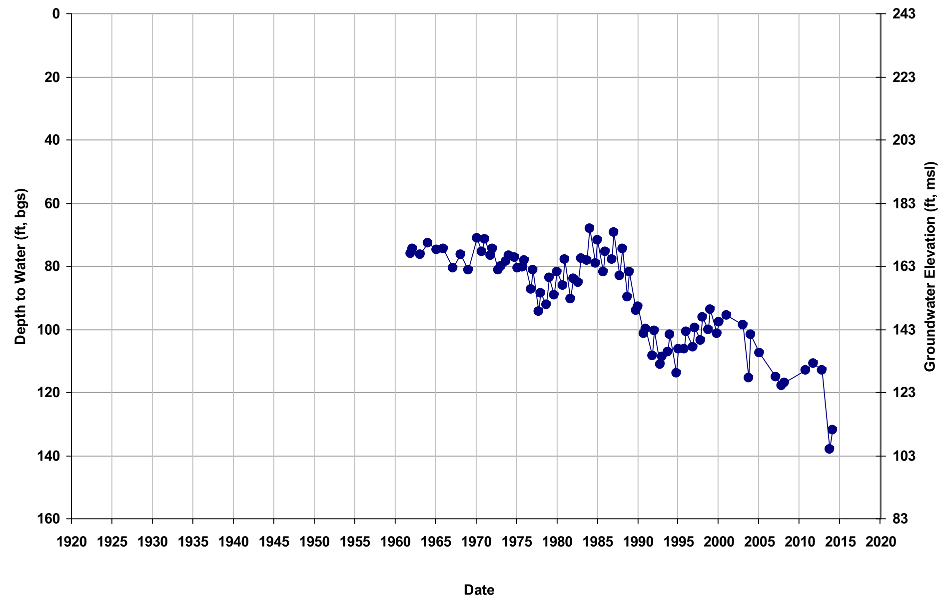
Well ID: 12S17E10H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 241
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



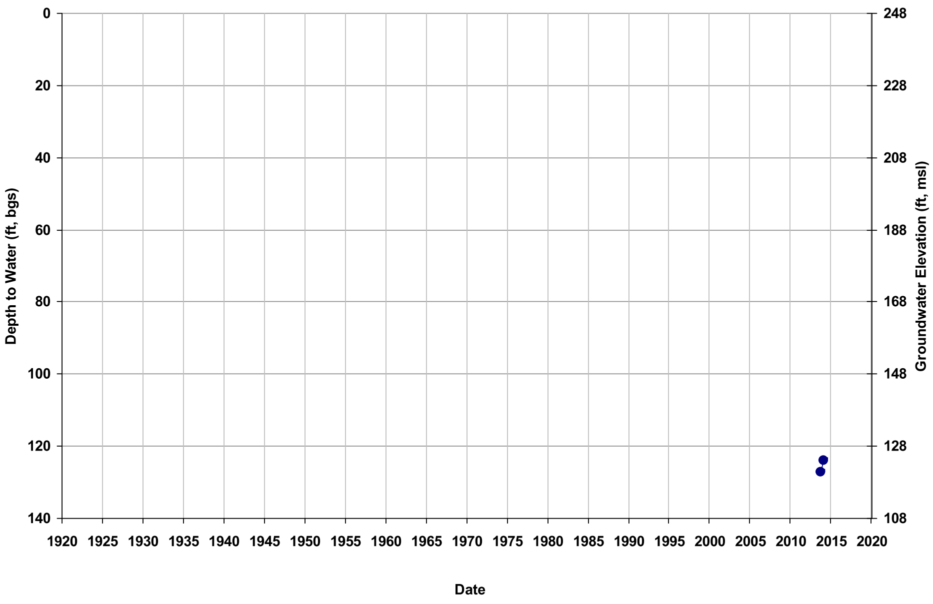
Well ID: 12S17E11D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 243
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



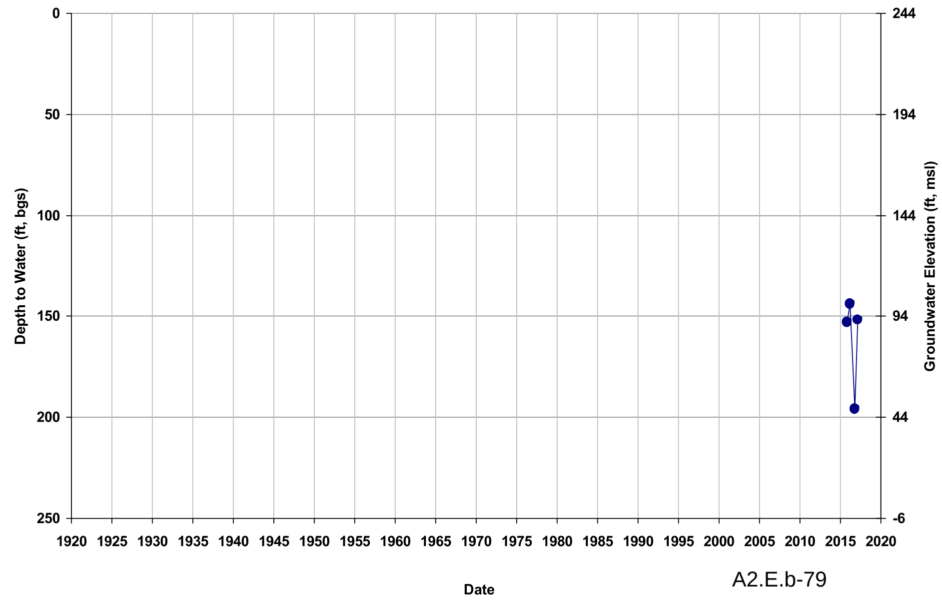
Well ID: 12S17E11J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 248
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



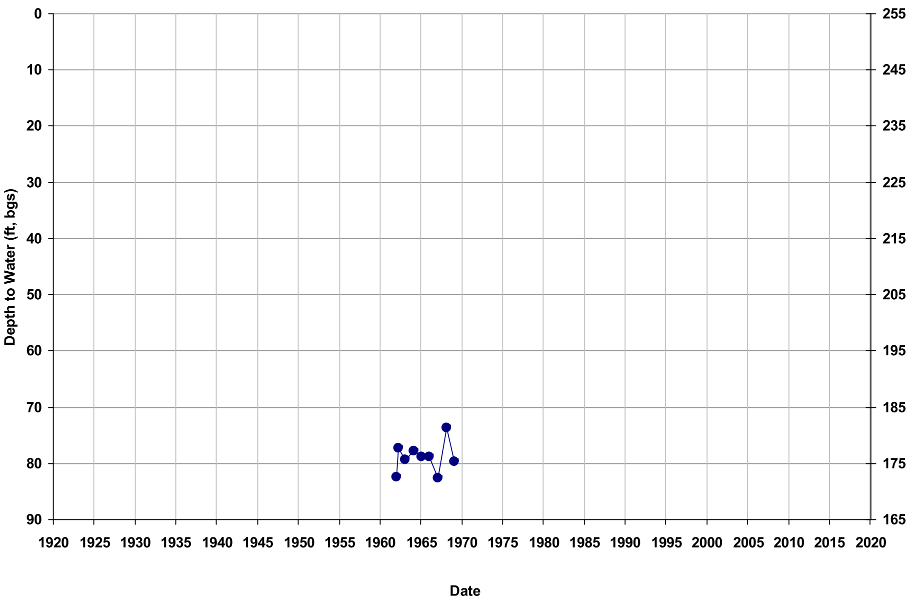
Well ID: 12S17E11P001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 243
Total Depth (ft): 660
Perf Top (ft): 300
Perf Bottom (ft): 660



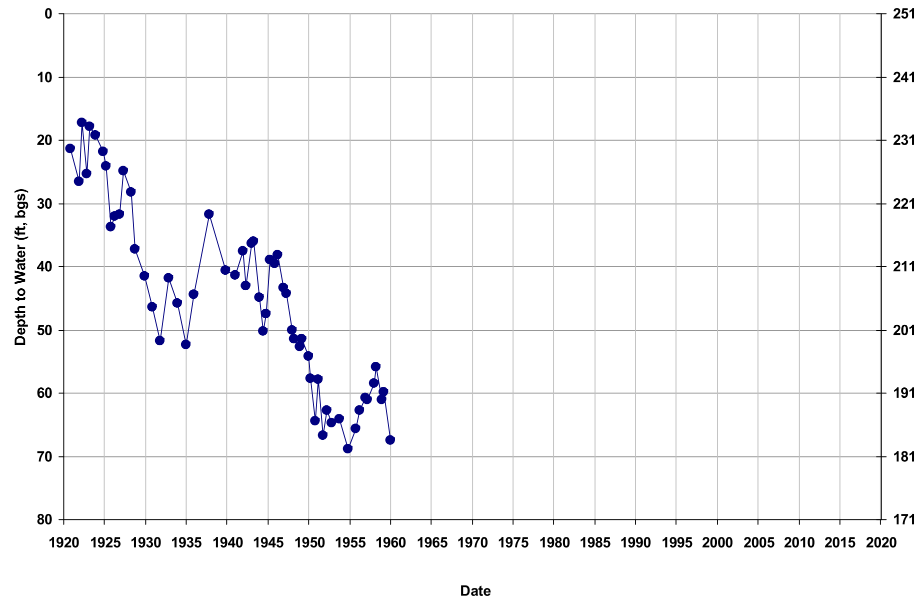
Well ID: 12S17E12A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 254
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



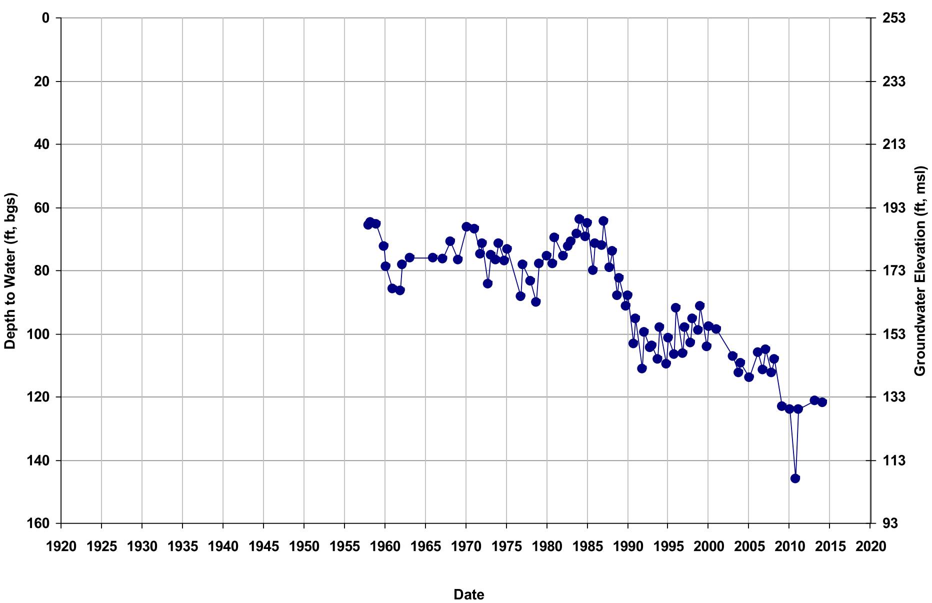
Well ID: 12S17E12C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 251
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



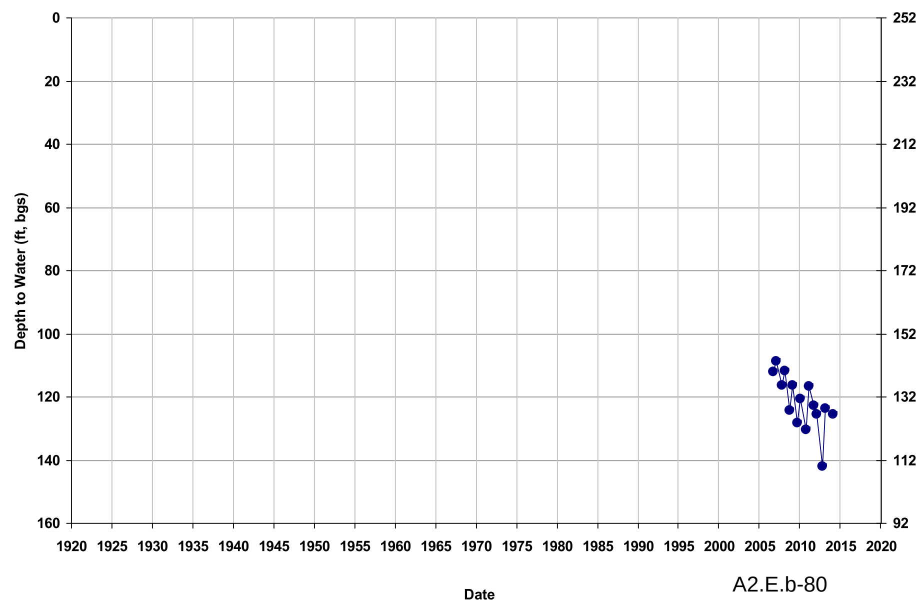
Well ID: 12S17E13J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 252
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



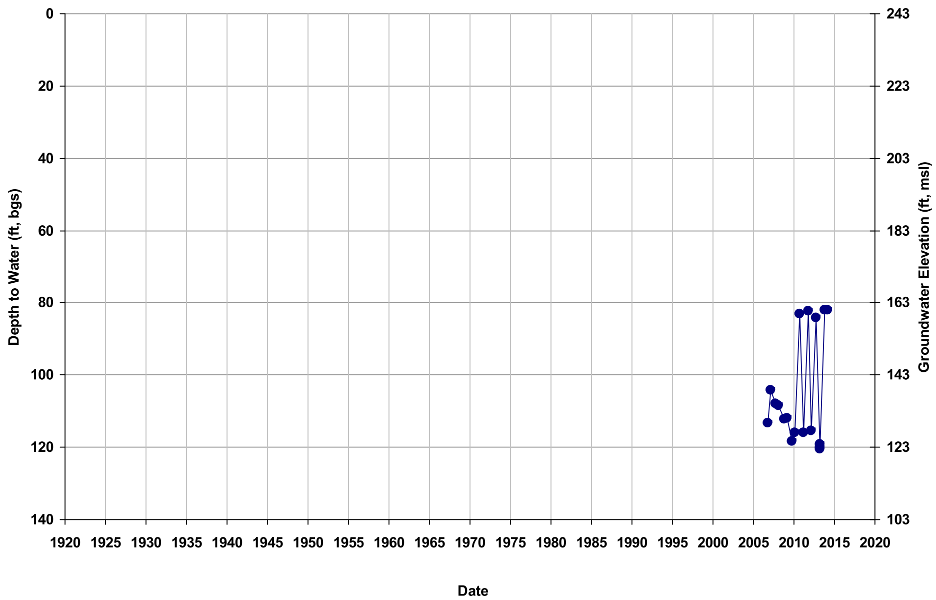
Well ID: 12S17E13K001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 251
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



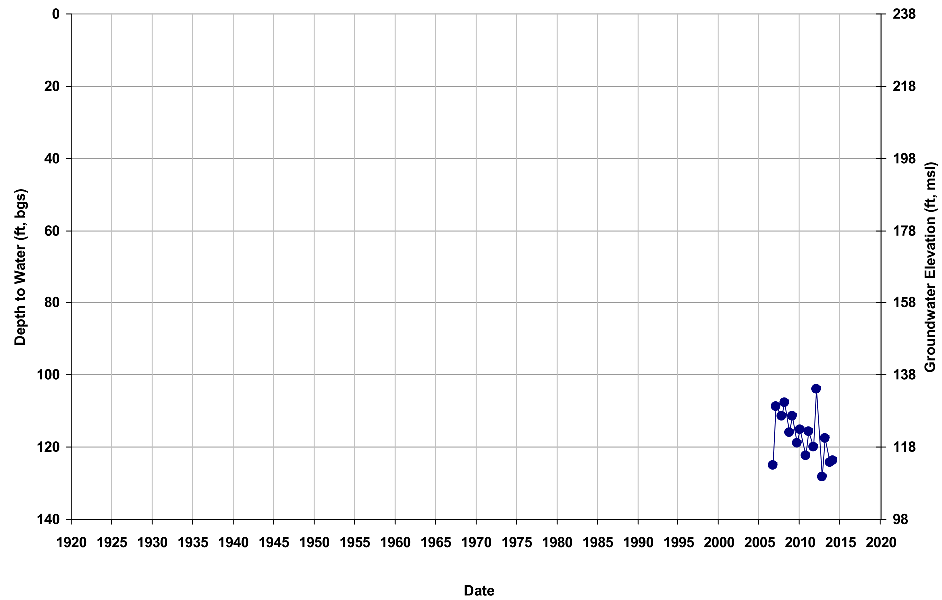
Well ID: 12S17E14F001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 242
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



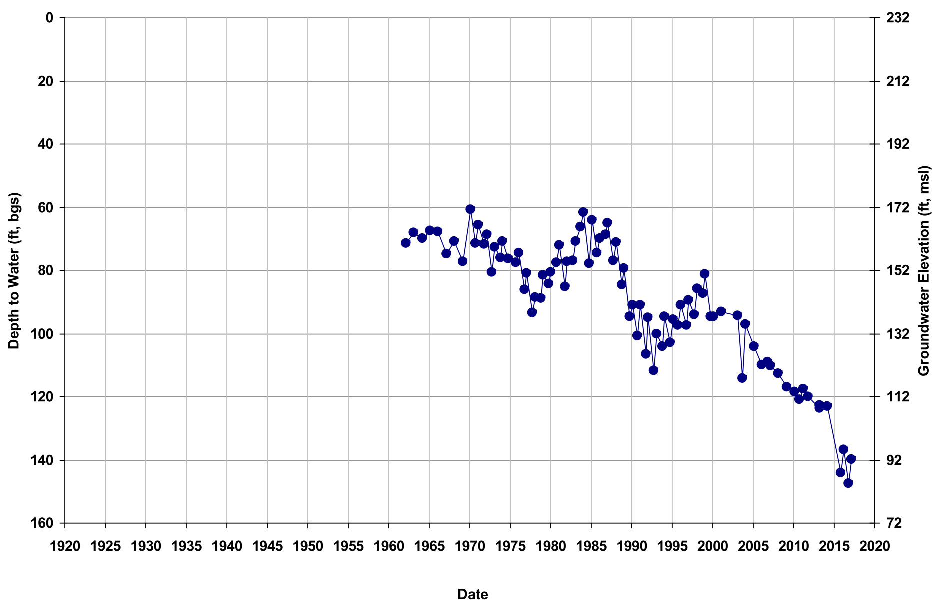
Well ID: 12S17E15J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 237
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



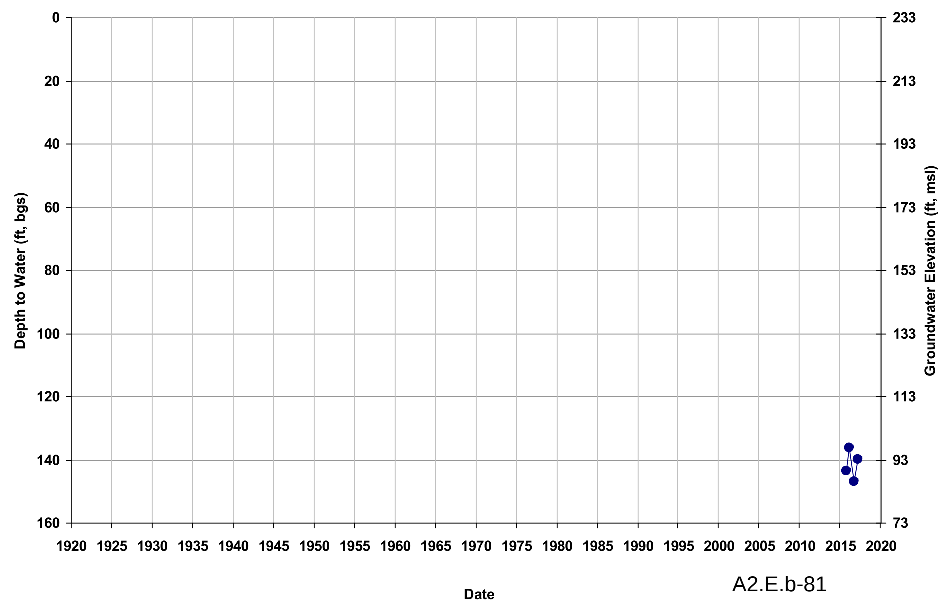
Well ID: 12S17E16A002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 232
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



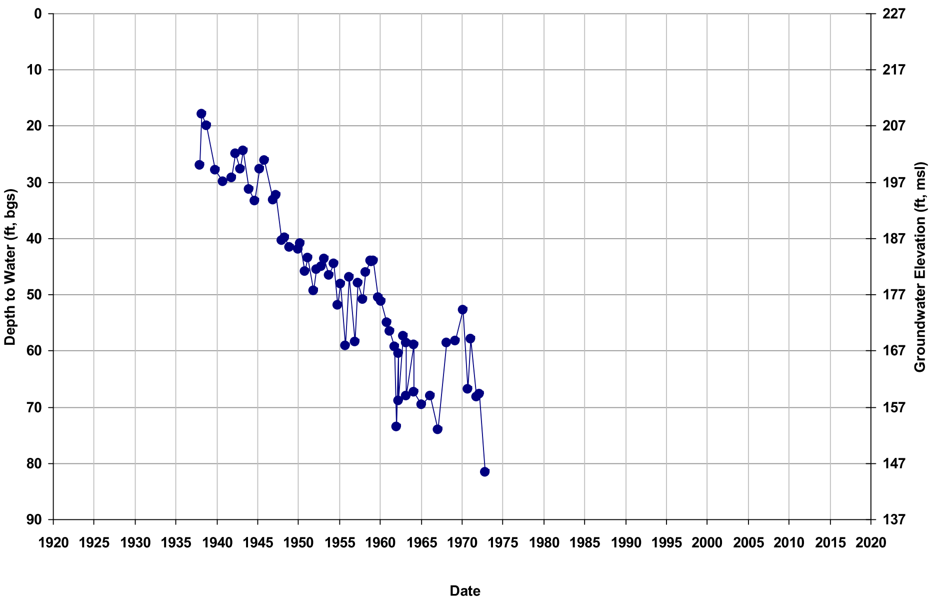
Well ID: 12S17E16A003M
Depth Zone: Composite or Lower; O
Subbasin: Madera

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



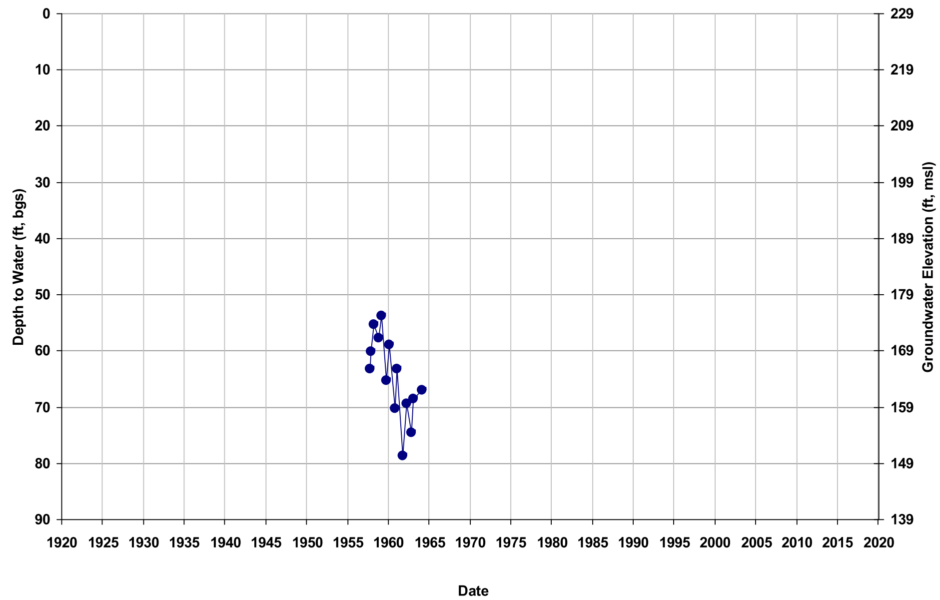
Well ID: 12S17E16D001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 227
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



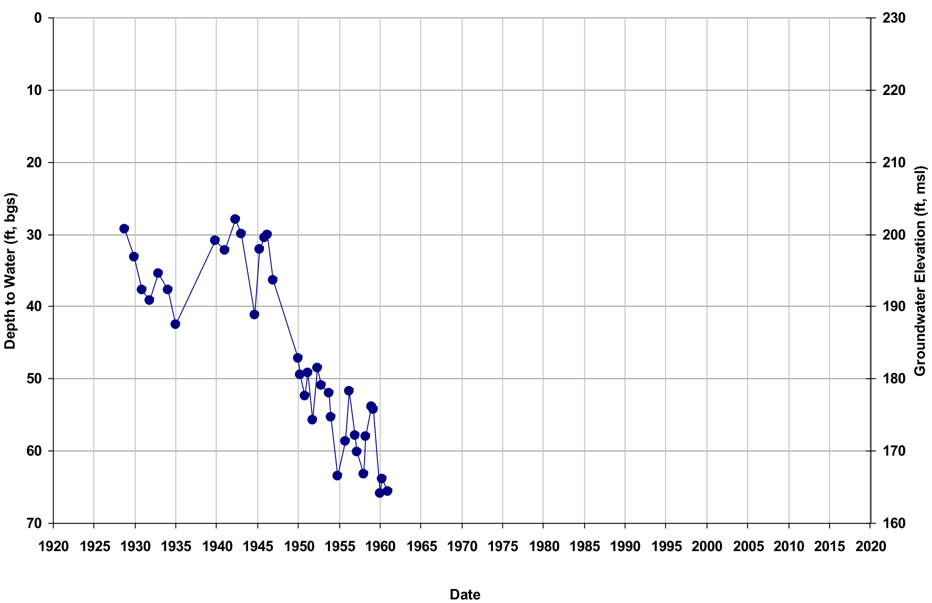
Well ID: 12S17E16D002M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 229
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



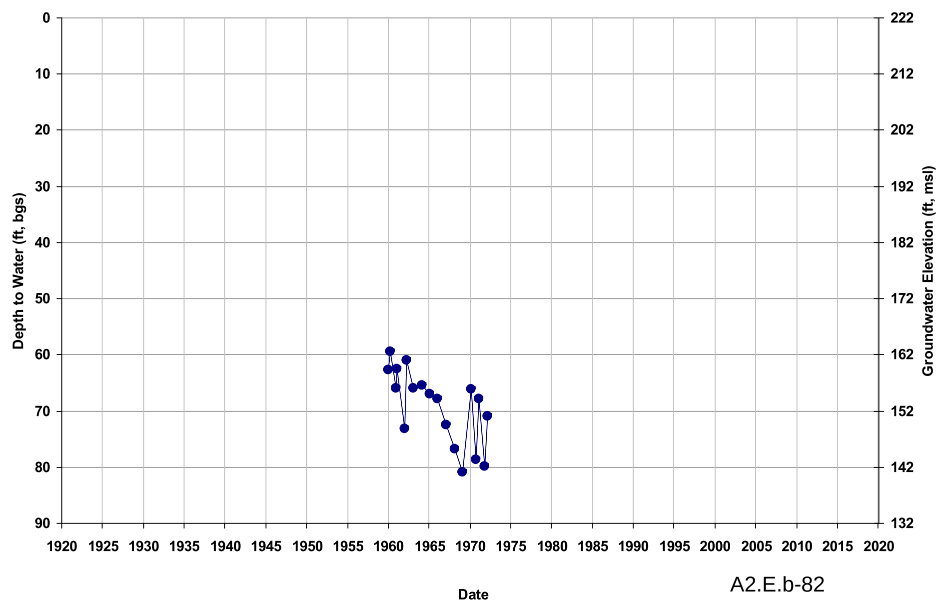
Well ID: 12S17E16H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 230
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



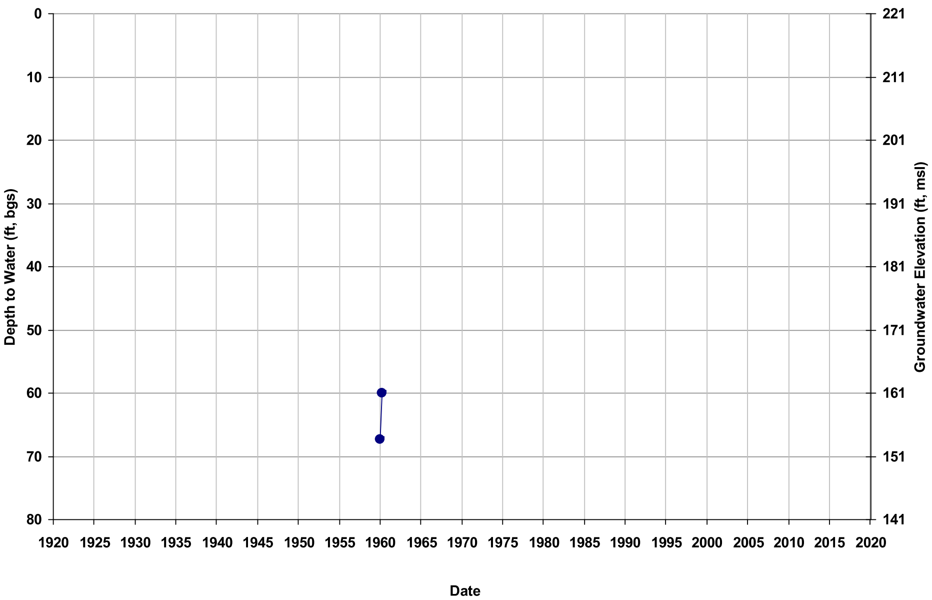
Well ID: 12S17E17M001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 222
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



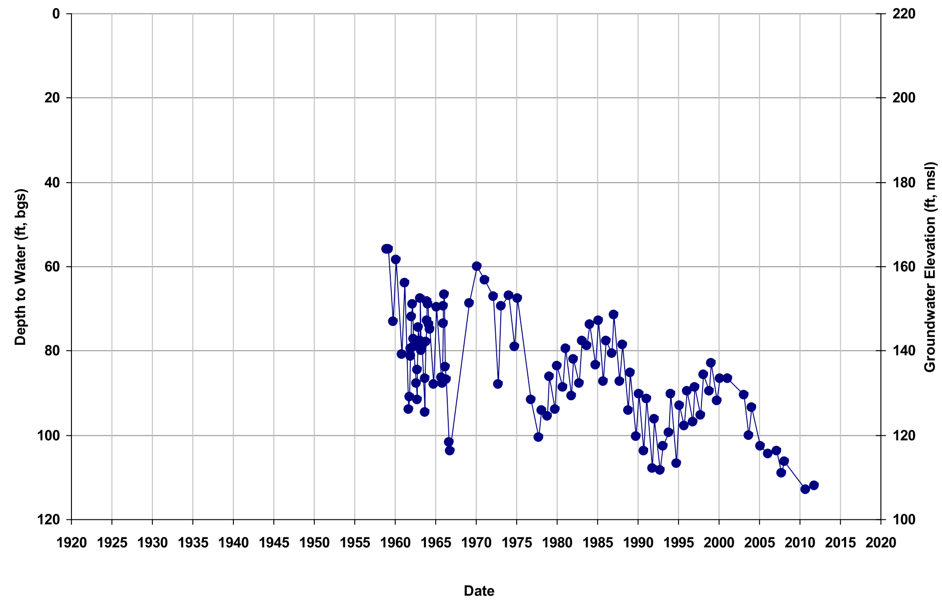
Well ID: 12S17E20A001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 221
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



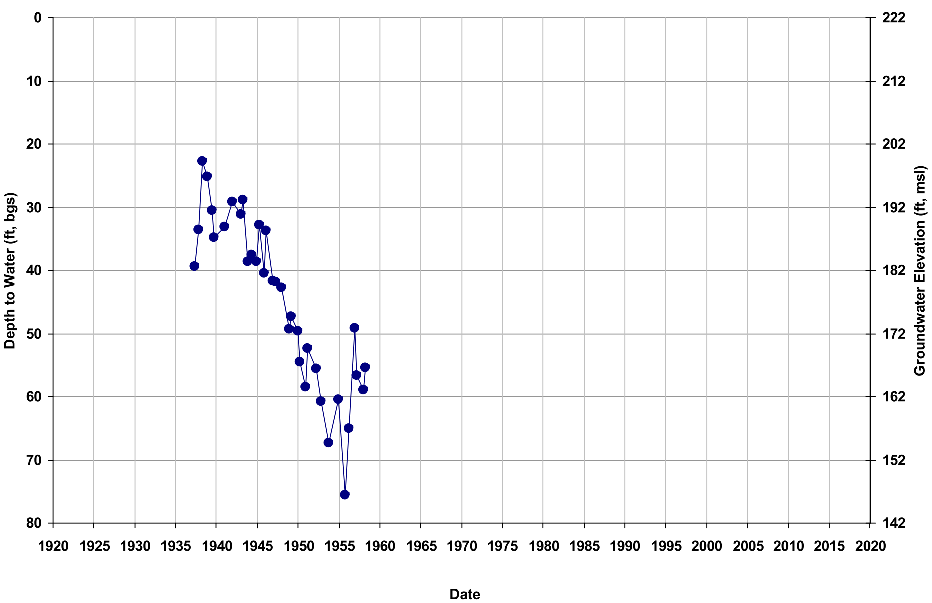
Well ID: 12S17E20P001M
Depth Zone: Upper; Within CC
Subbasin: Madera

GSE (ft, msl): 220
Total Depth (ft): 252
Perf Top (ft): NA
Perf Bottom (ft): NA



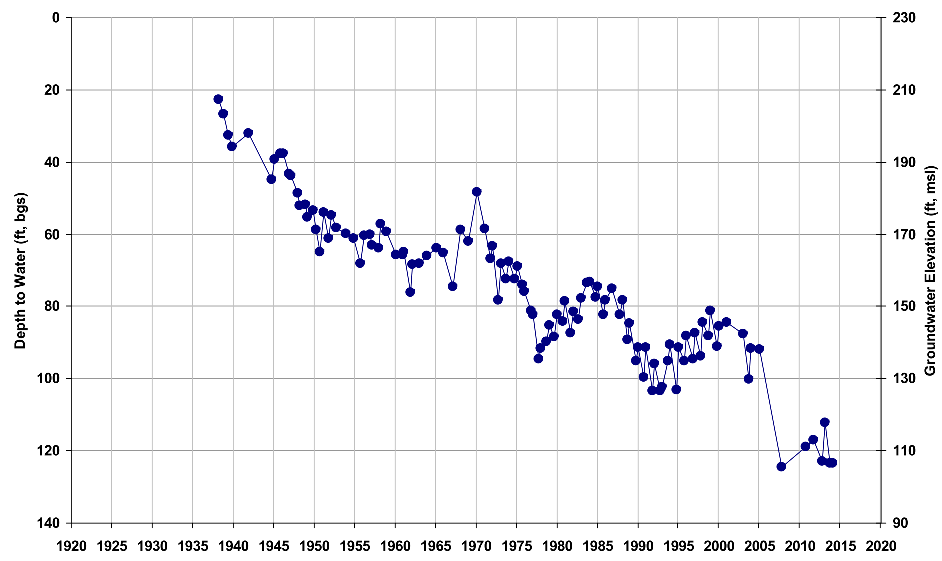
Well ID: 12S17E20Q001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 221
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



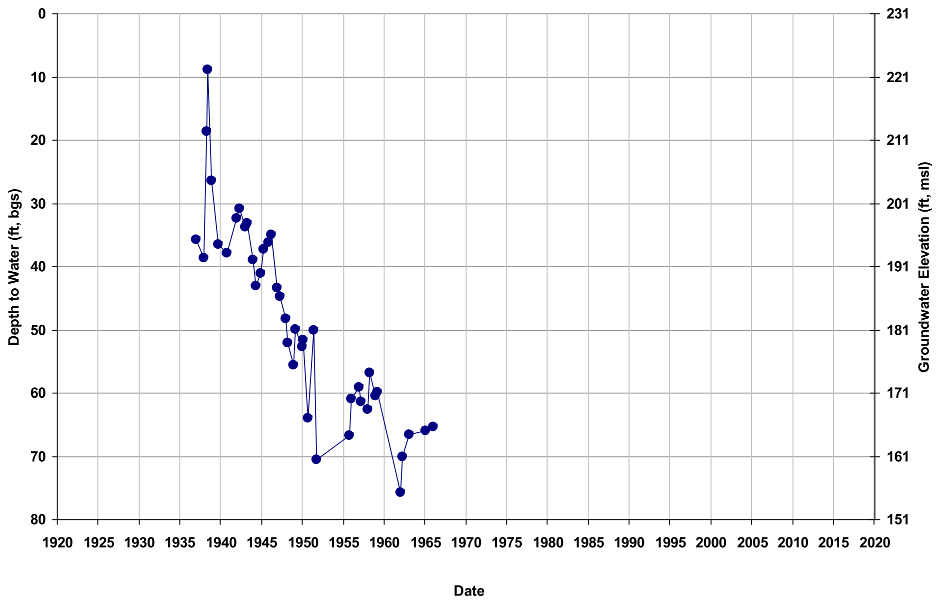
Well ID: 12S17E21H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 230
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



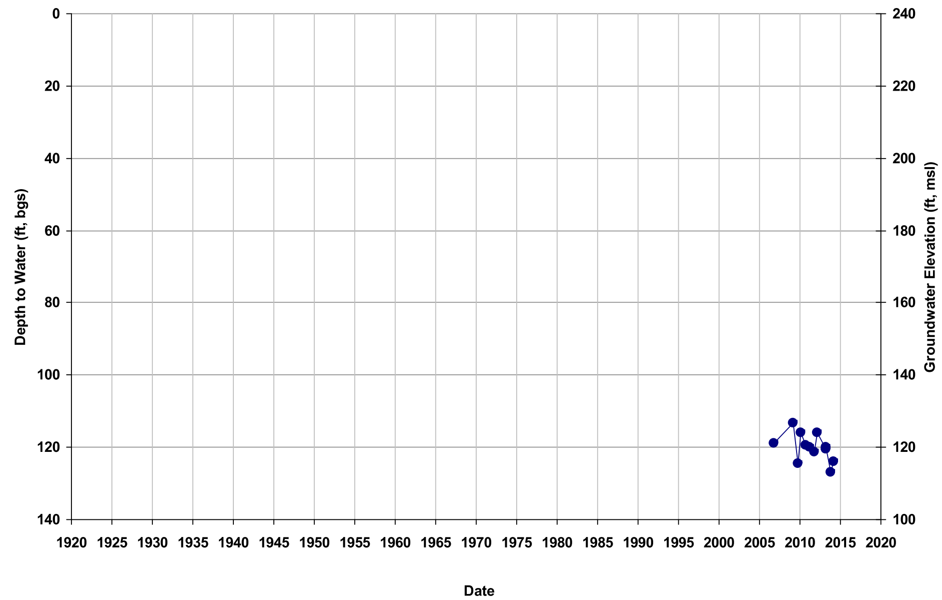
Well ID: 12S17E21J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 231
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



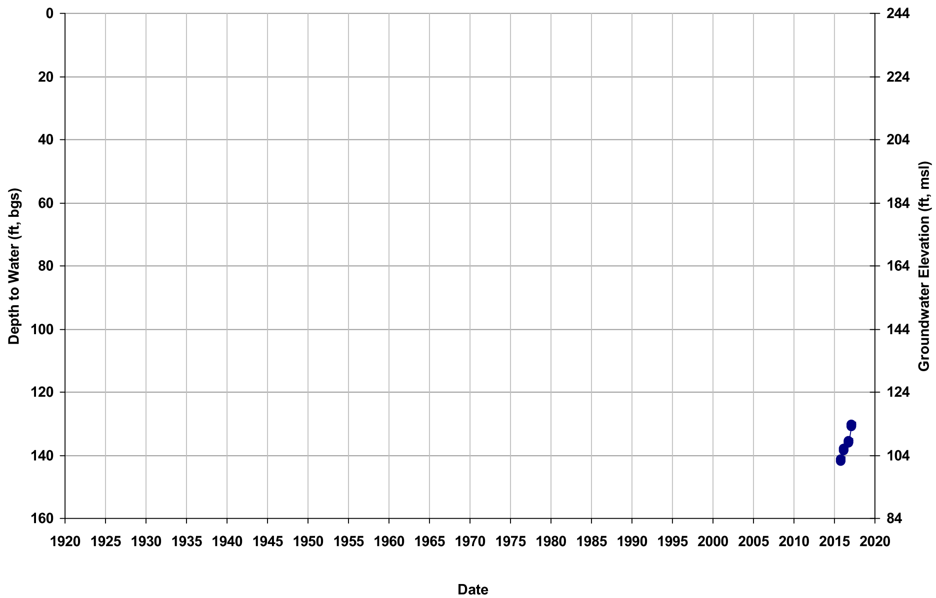
Well ID: 12S17E23C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 239
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



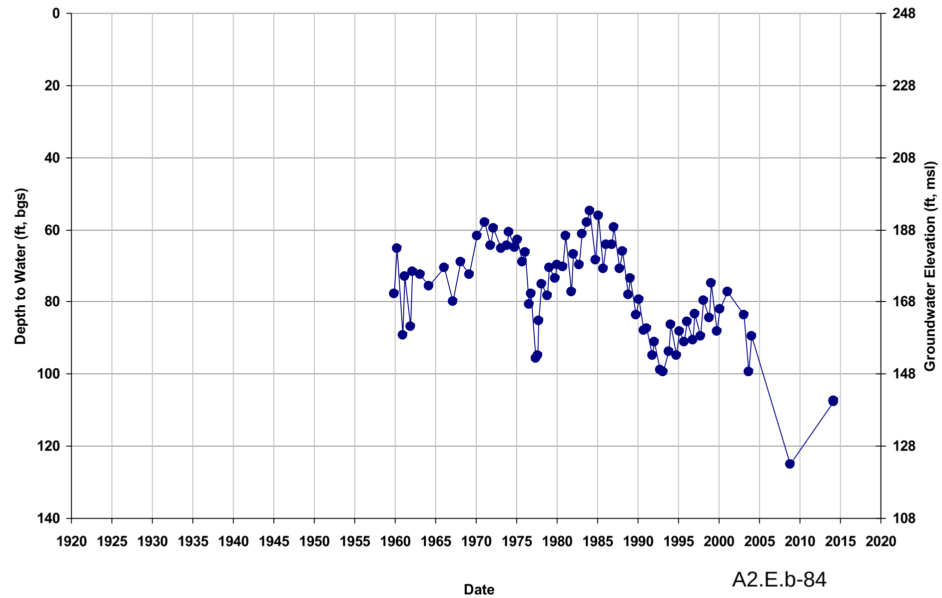
Well ID: 12S17E24D001M
Depth Zone: Composite; Outside CC
Subbasin: Madera

GSE (ft, msl): 244
Total Depth (ft): 510
Perf Top (ft): 240
Perf Bottom (ft): 510



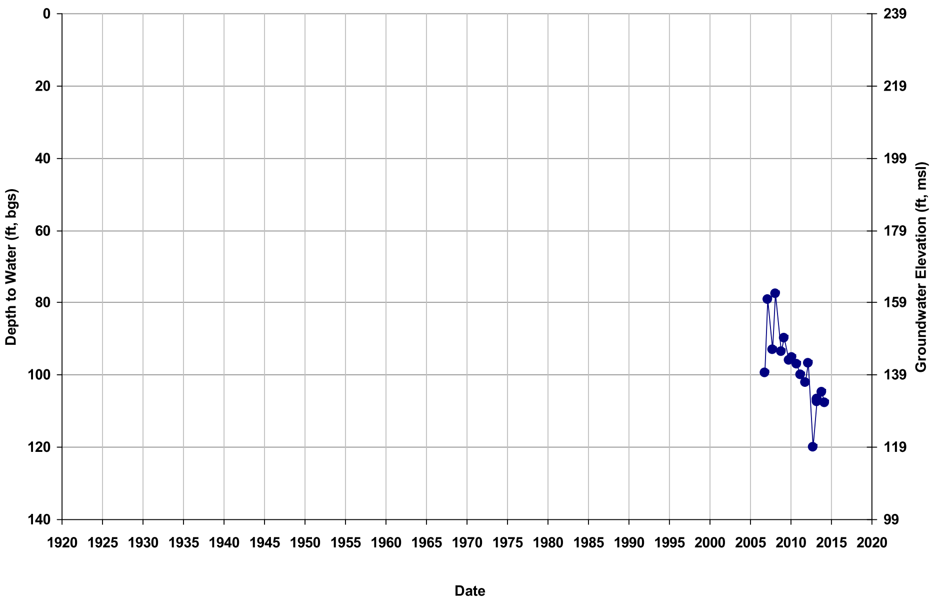
Well ID: 12S17E24H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 248
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



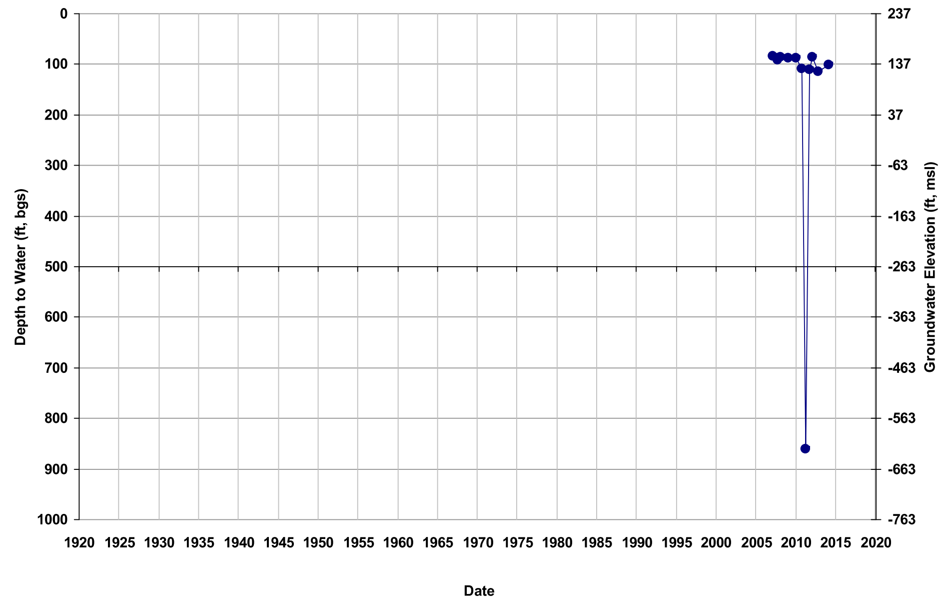
Well ID: 12S17E26A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 239
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



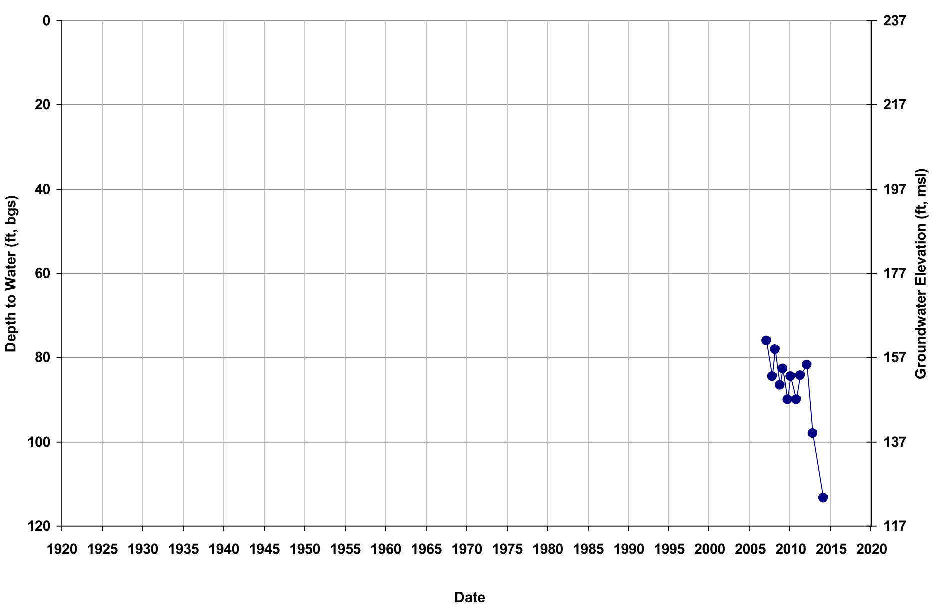
Well ID: 12S17E26C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 237
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



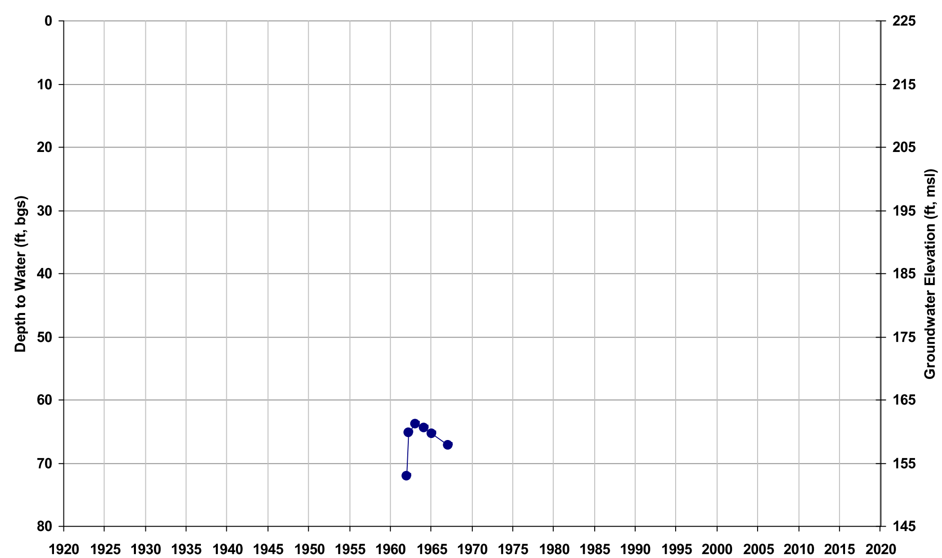
Well ID: 12S17E26N001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 236
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



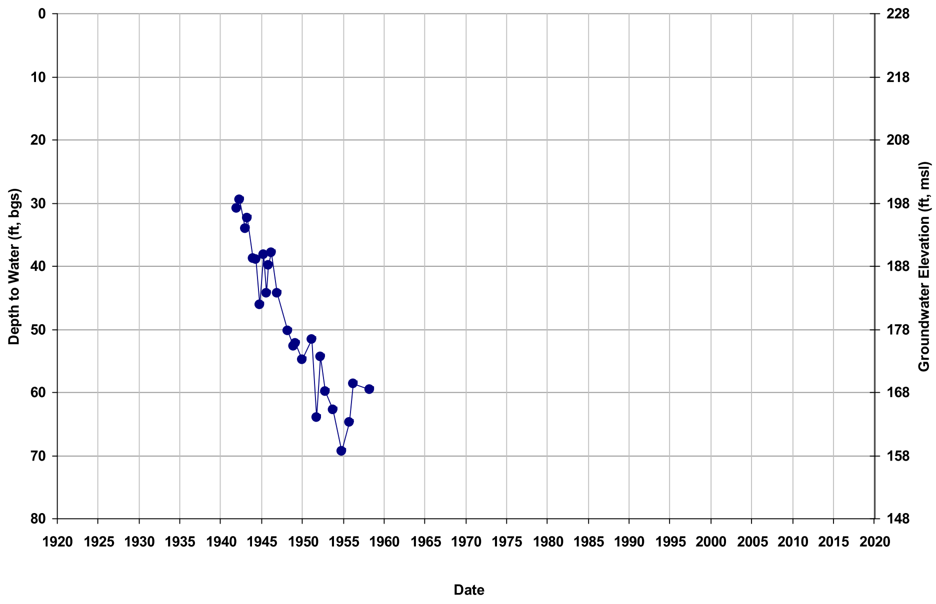
Well ID: 12S17E28G001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 225
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



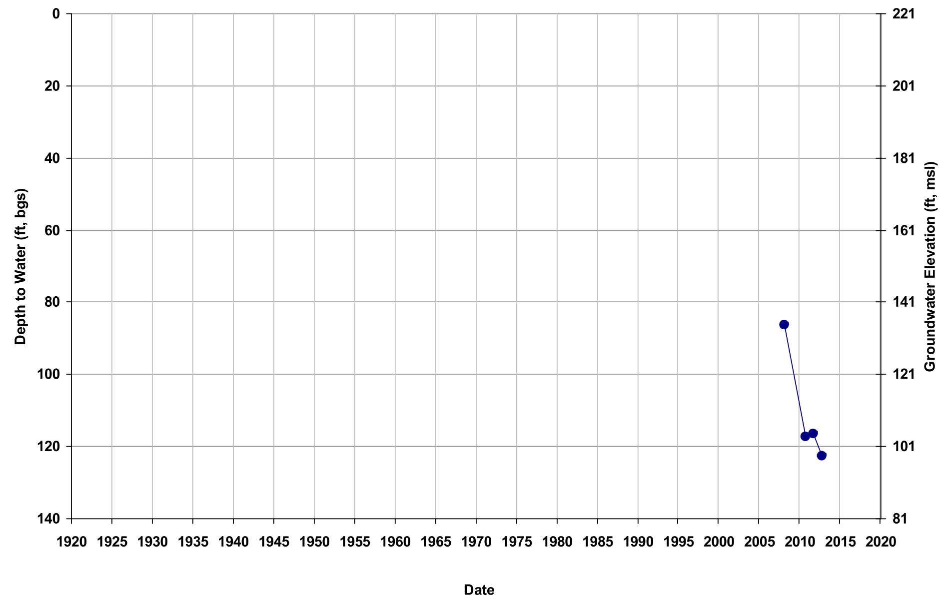
Well ID: 12S17E28H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 227
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



Well ID: 12S17E29H002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 220
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

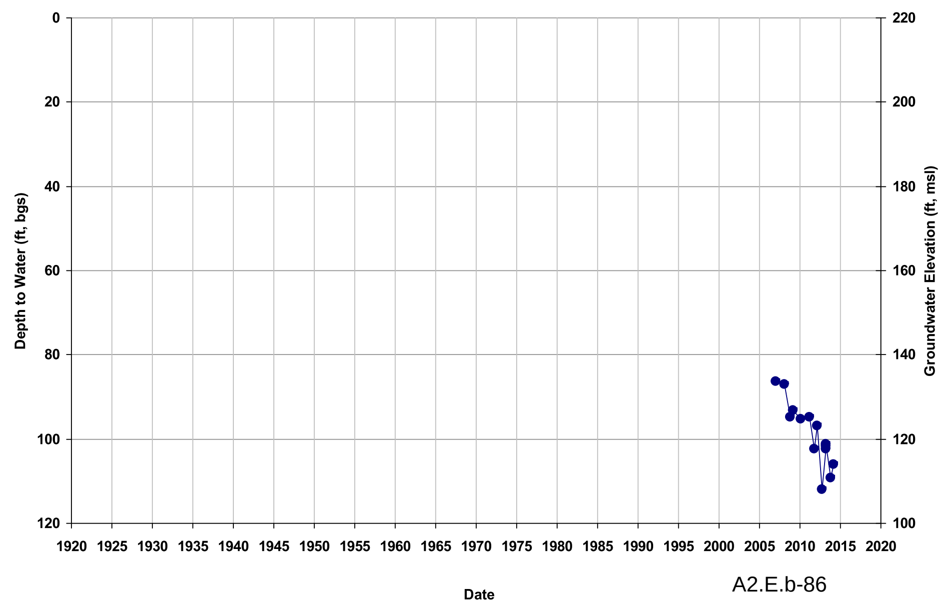


Well ID: 12S17E31A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 213
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

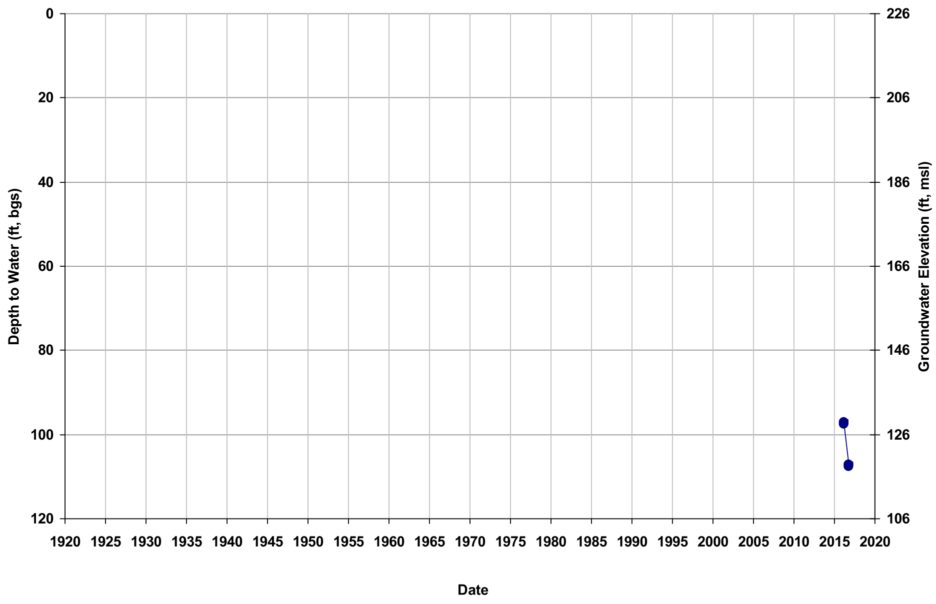
Well ID: 12S17E32H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 219
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



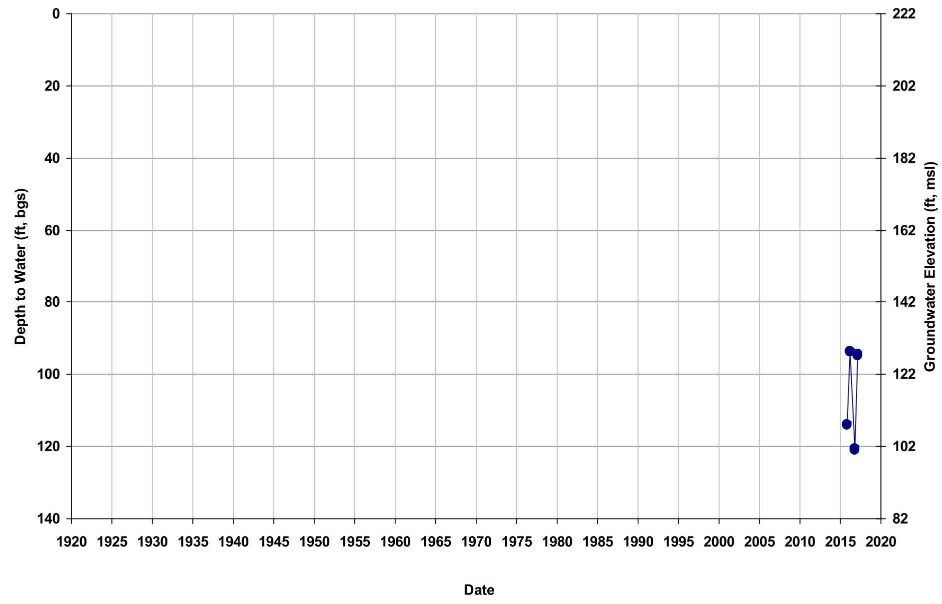
Well ID: 12S17E33K001M
Depth Zone: Upper; Outside CC
Subbasin: Madera

GSE (ft, msl): 225
Total Depth (ft): 247
Perf Top (ft): NA
Perf Bottom (ft): NA



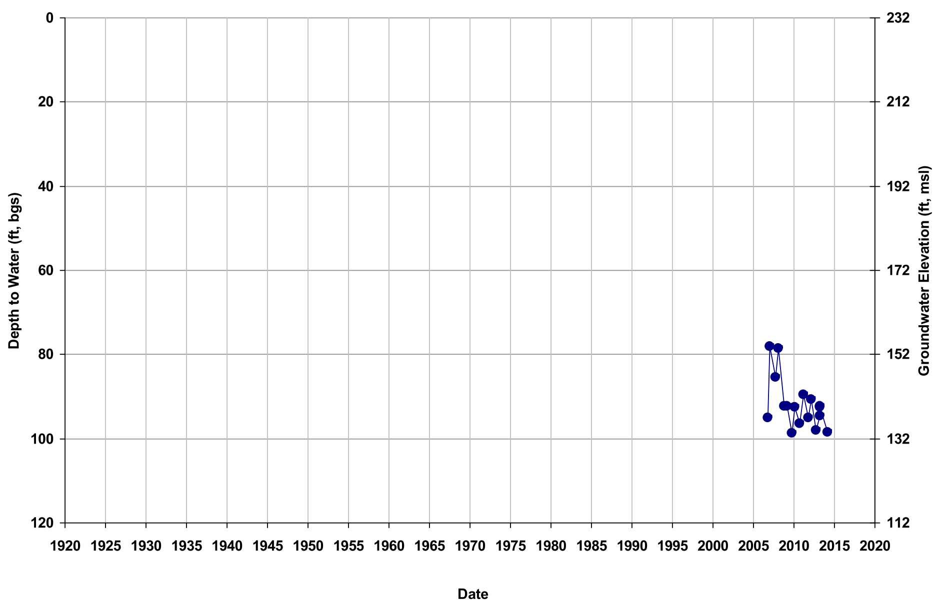
Well ID: 12S17E33N001M
Depth Zone: Composite; Outside CC
Subbasin: Madera

GSE (ft, msl): 222
Total Depth (ft): 580
Perf Top (ft): 230
Perf Bottom (ft): 580



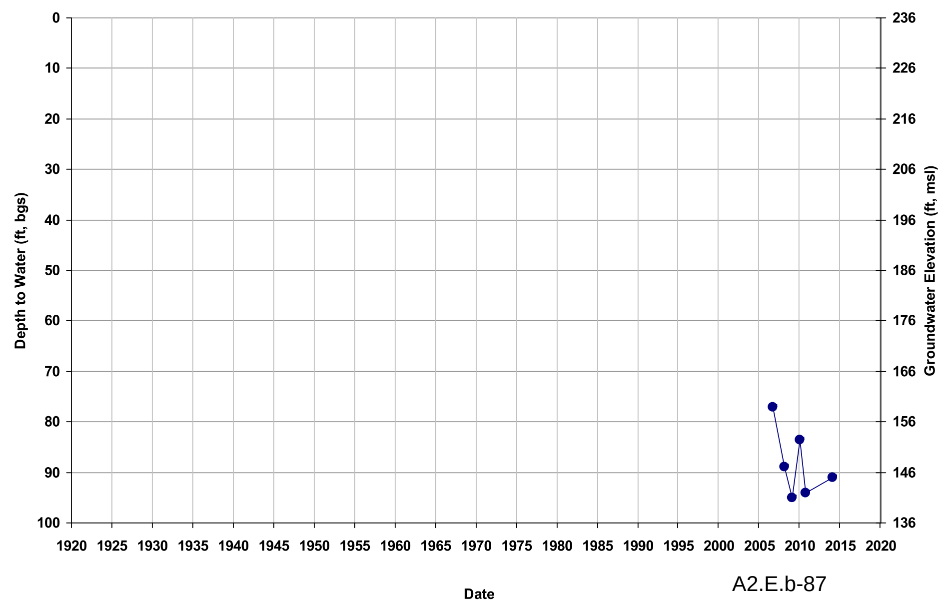
Well ID: 12S17E34A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 232
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



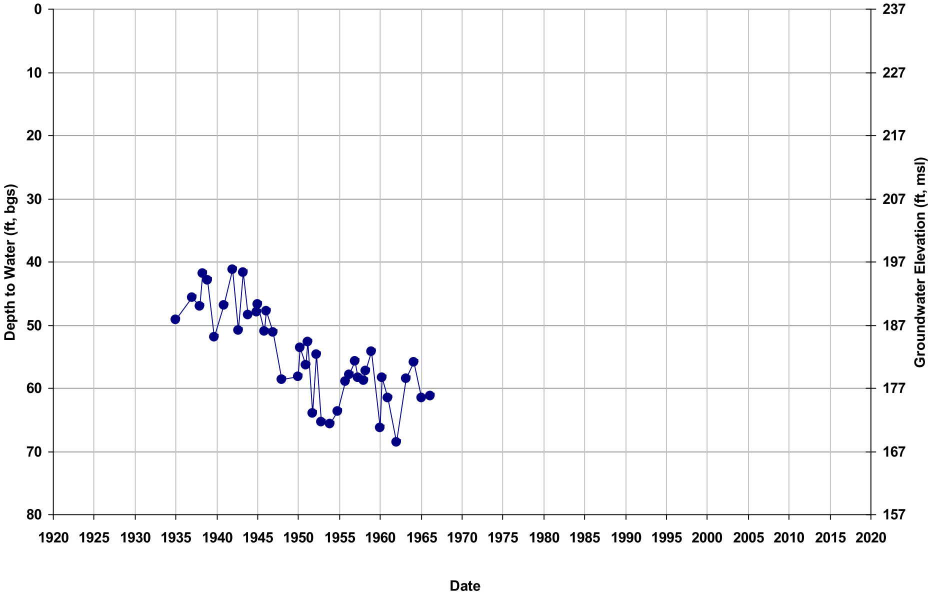
Well ID: 12S17E34R001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 236
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



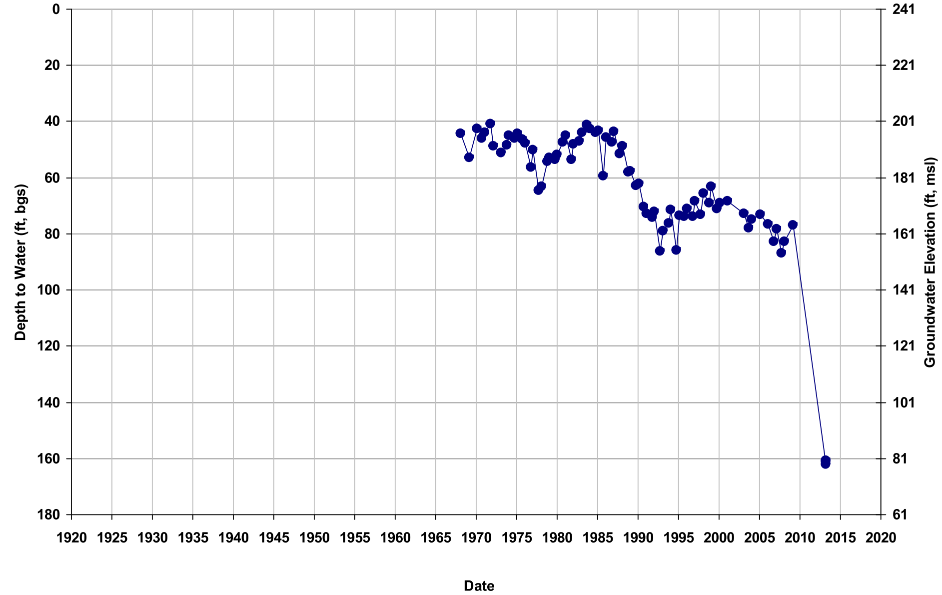
Well ID: 12S17E35B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 236
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



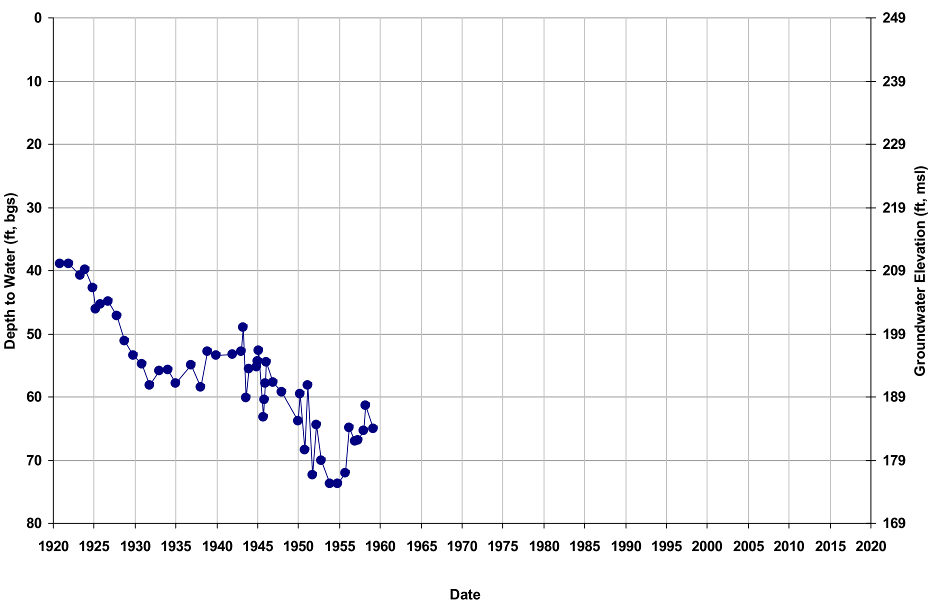
Well ID: 12S17E35R001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 241
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



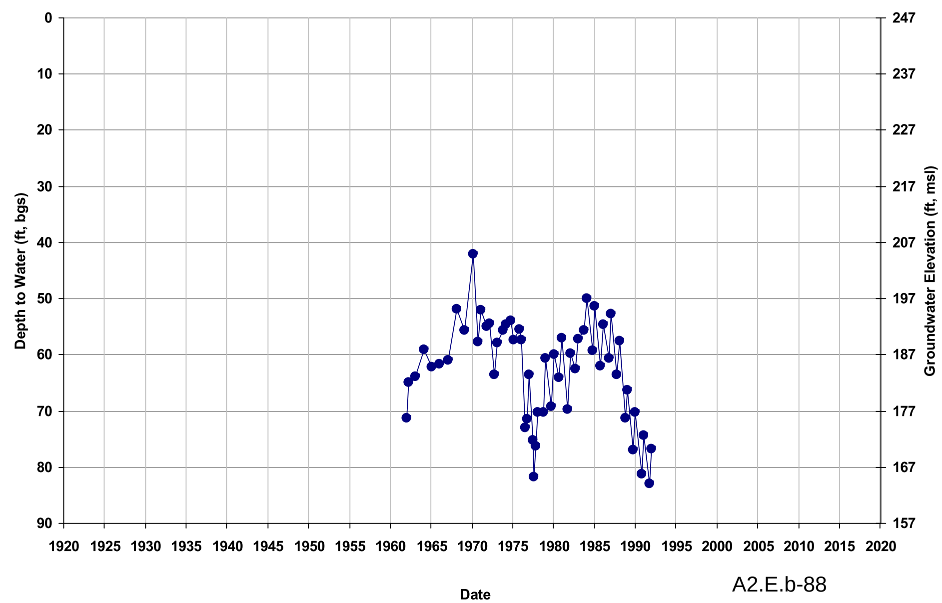
Well ID: 12S17E36A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 248
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



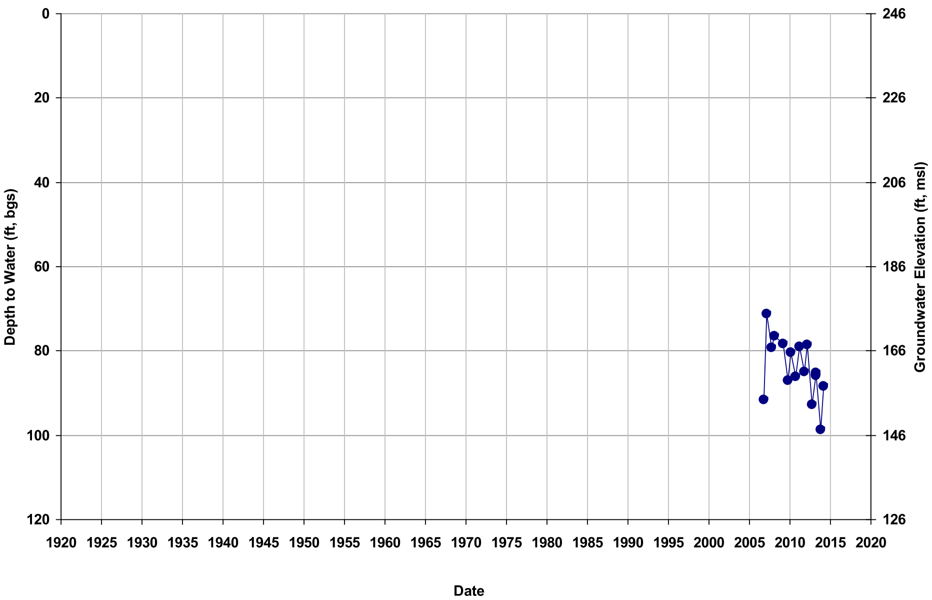
Well ID: 12S17E36B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 247
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



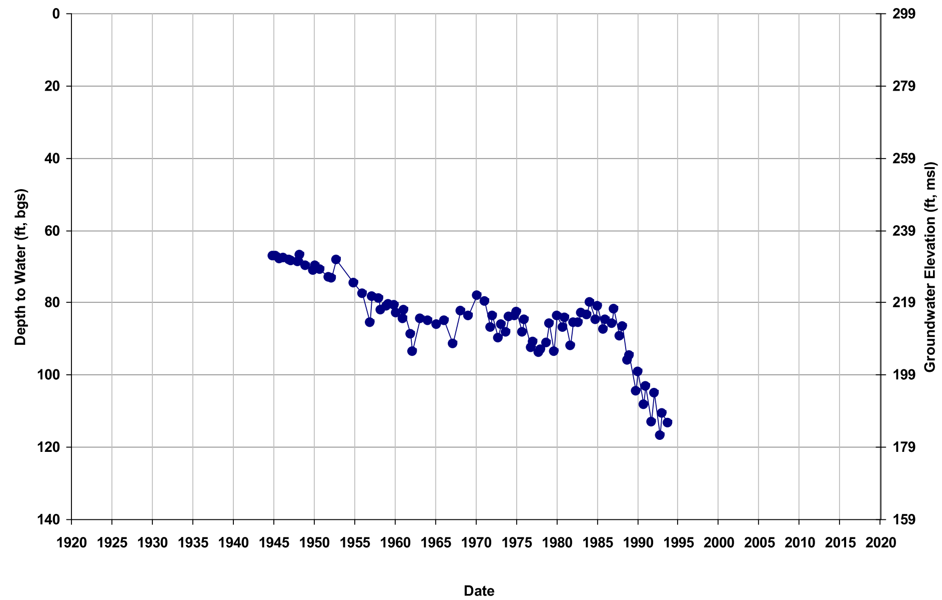
Well ID: 12S17E36K001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 246
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



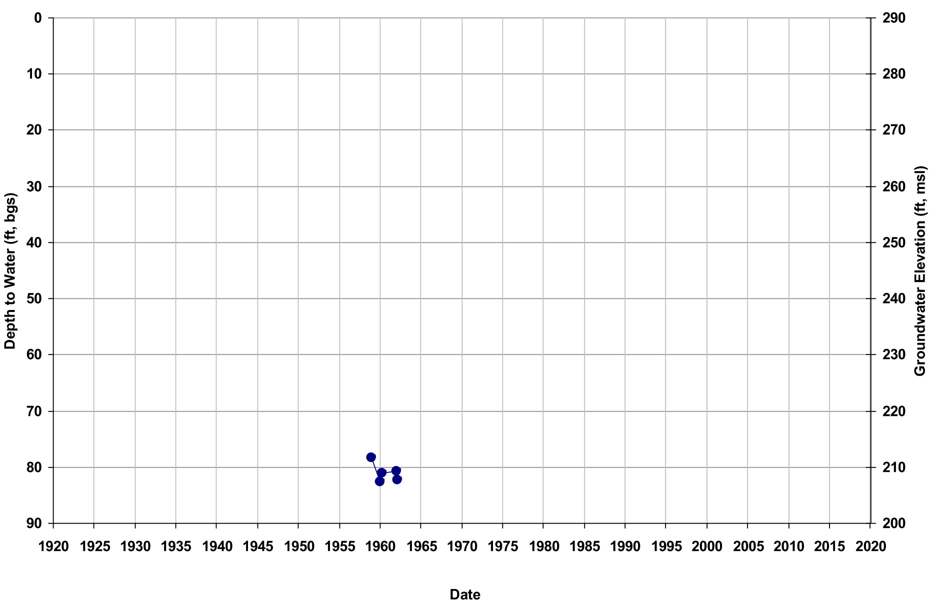
Well ID: 12S18E01A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 299
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



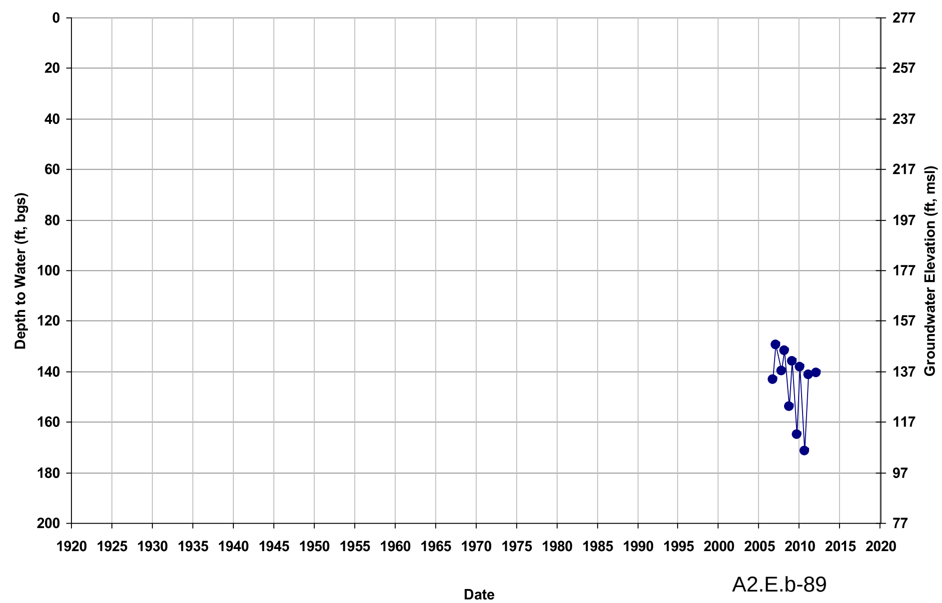
Well ID: 12S18E01P001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 290
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



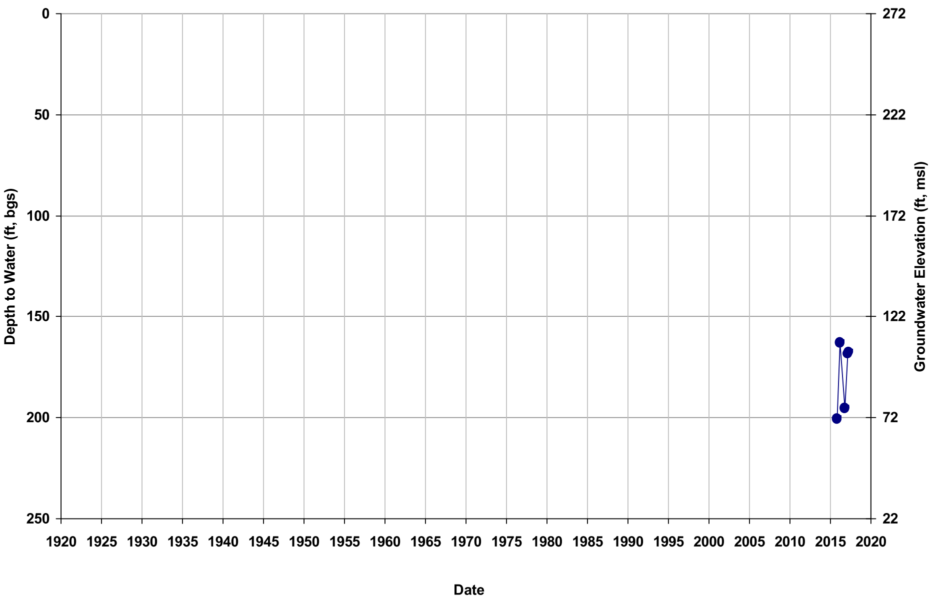
Well ID: 12S18E03D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 276
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



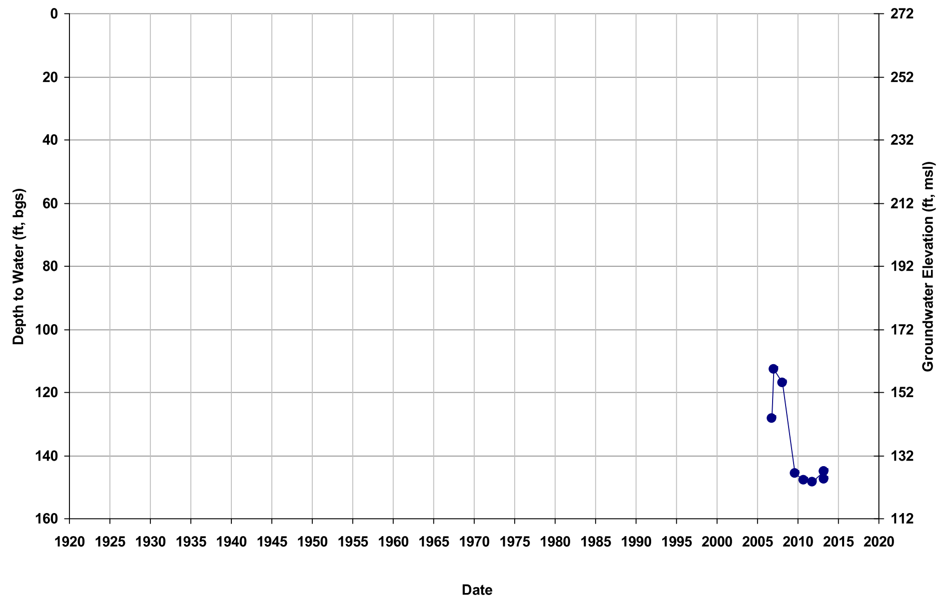
Well ID: 12S18E04J001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 272
Total Depth (ft): 560
Perf Top (ft): 272
Perf Bottom (ft): 556



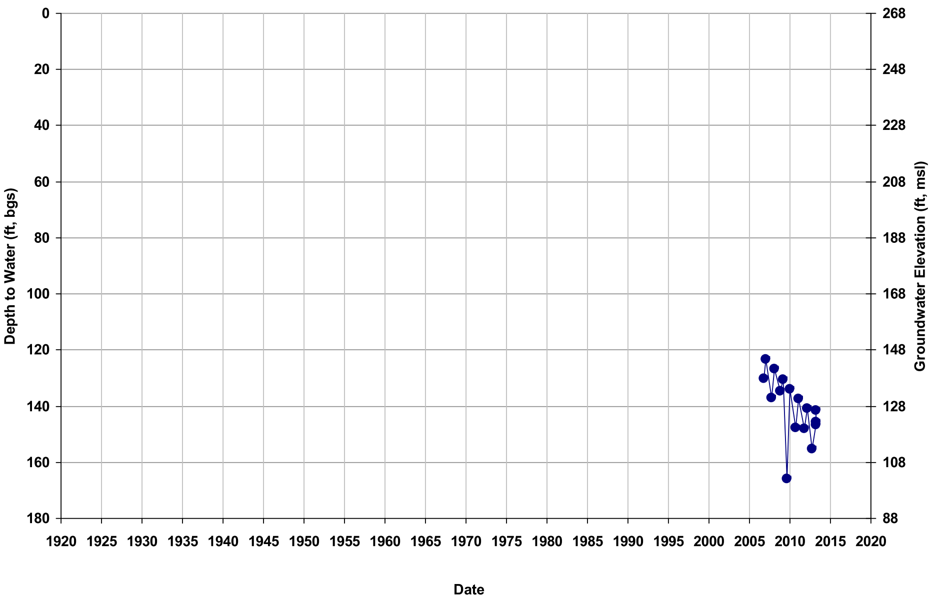
Well ID: 12S18E04L001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 271
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



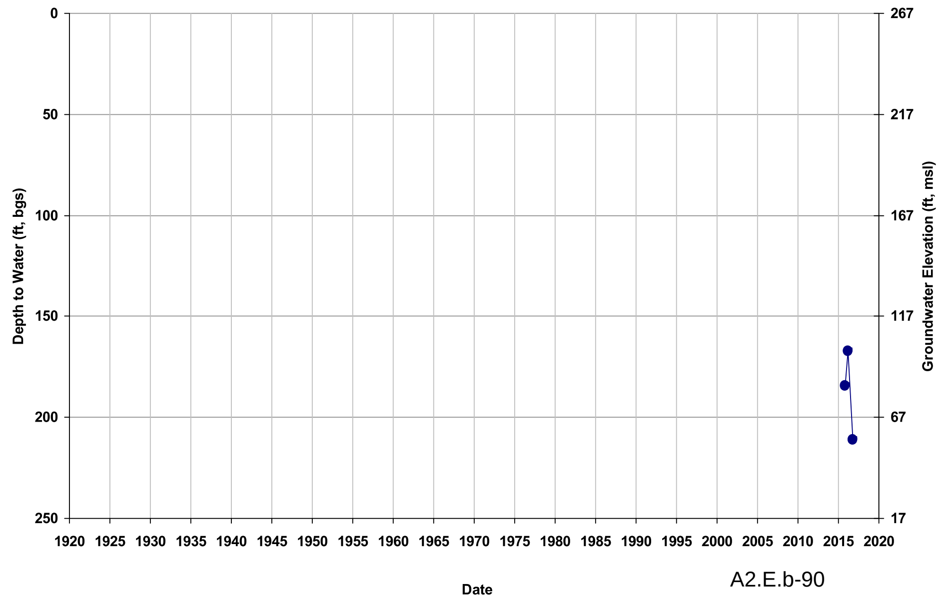
Well ID: 12S18E05A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

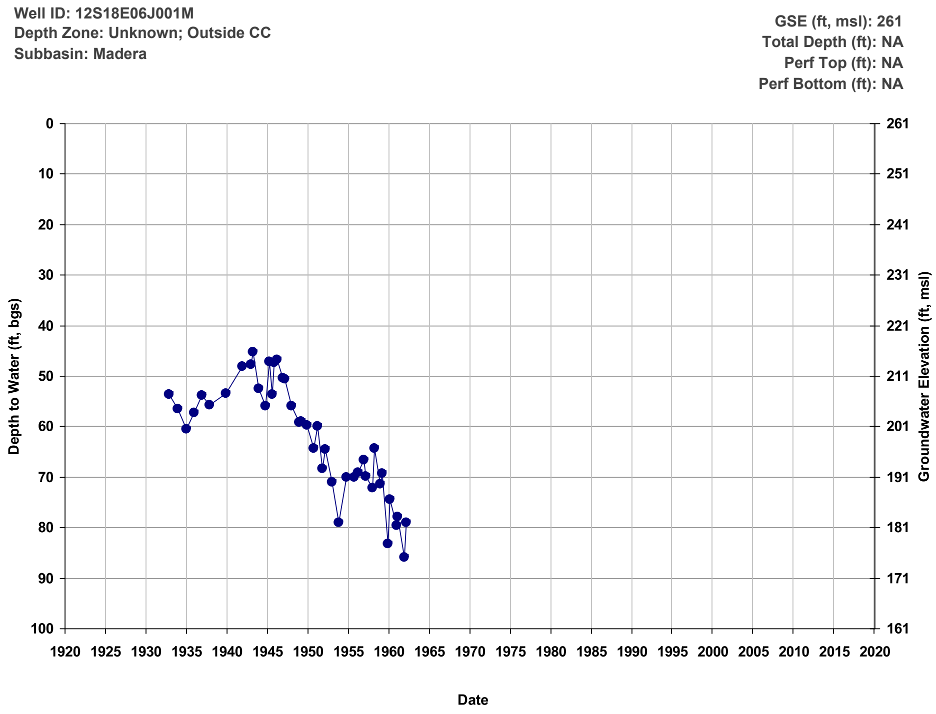
GSE (ft, msl): 268
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



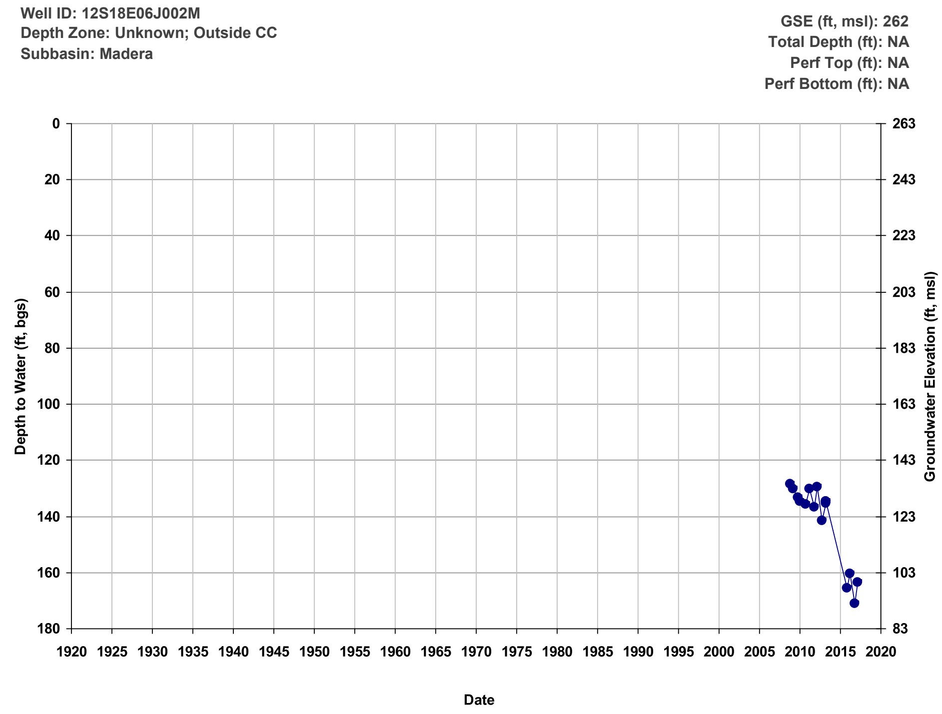
Well ID: 12S18E05F001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 267
Total Depth (ft): 570
Perf Top (ft): 240
Perf Bottom (ft): 570

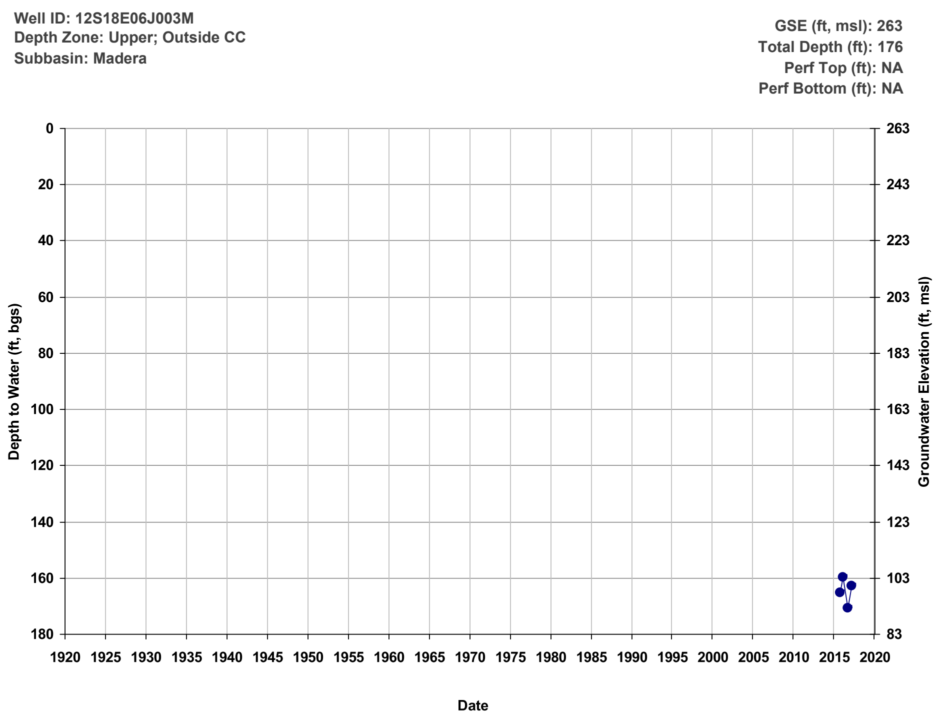




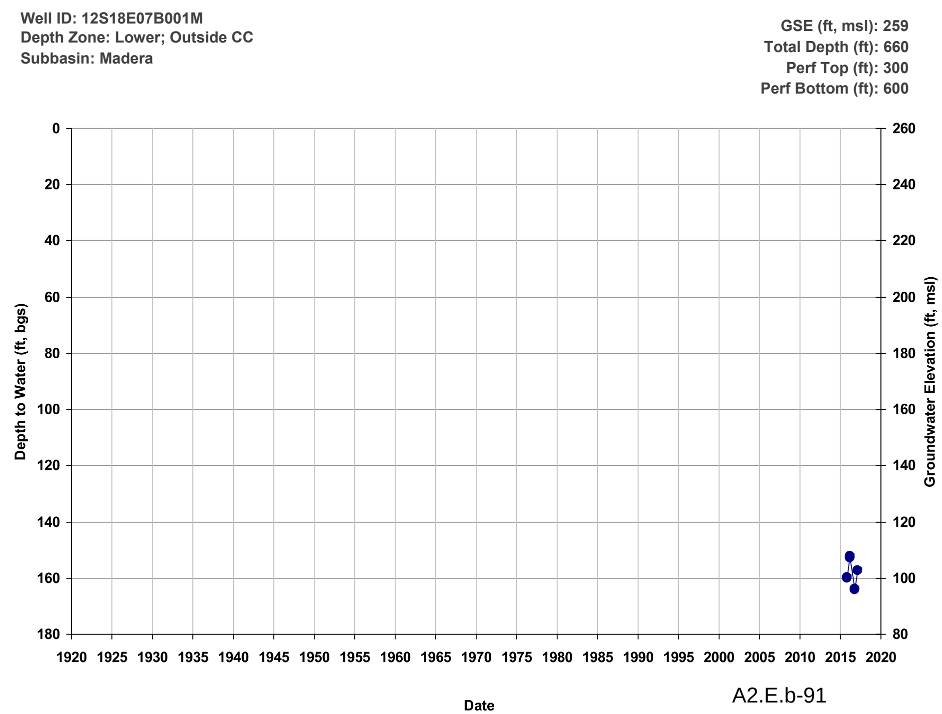
Well ID: 12S18E06J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 261
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



Well ID: 12S18E06J002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 262
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



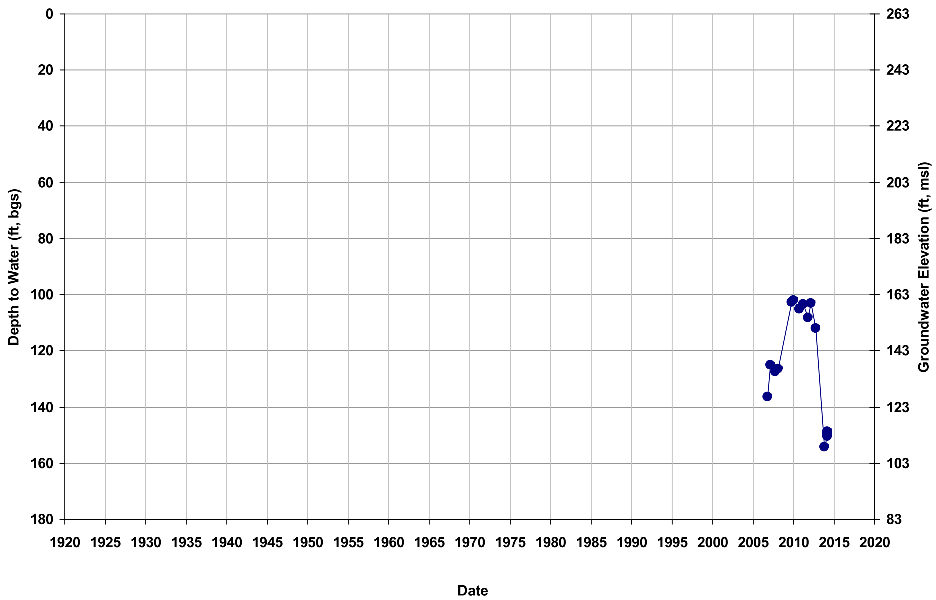
Well ID: 12S18E06J003M
Depth Zone: Upper; Outside CC
Subbasin: Madera
GSE (ft, msl): 263
Total Depth (ft): 176
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



Well ID: 12S18E07B001M
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 259
Total Depth (ft): 660
Perf Top (ft): 300
Perf Bottom (ft): 600
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

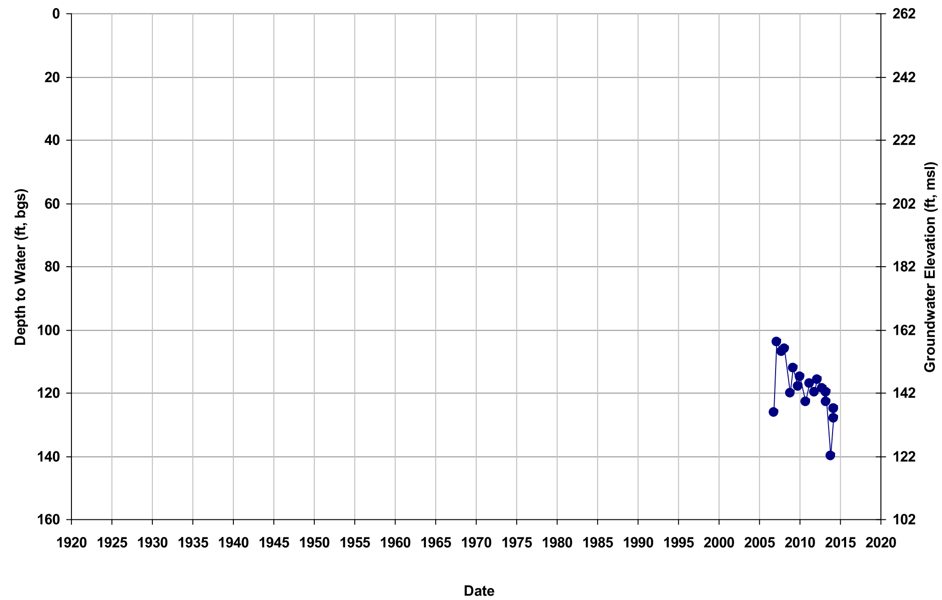
Well ID: 12S18E07H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 263
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



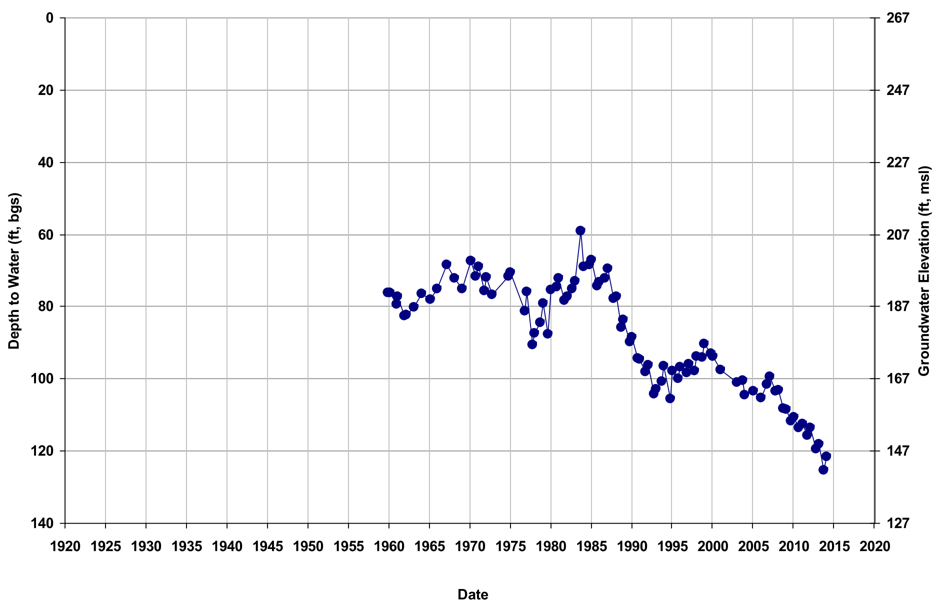
Well ID: 12S18E08Q001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 262
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



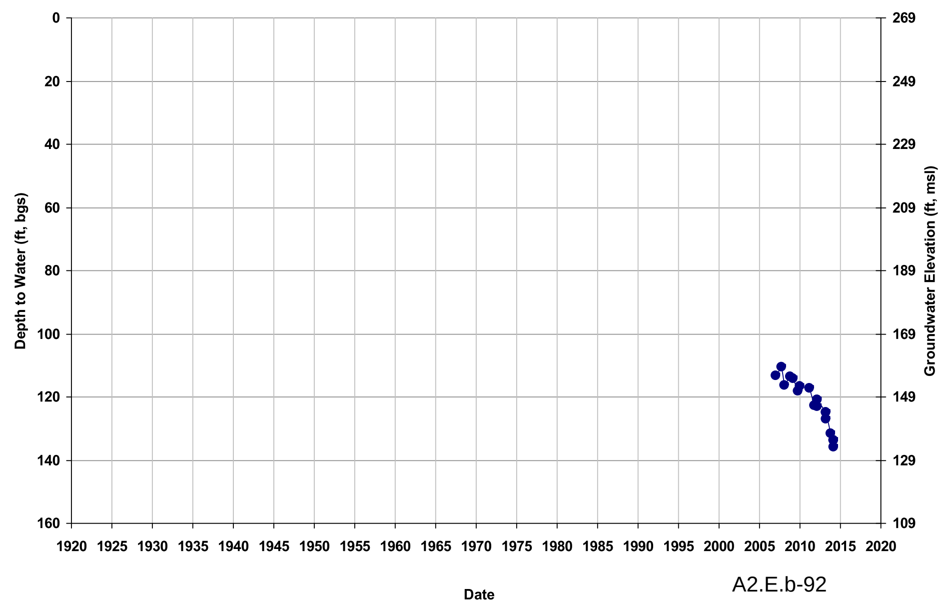
Well ID: 12S18E09P001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 267
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



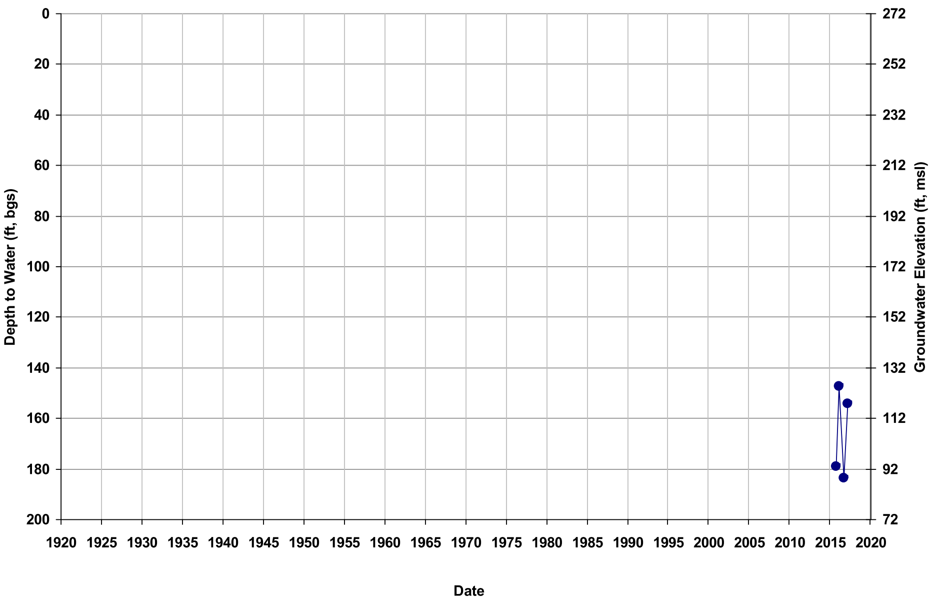
Well ID: 12S18E10D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 269
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



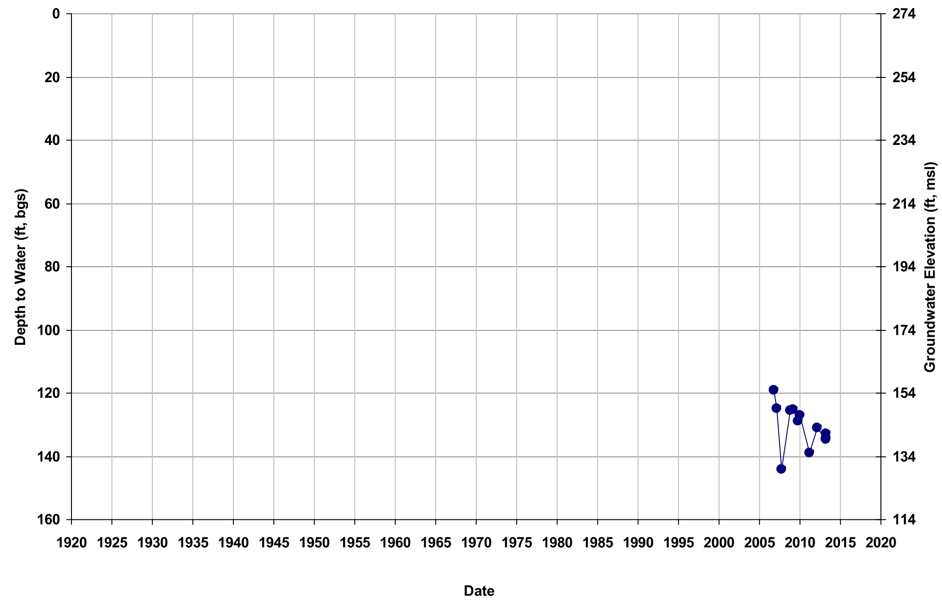
Well ID: 12S18E10K002M
Depth Zone: Lower; Outside CC
Subbasin: Madera

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



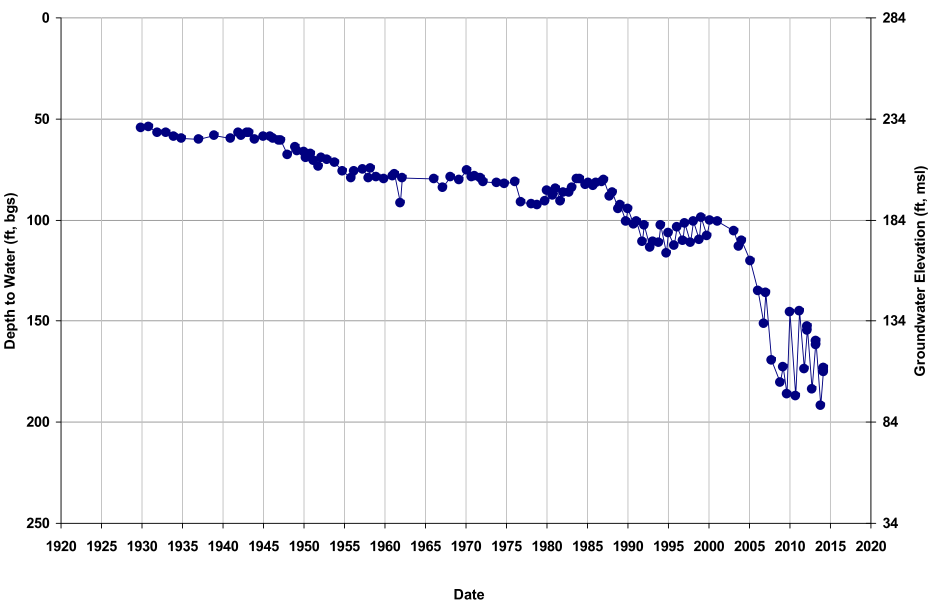
Well ID: 12S18E10R001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 273
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



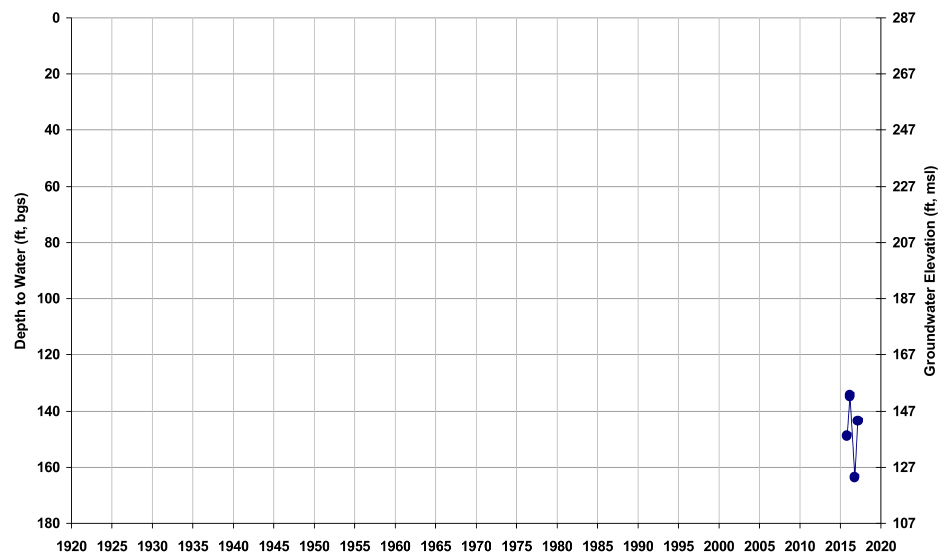
Well ID: 12S18E12N001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 284
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



Well ID: 12S18E13K001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

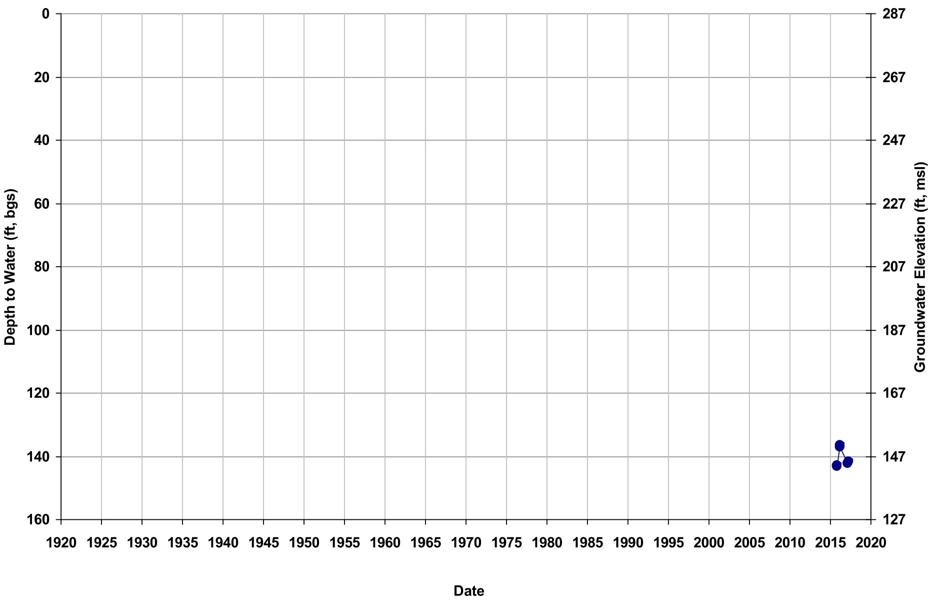
GSE (ft, msl): 287
Total Depth (ft): 600
Perf Top (ft): 320
Perf Bottom (ft): 600



Date

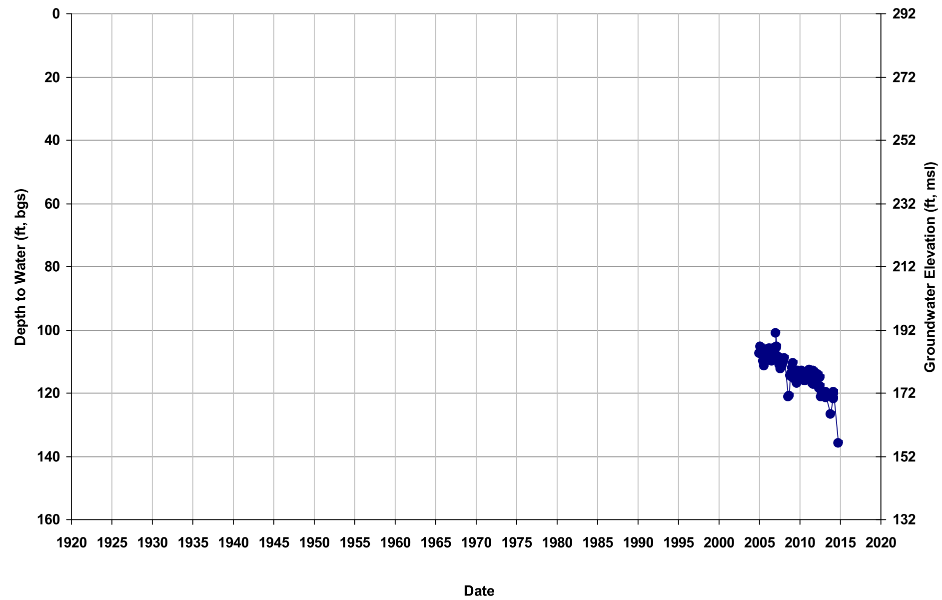
Well ID: 12S18E13L001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 287
Total Depth (ft): 510
Perf Top (ft): 240
Perf Bottom (ft): 510



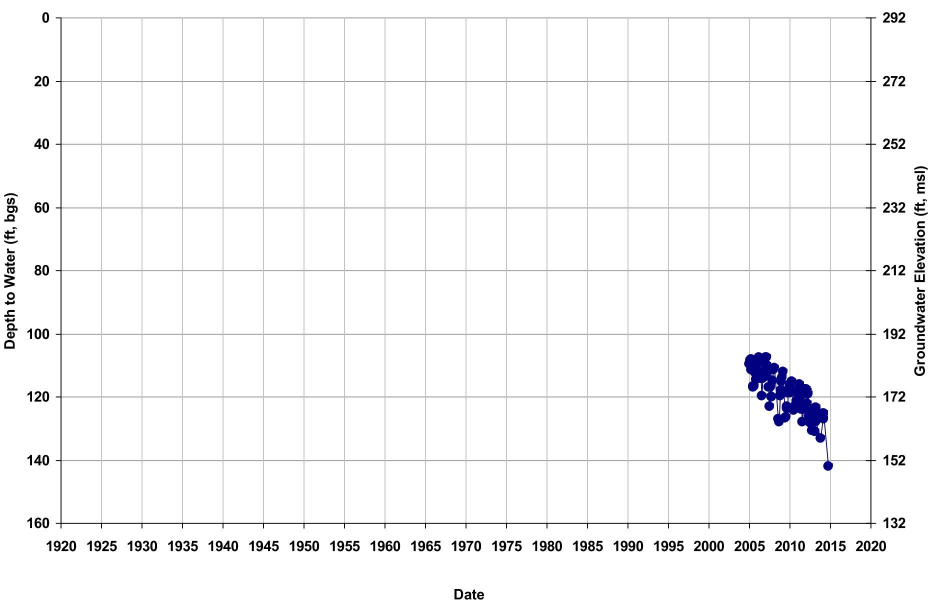
Well ID: 12S18E13R001M
Depth Zone: Upper; Outside CC
Subbasin: Madera

GSE (ft, msl): 292
Total Depth (ft): 205
Perf Top (ft): NA
Perf Bottom (ft): NA



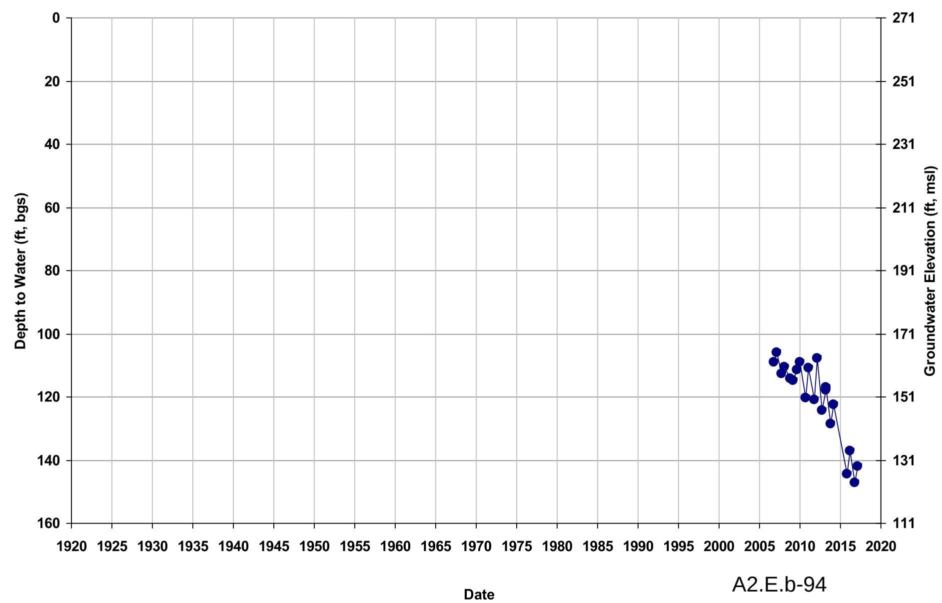
Well ID: 12S18E13R002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 292
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



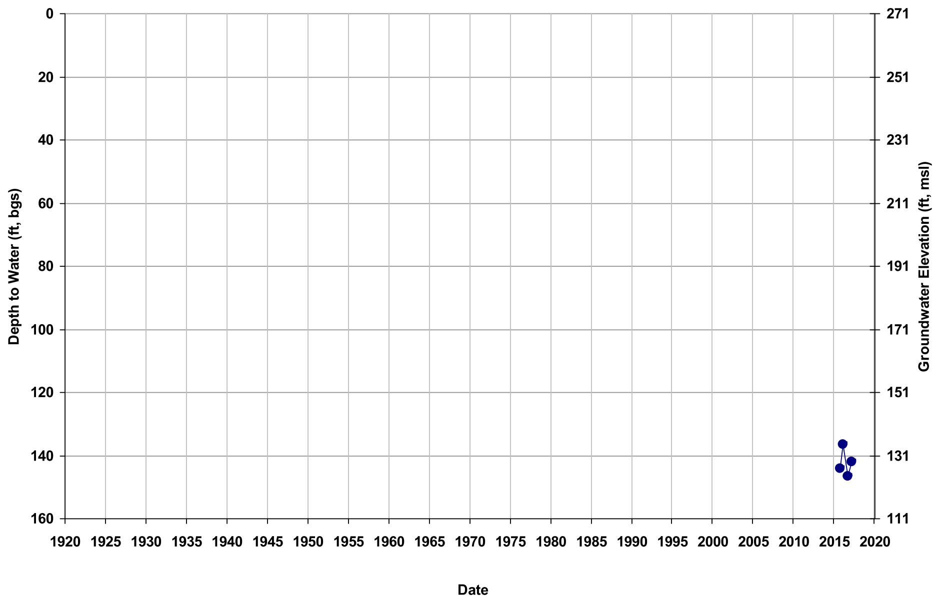
Well ID: 12S18E16A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 271
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



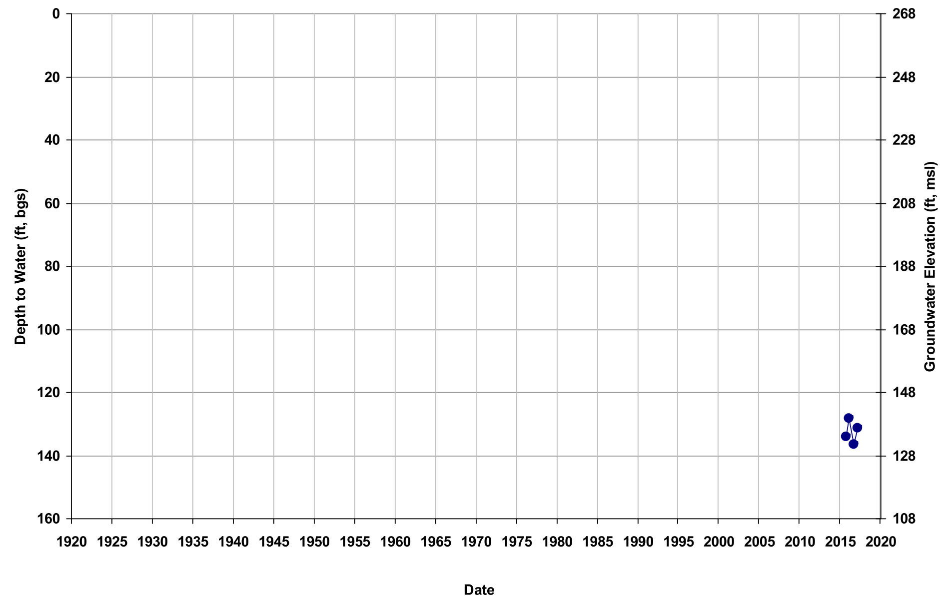
Well ID: 12S18E16A002M
Depth Zone: Upper; Outside CC
Subbasin: Madera

GSE (ft, msl): 271
Total Depth (ft): 200
Perf Top (ft): NA
Perf Bottom (ft): NA



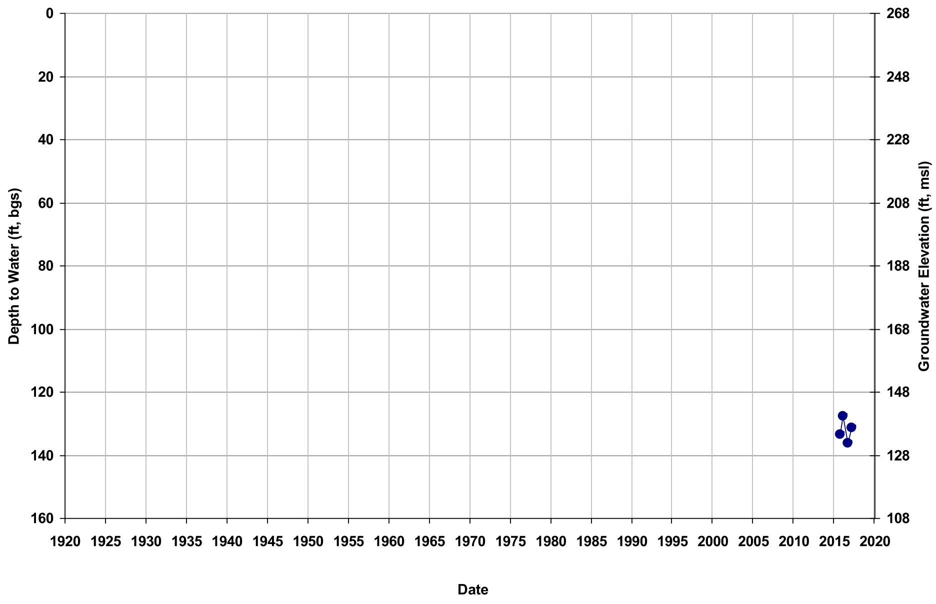
Well ID: 12S18E16K001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 267
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



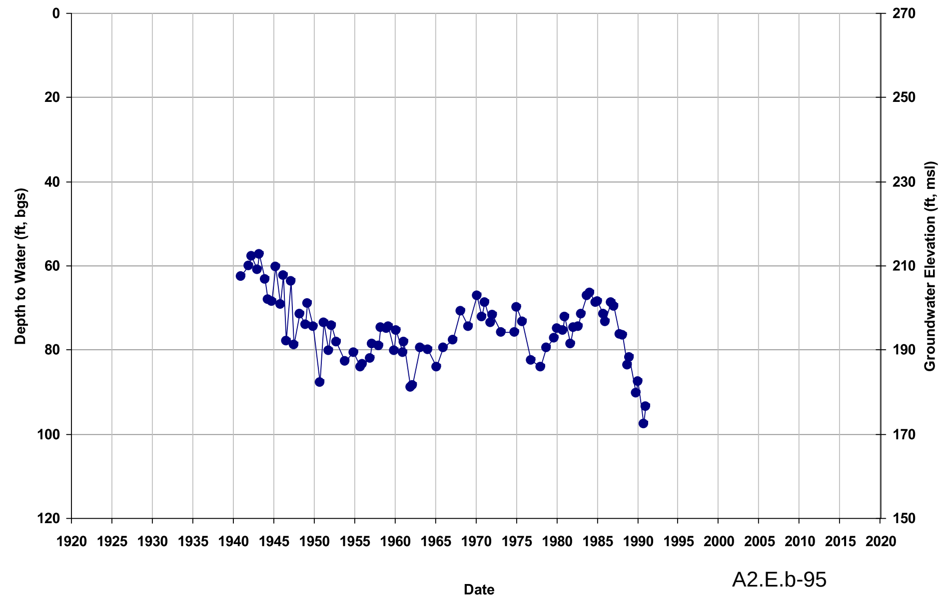
Well ID: 12S18E16K002M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 268
Total Depth (ft): 340
Perf Top (ft): 240
Perf Bottom (ft): 340



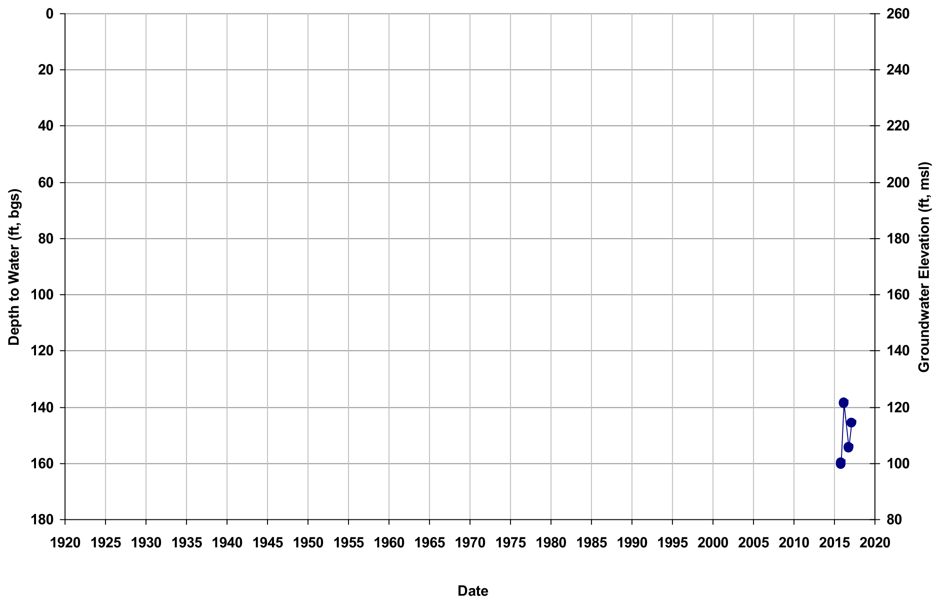
Well ID: 12S18E16Q001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 269
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



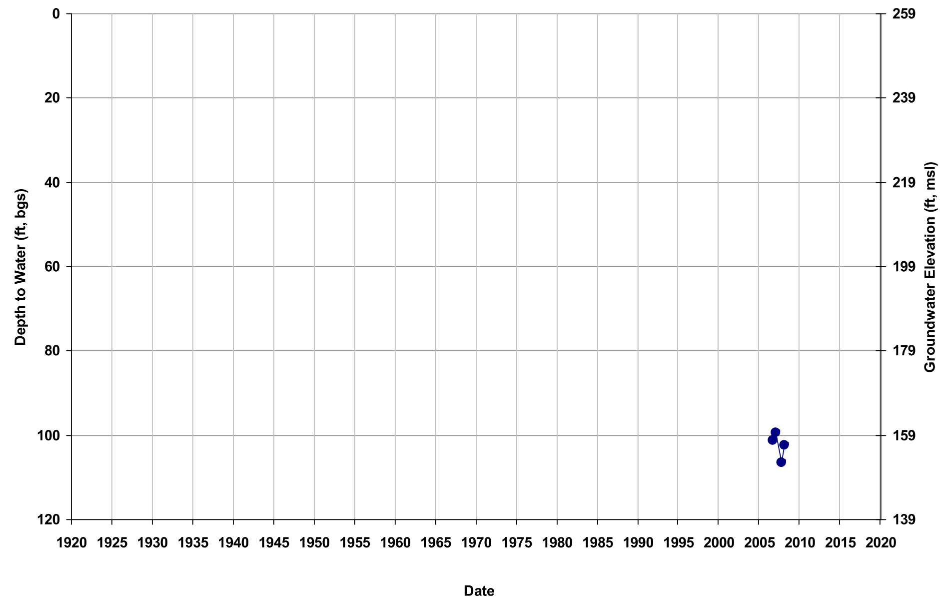
Well ID: 12S18E17C001M
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 259
Total Depth (ft): 600
Perf Top (ft): 280
Perf Bottom (ft): 600



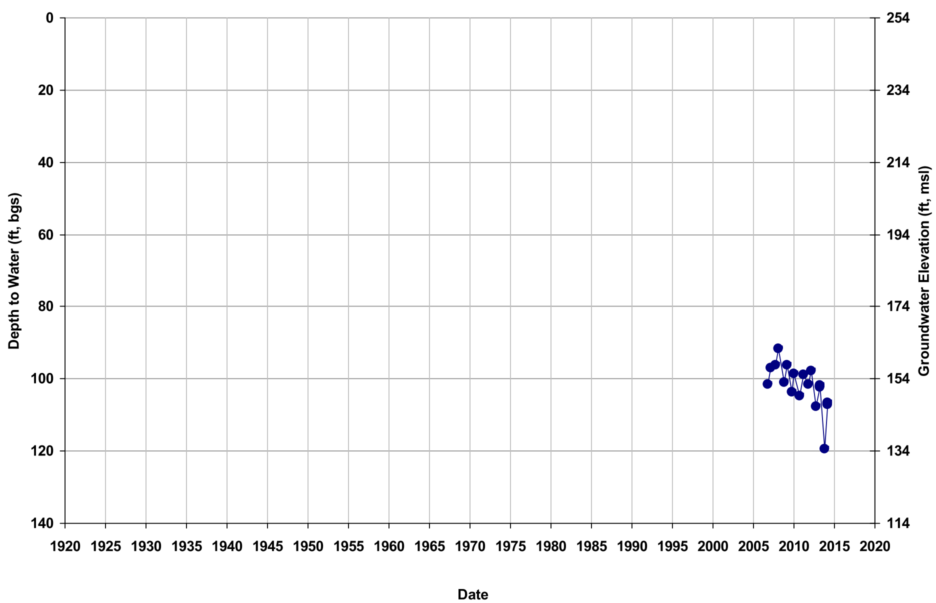
Well ID: 12S18E17L001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 259
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



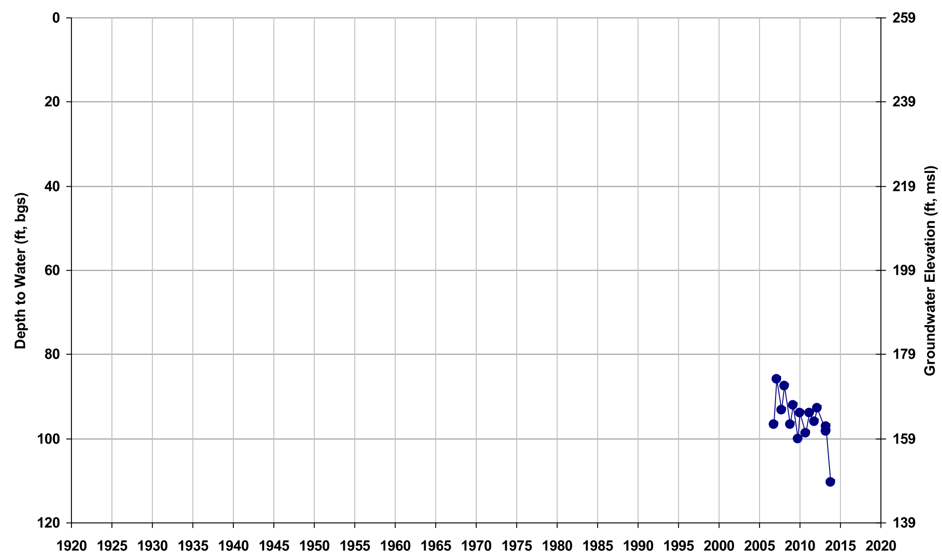
Well ID: 12S18E19H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 253
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



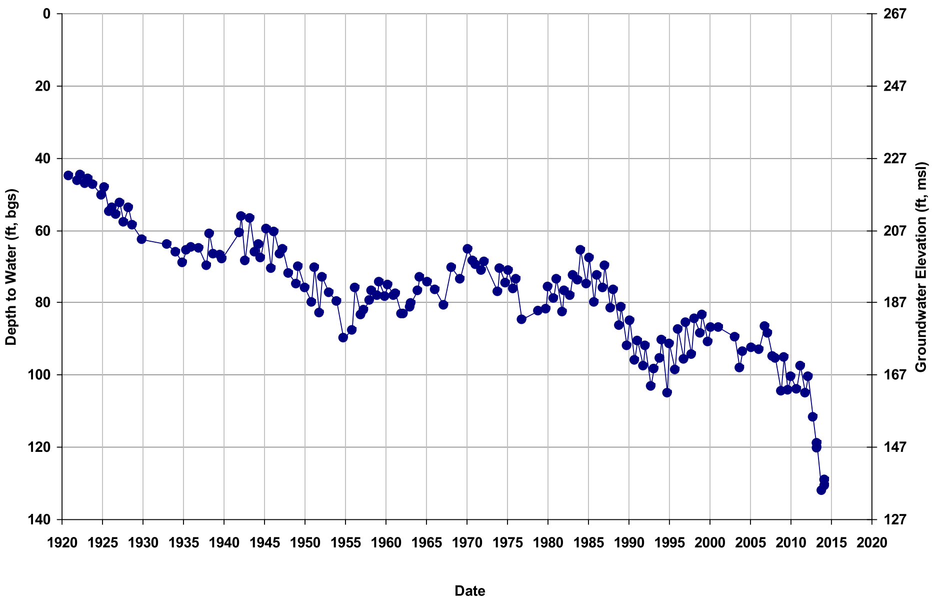
Well ID: 12S18E20P001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 259
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



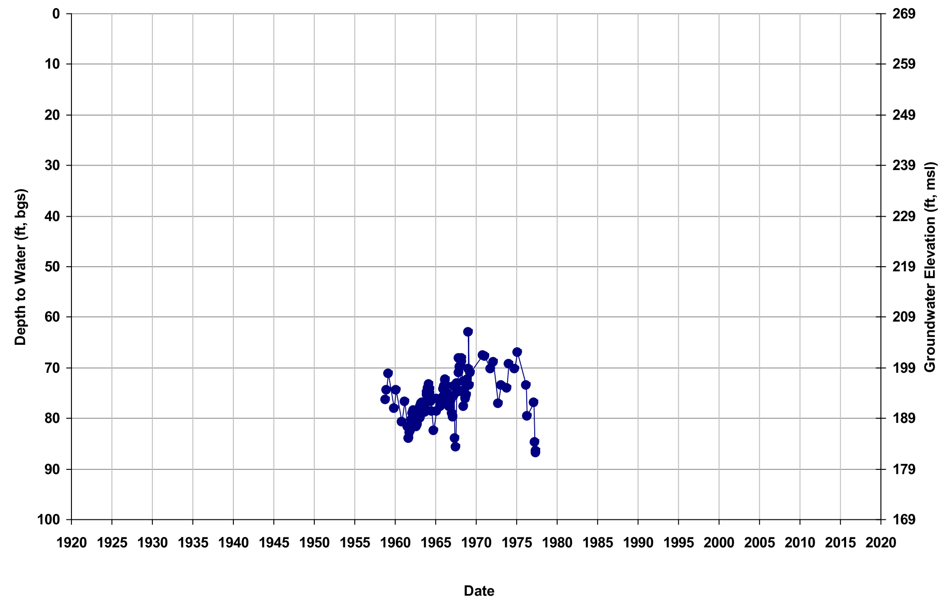
Well ID: 12S18E21G001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 267
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



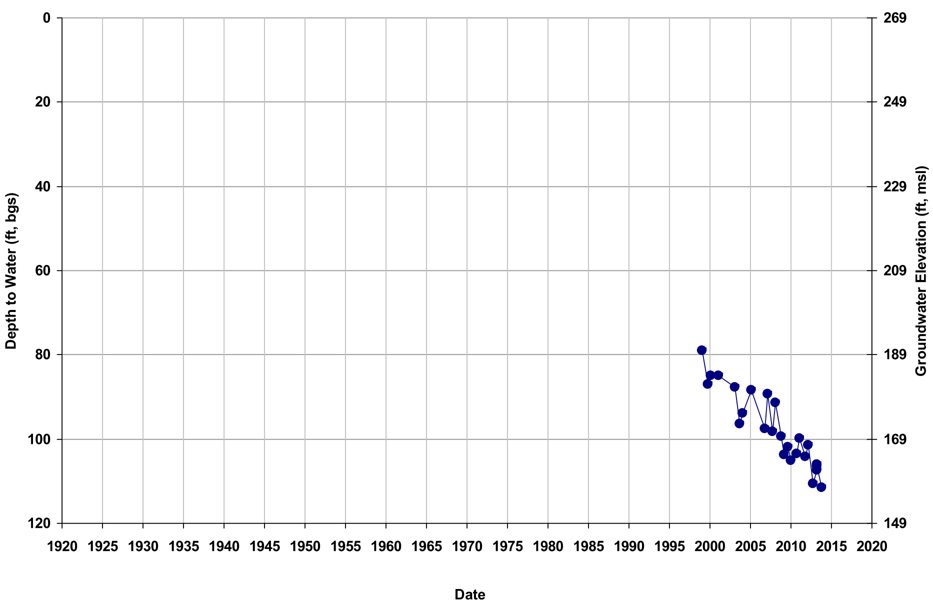
Well ID: 12S18E21H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 269
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



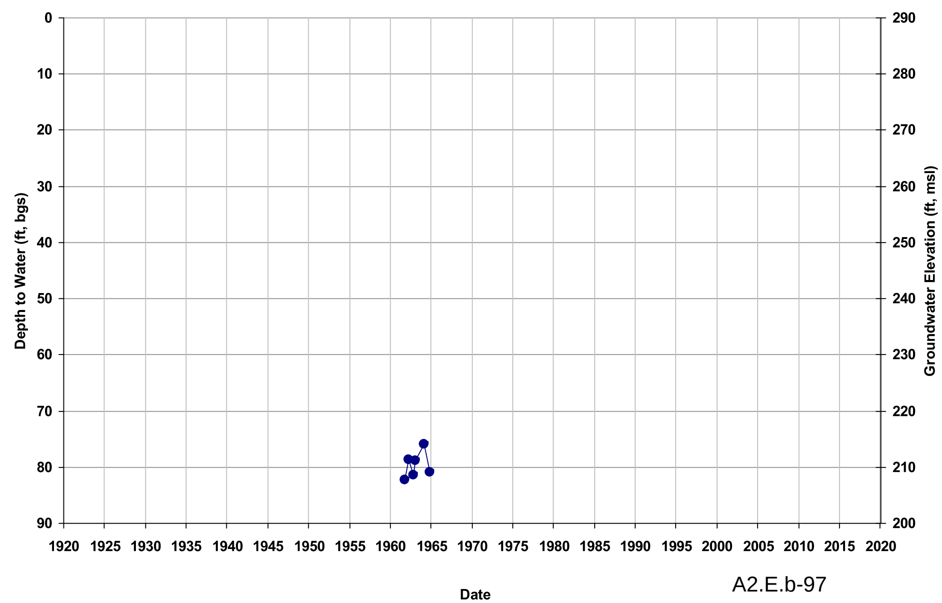
Well ID: 12S18E21H002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 269
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



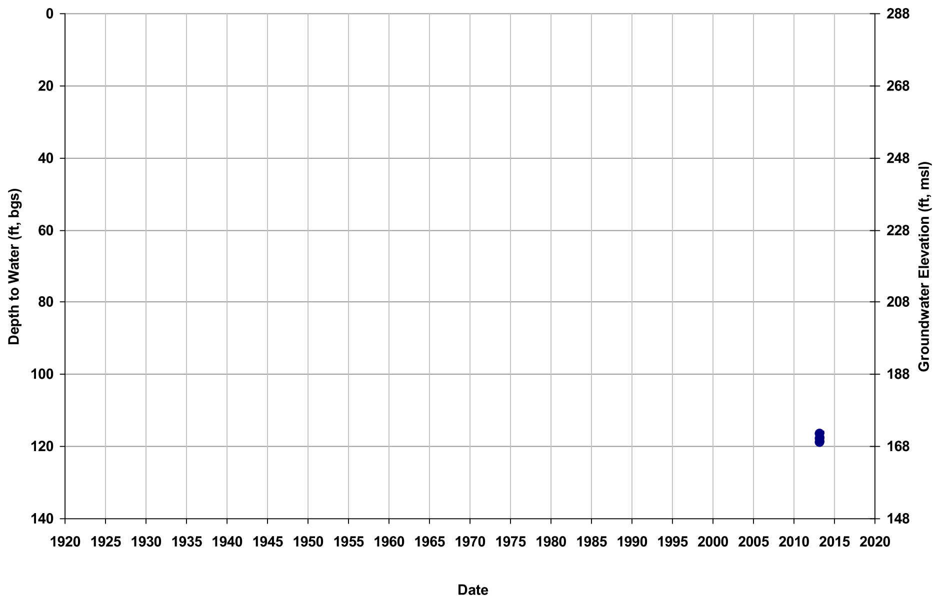
Well ID: 12S18E25A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 290
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



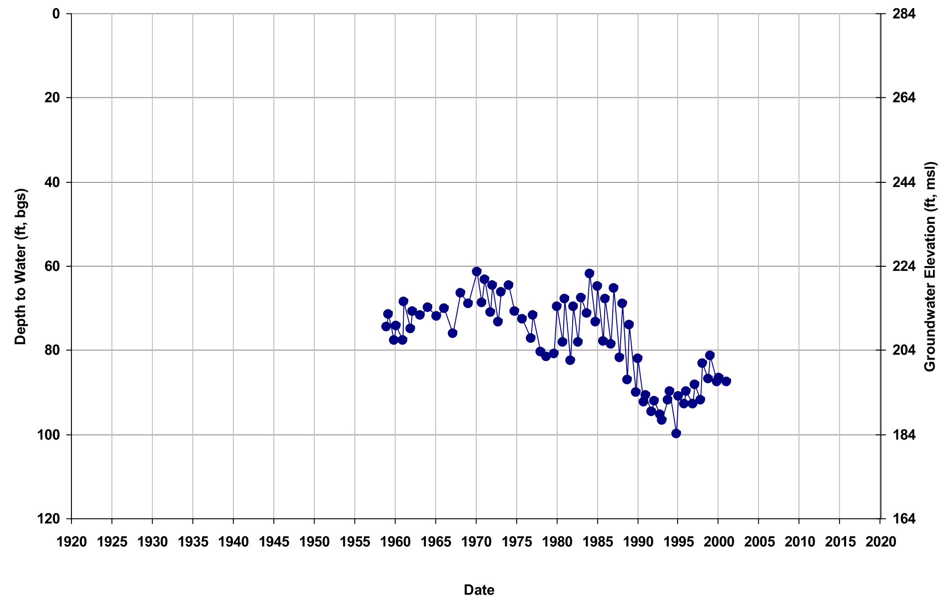
Well ID: 12S18E25B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 287
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



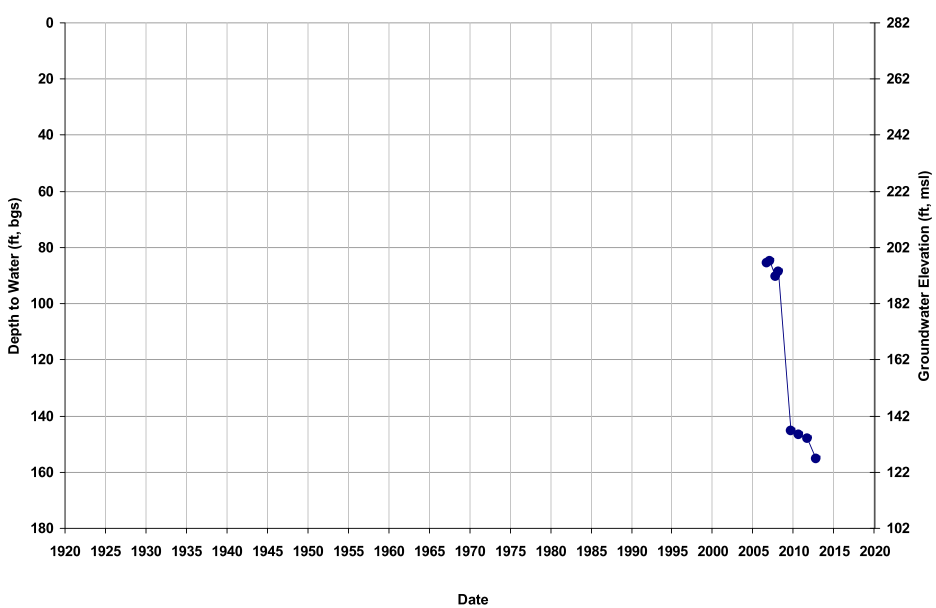
Well ID: 12S18E25L001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 284
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



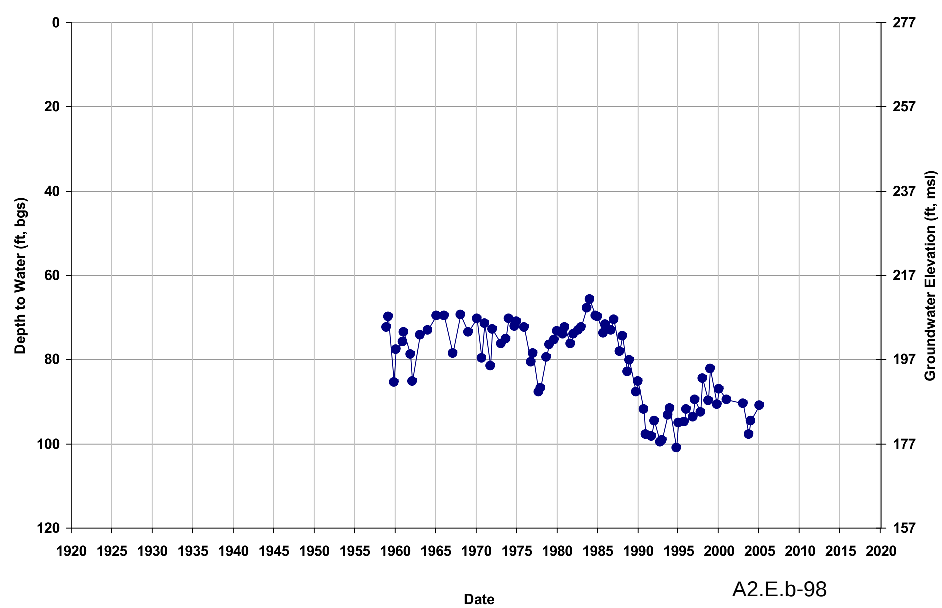
Well ID: 12S18E25M001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 282
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



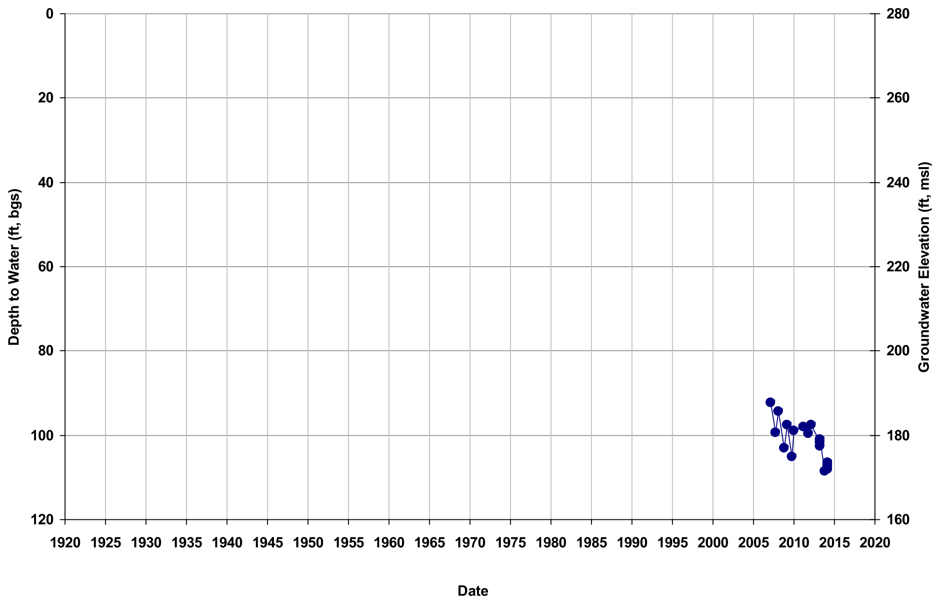
Well ID: 12S18E26D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 277
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



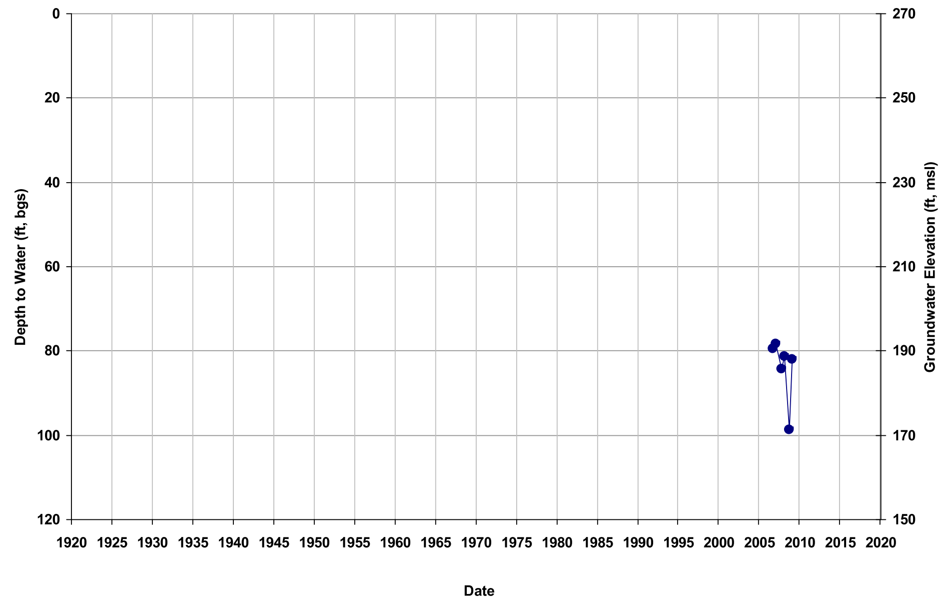
Well ID: 12S18E26L001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 279
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



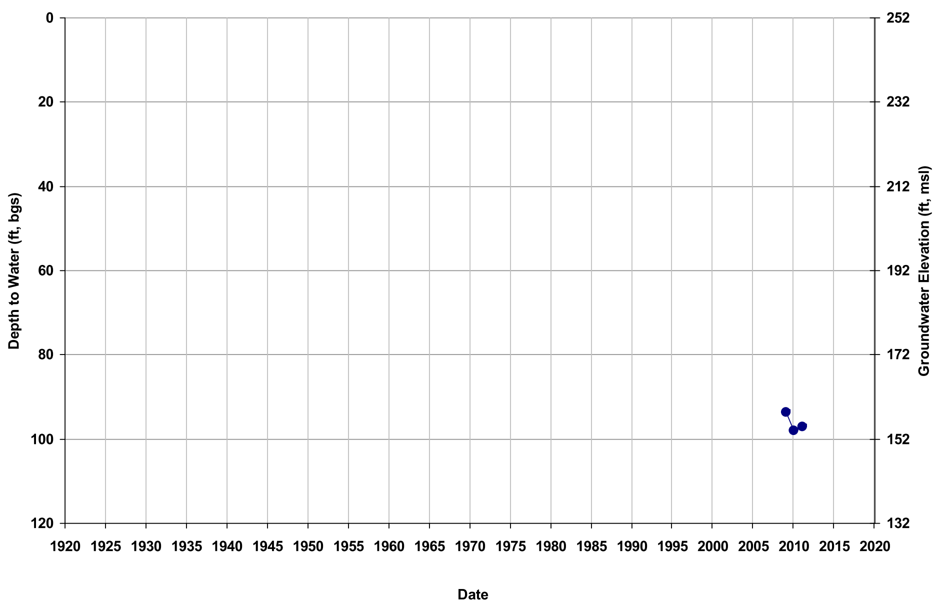
Well ID: 12S18E28J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 270
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



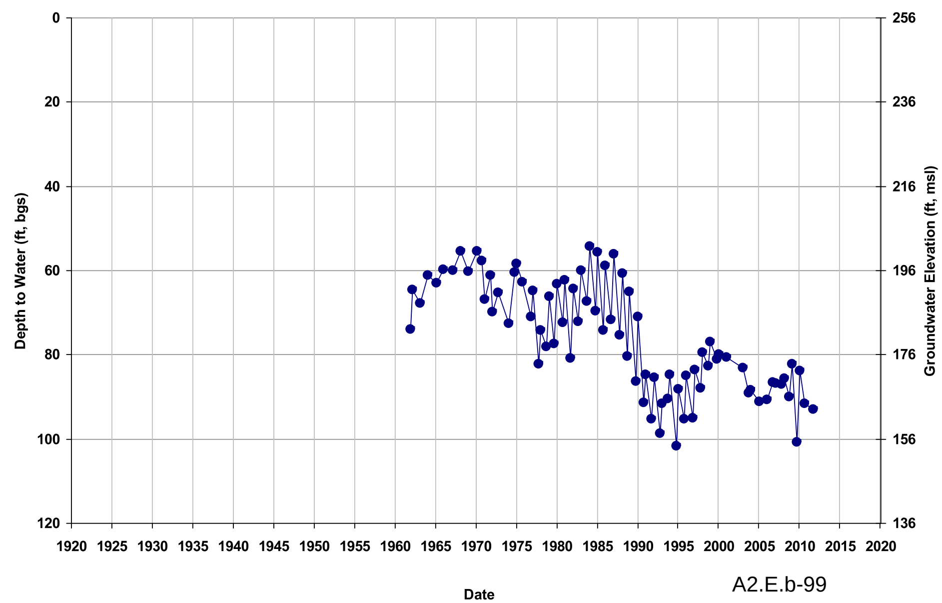
Well ID: 12S18E30C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 251
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



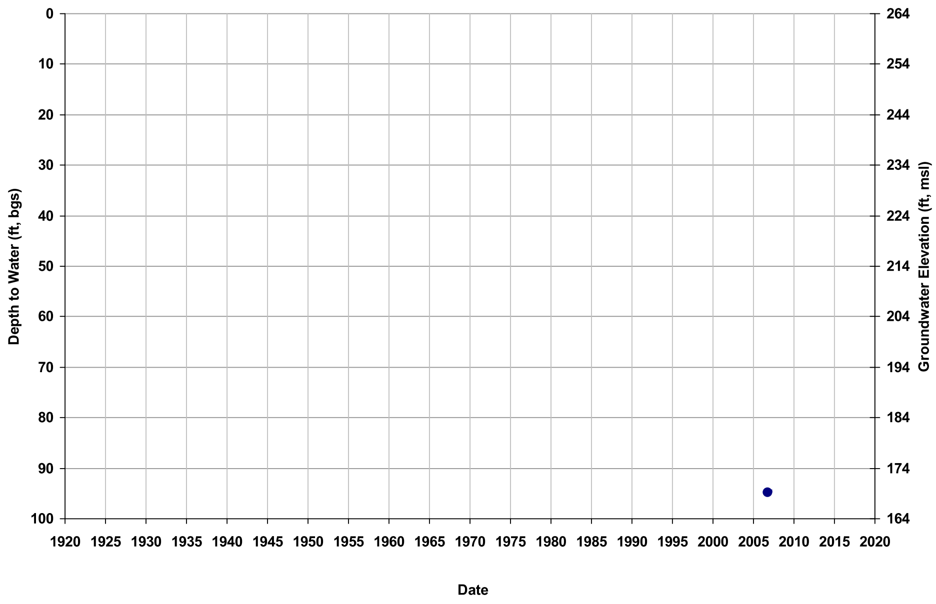
Well ID: 12S18E31J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 256
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



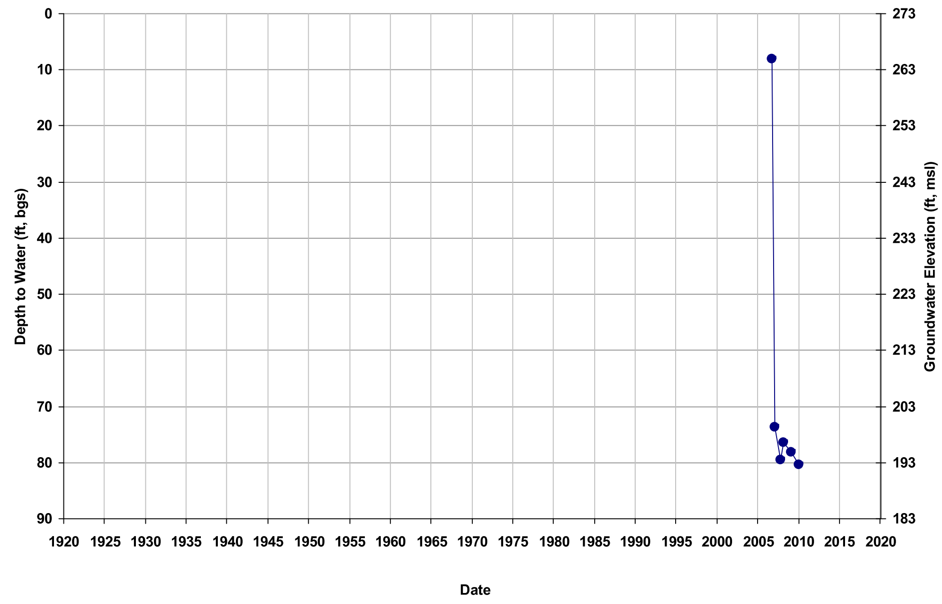
Well ID: 12S18E33C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 263
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



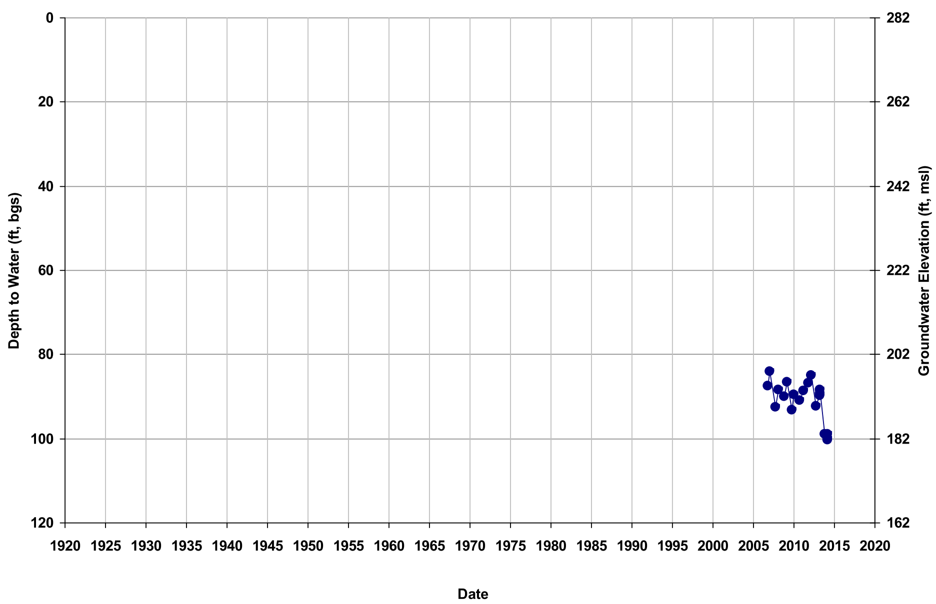
Well ID: 12S18E34L001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 272
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



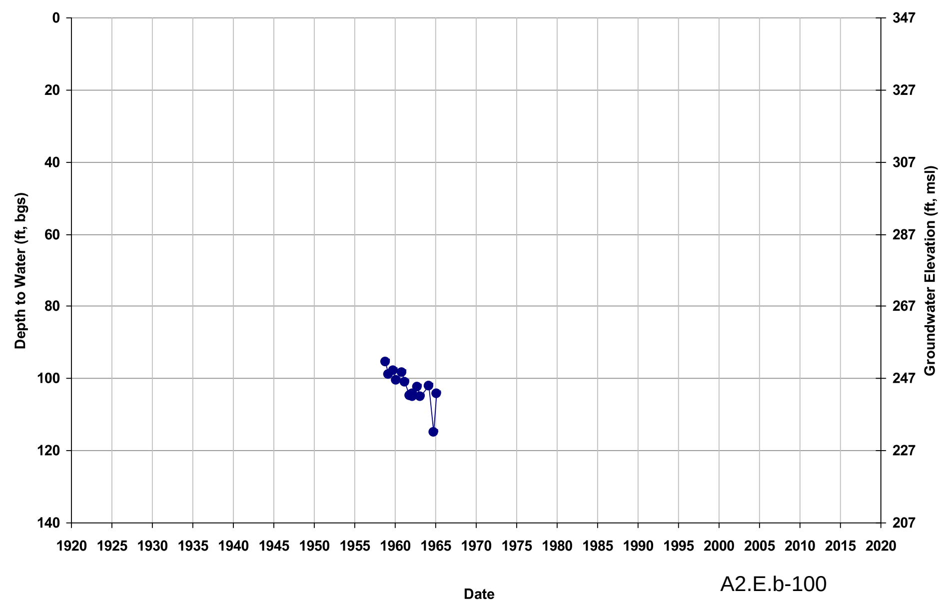
Well ID: 12S18E35G001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 281
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



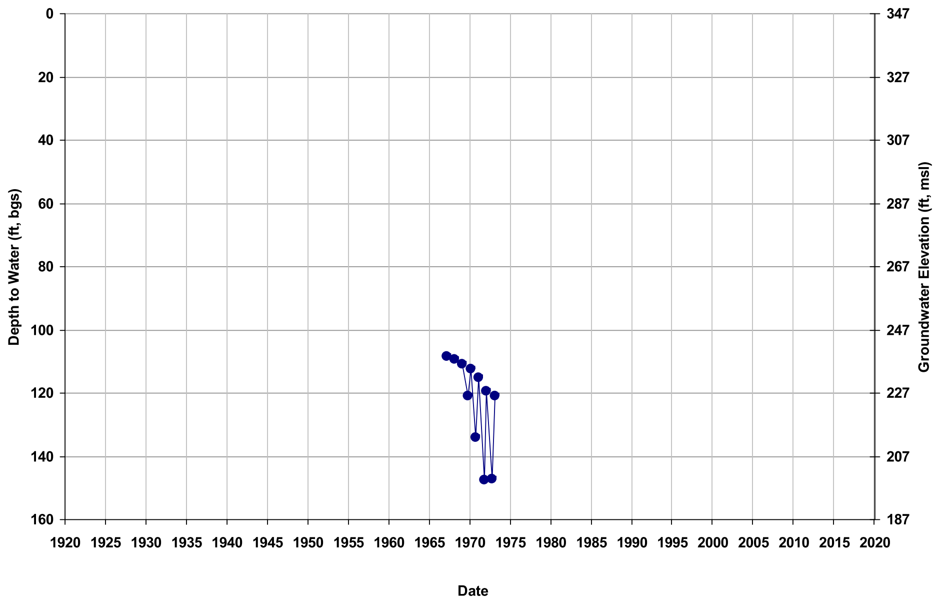
Well ID: 12S19E01M001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 347
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



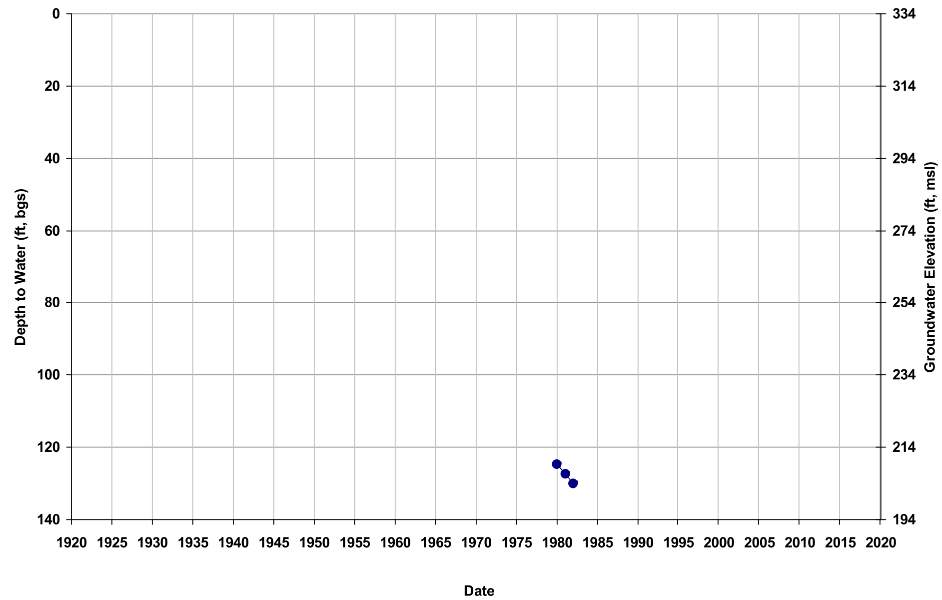
Well ID: 12S19E01M002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 347
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



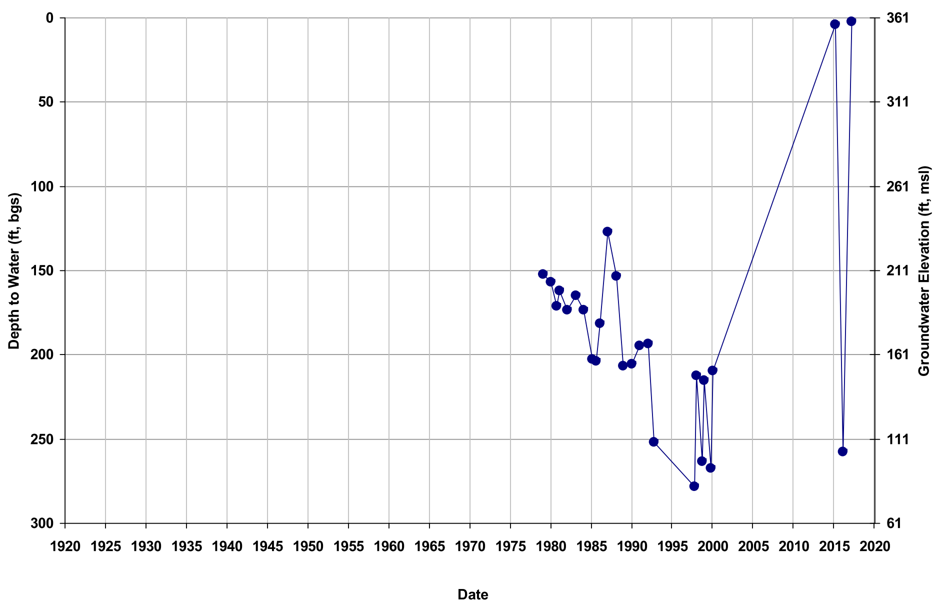
Well ID: 12S19E01M003M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 333
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



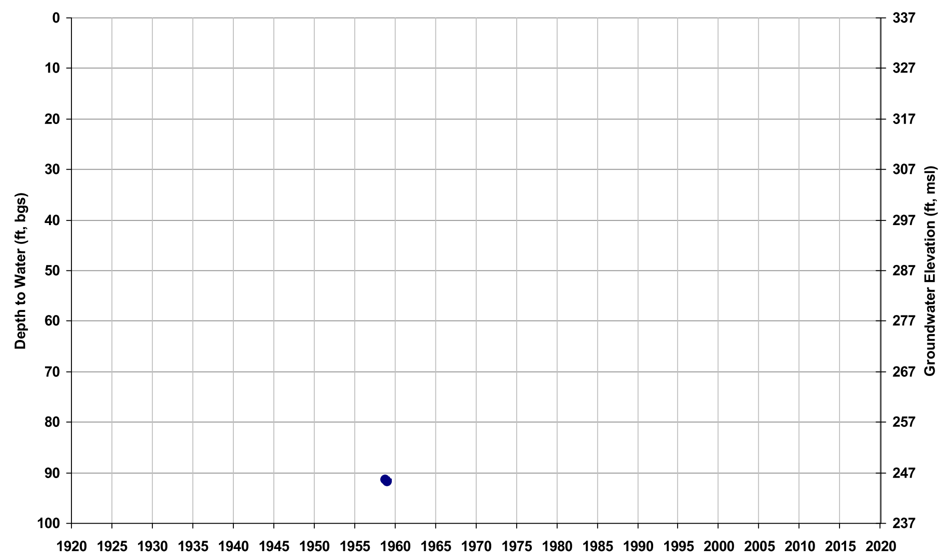
Well ID: 12S19E02A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 360
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



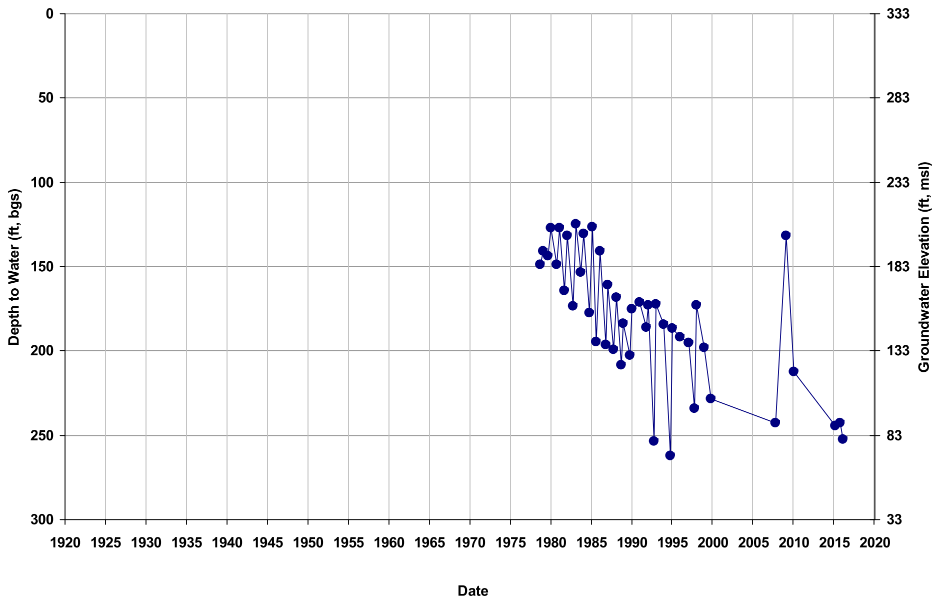
Well ID: 12S19E03B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 337
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



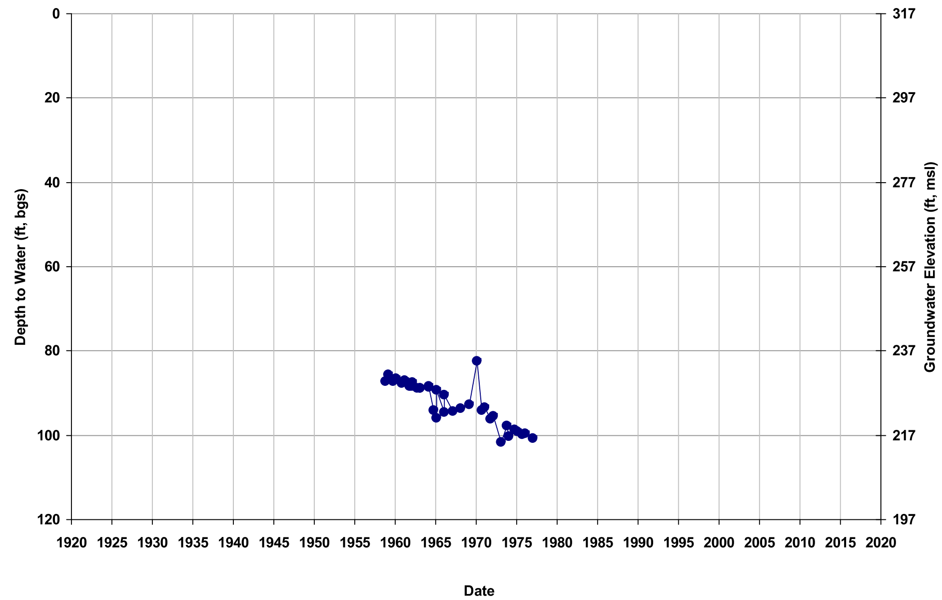
Well ID: 12S19E03Q001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 332
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



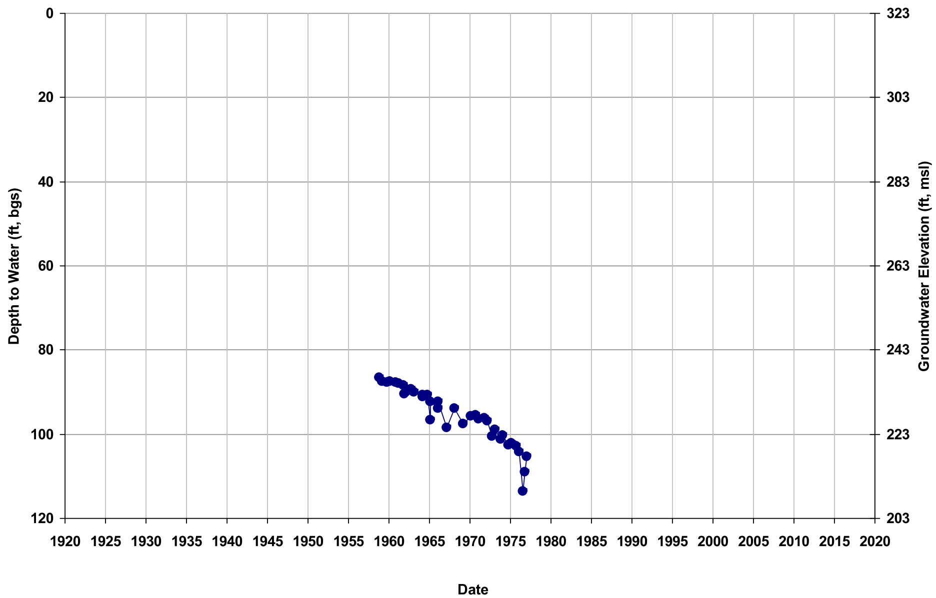
Well ID: 12S19E04D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 317
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



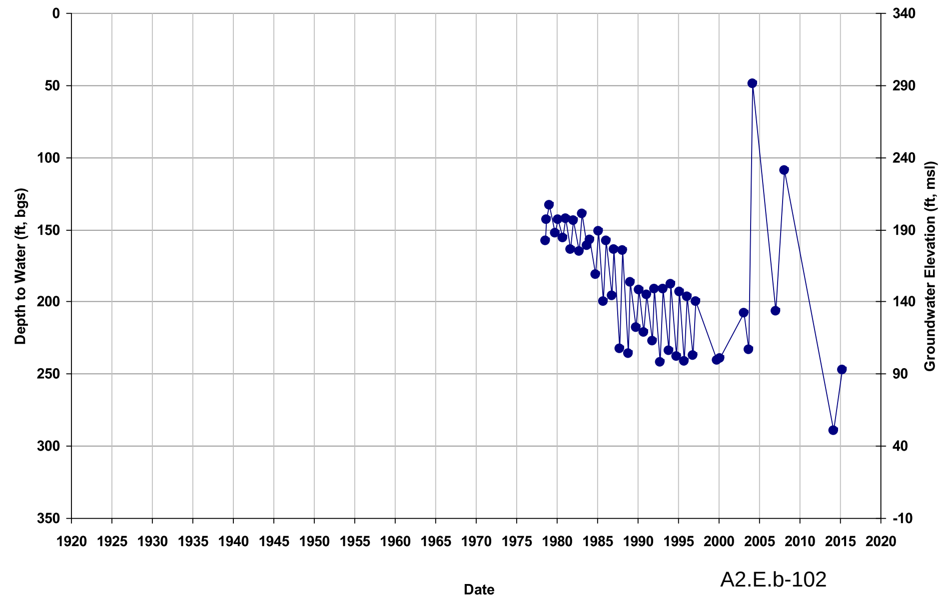
Well ID: 12S19E09H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

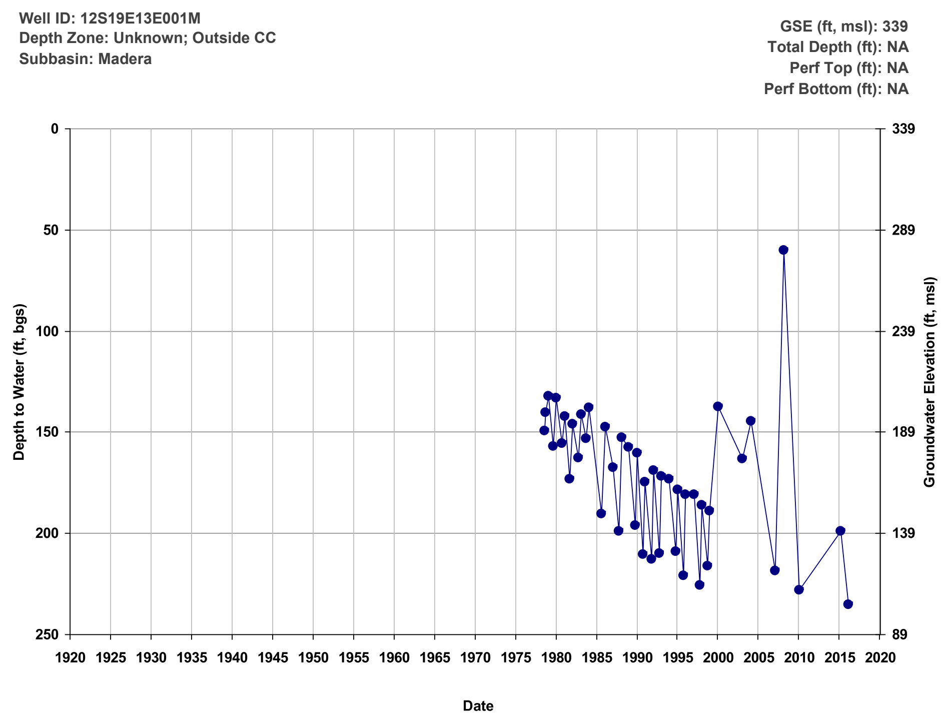
GSE (ft, msl): 322
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



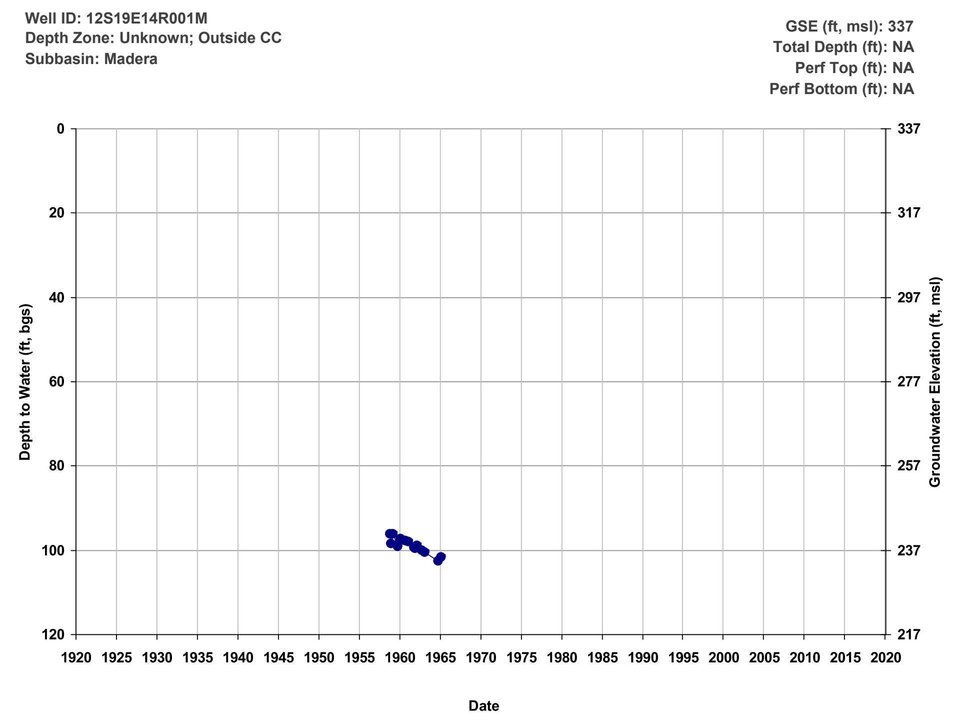
Well ID: 12S19E11B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 340
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

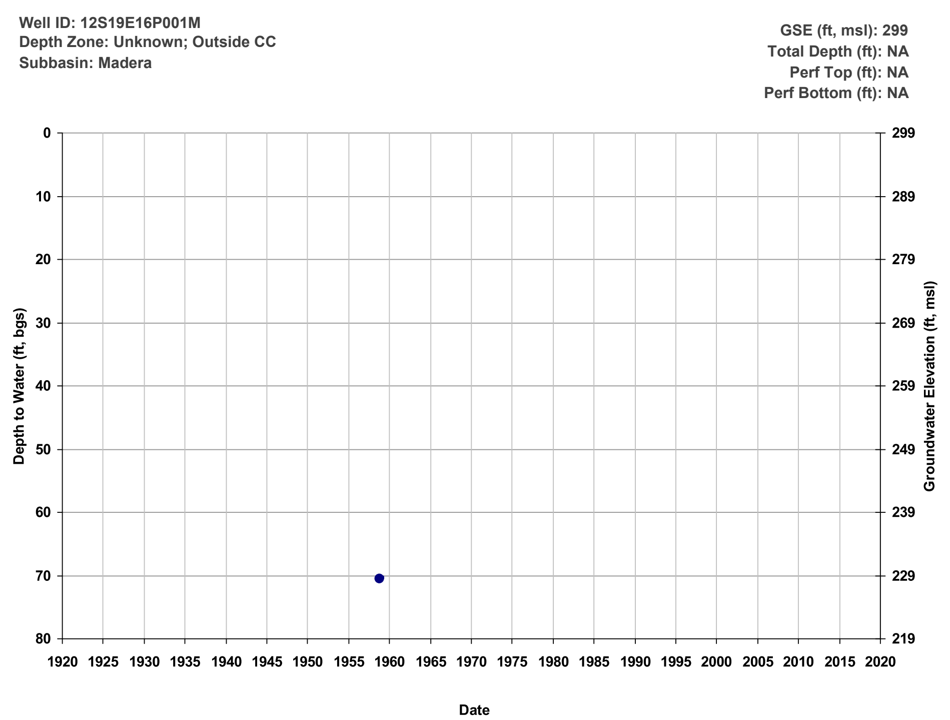




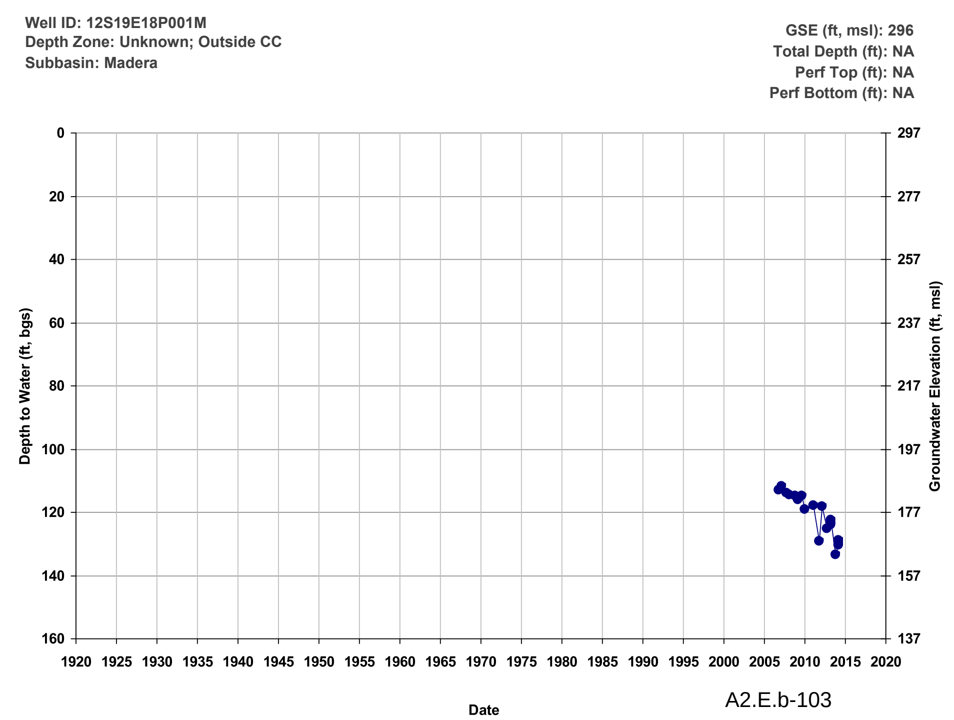
Well ID: 12S19E13E001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 339
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



Well ID: 12S19E14R001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 337
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



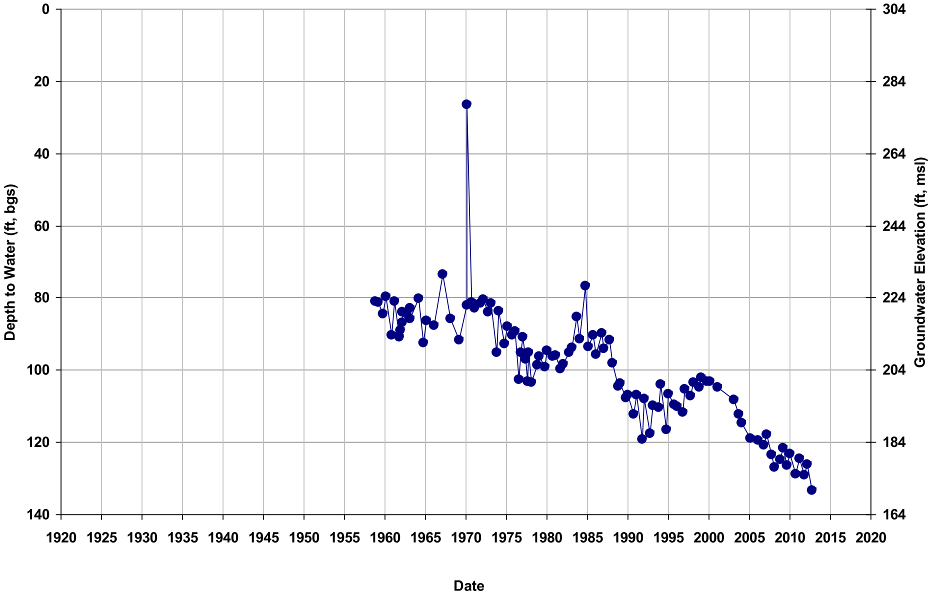
Well ID: 12S19E16P001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 299
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date



Well ID: 12S19E18P001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 296
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

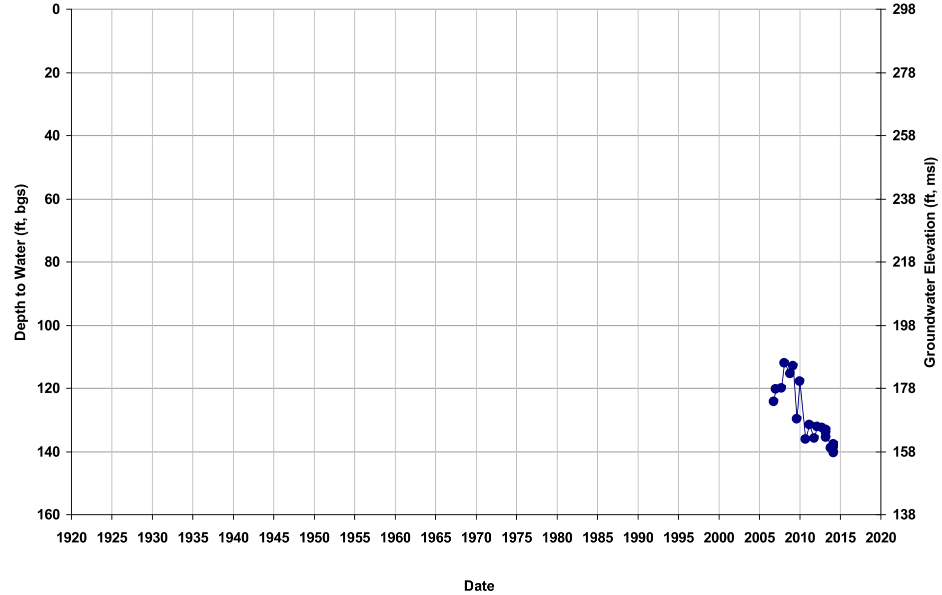
Well ID: 12S19E20A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 303
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



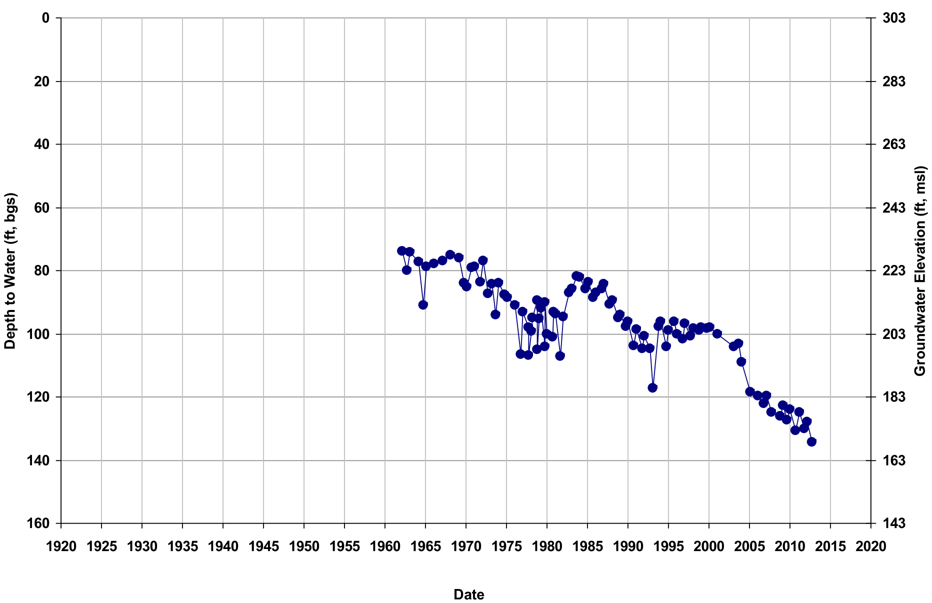
Well ID: 12S19E20D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 298
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



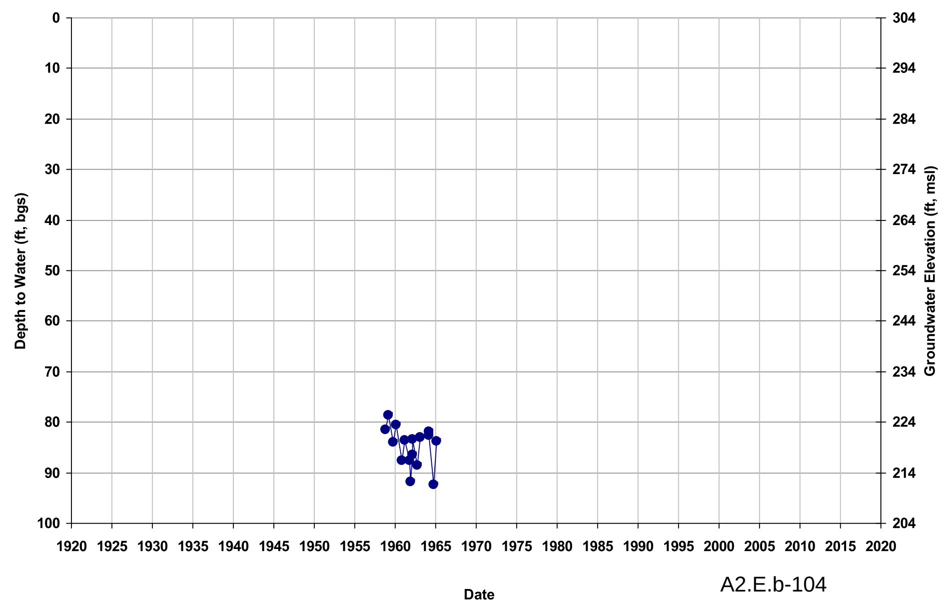
Well ID: 12S19E21B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 302
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



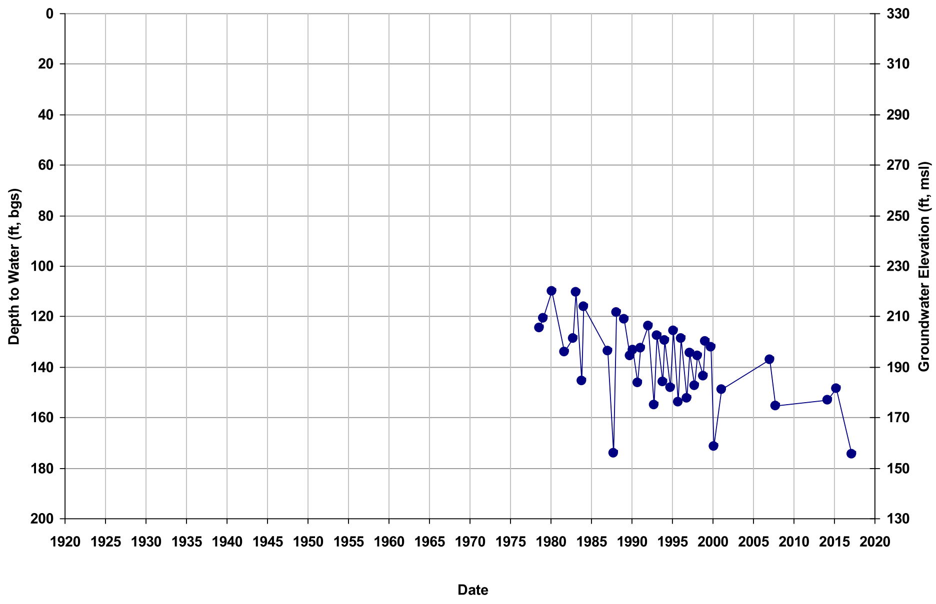
Well ID: 12S19E21N002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 304
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



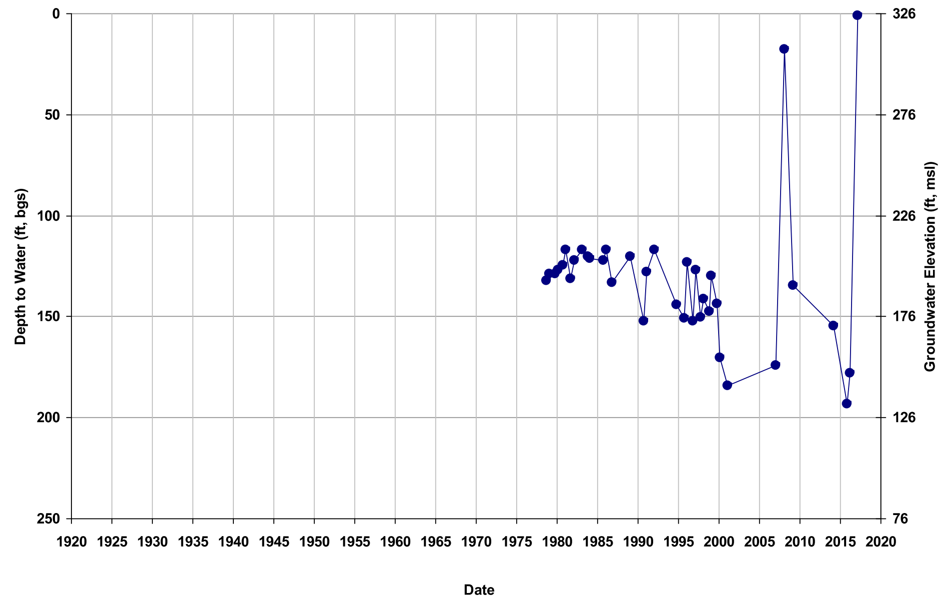
Well ID: 12S19E23K001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 329
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



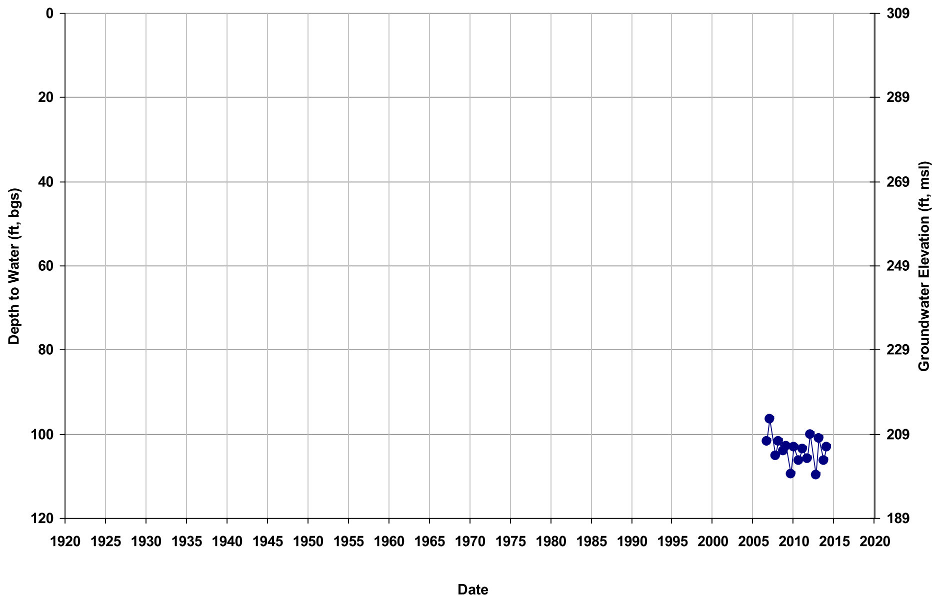
Well ID: 12S19E26C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 326
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



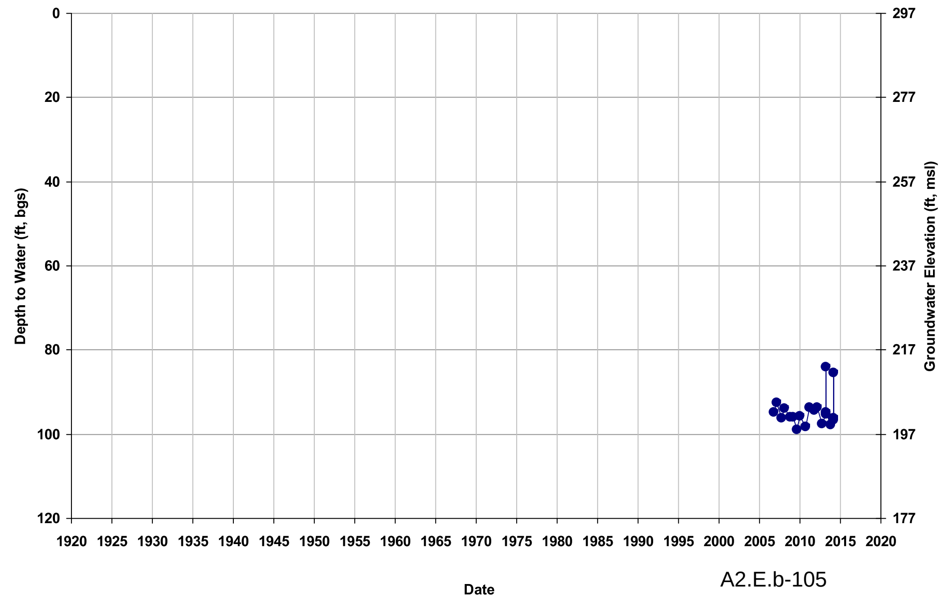
Well ID: 12S19E28A001M
Depth Zone: Upper; Outside CC
Subbasin: Madera

GSE (ft, msl): 308
Total Depth (ft): 200
Perf Top (ft): NA
Perf Bottom (ft): NA



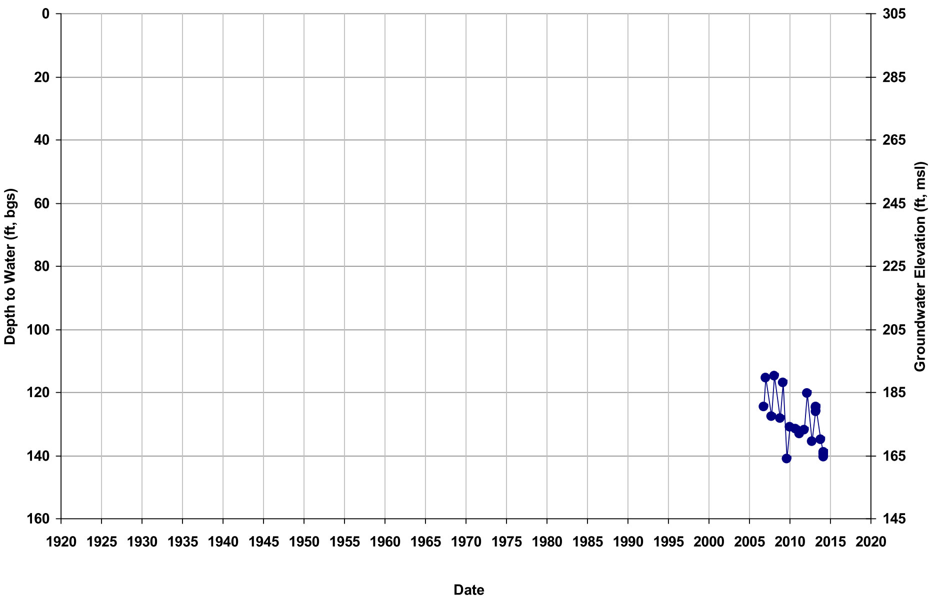
Well ID: 12S19E28P001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 296
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



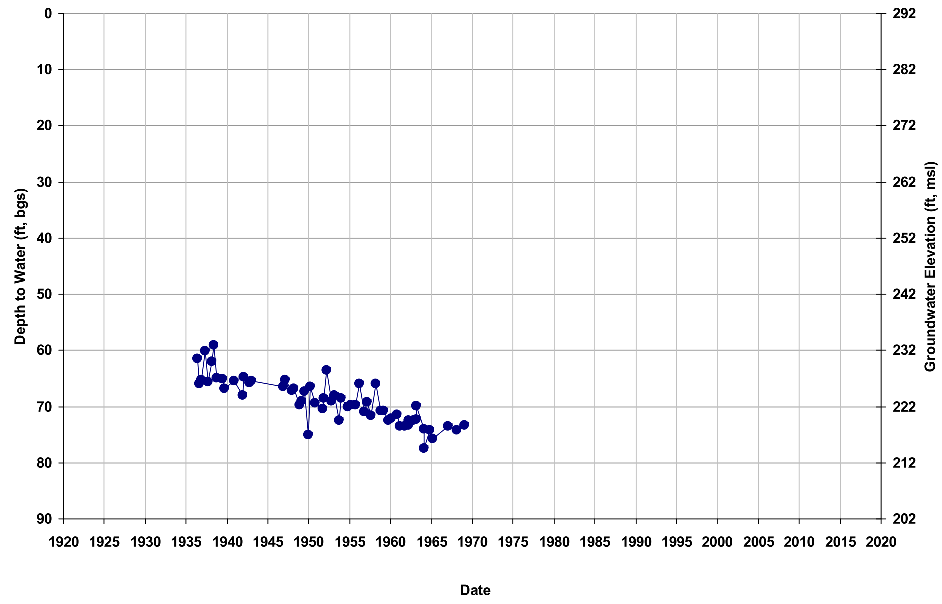
Well ID: 12S19E29A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 304
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



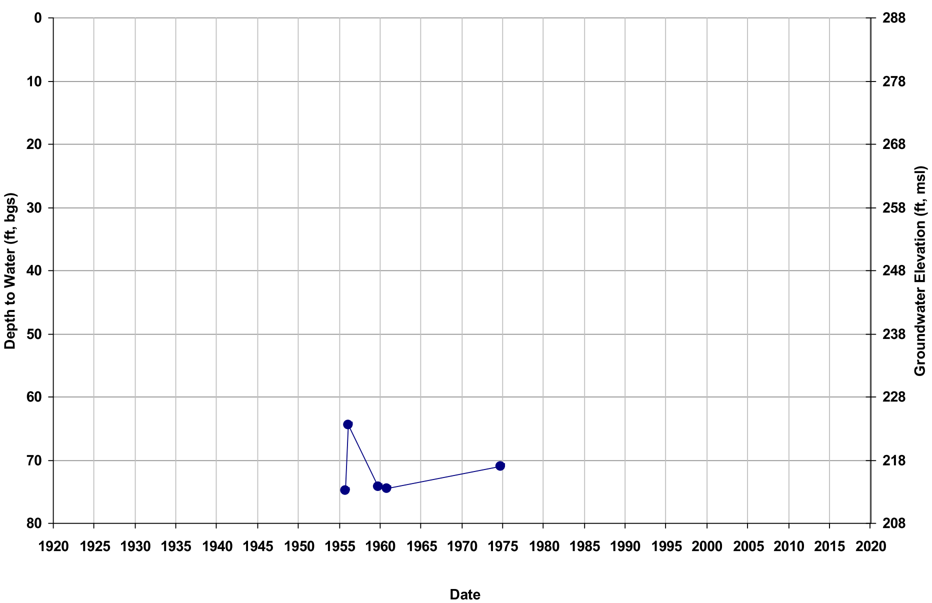
Well ID: 12S19E31A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 292
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



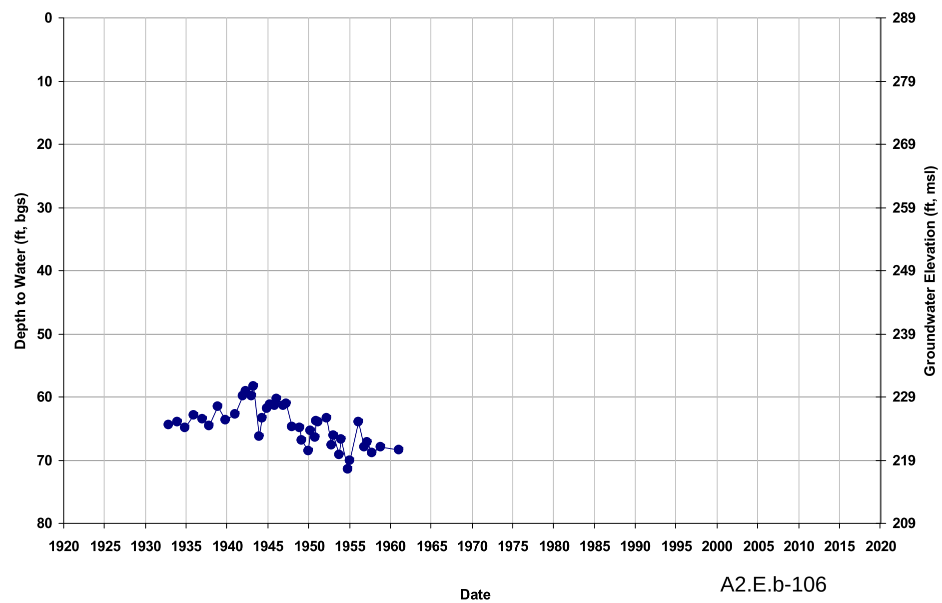
Well ID: 12S19E31M001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

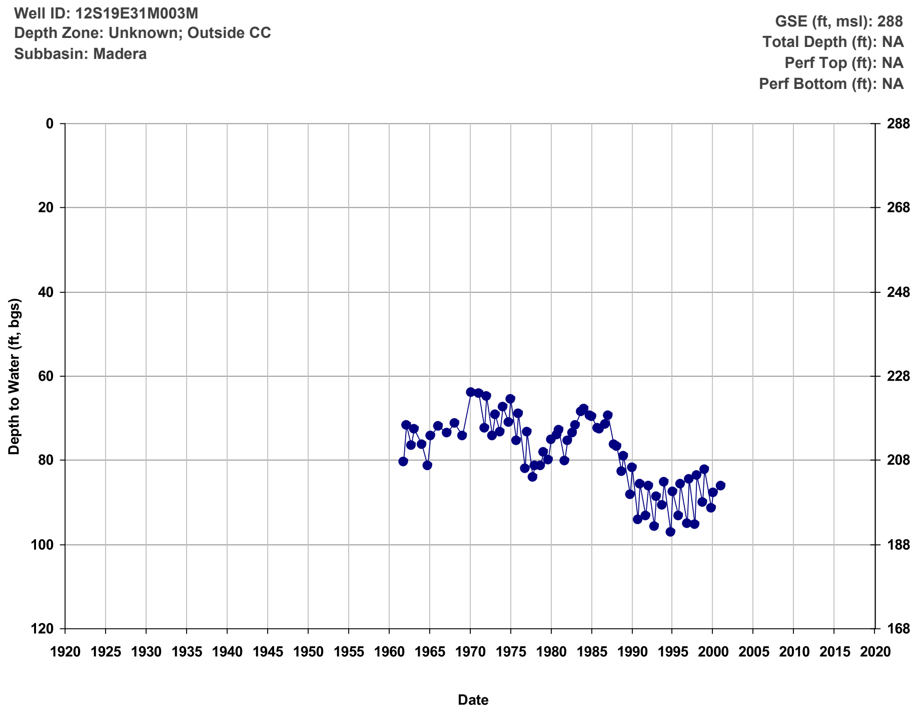
GSE (ft, msl): 288
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

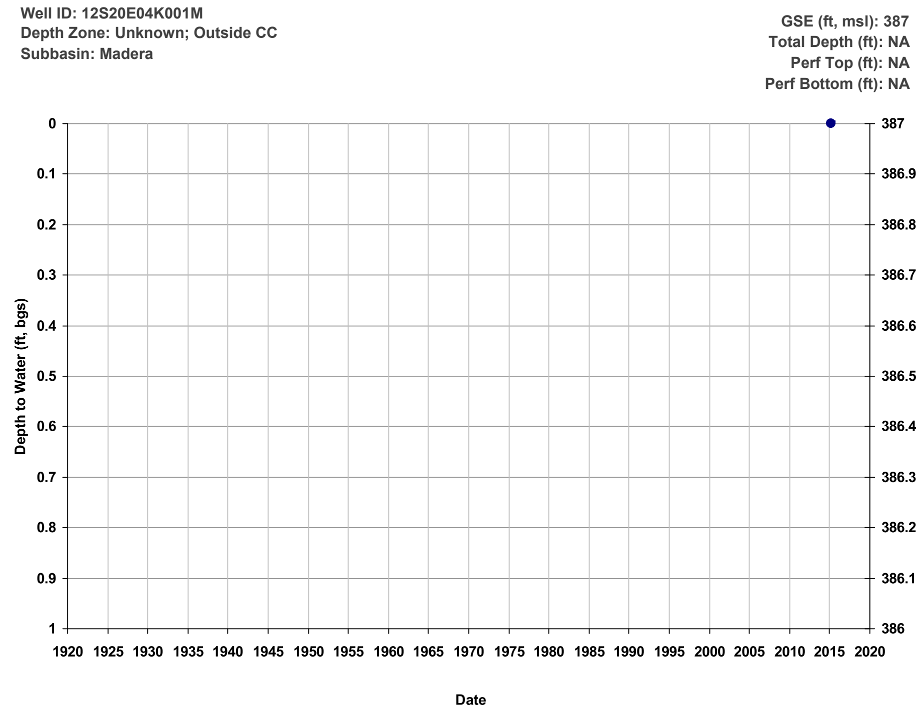


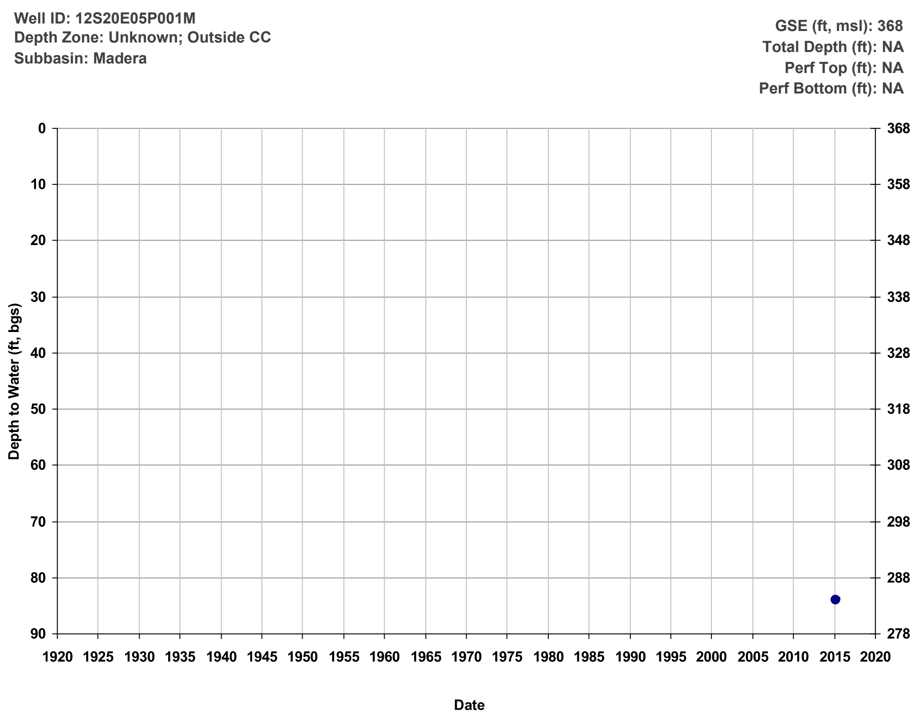
Well ID: 12S19E31M002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

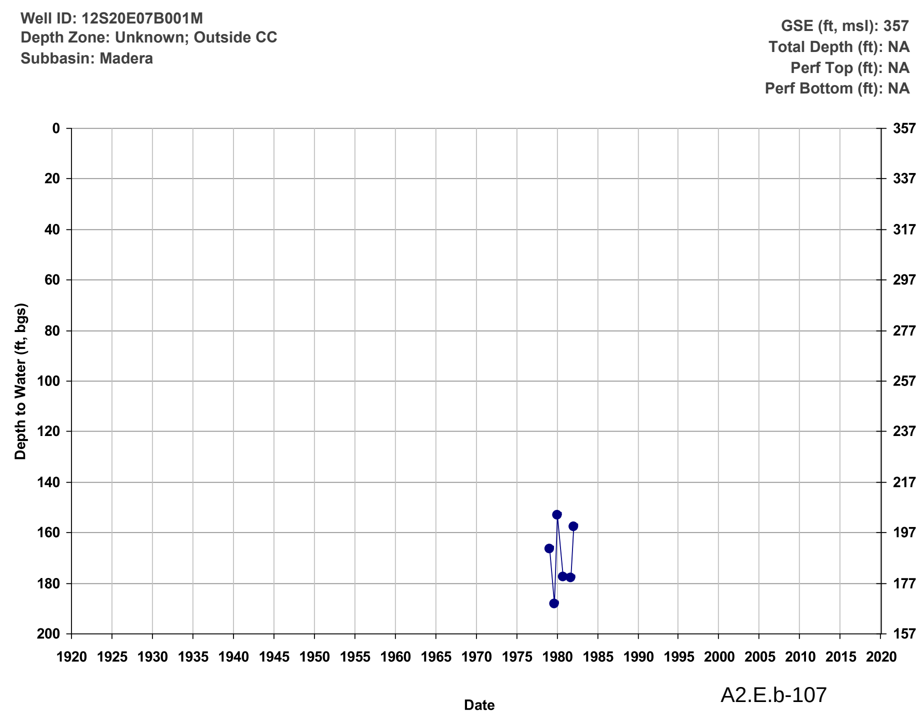
GSE (ft, msl): 289
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA




Well ID: 12S19E31M003M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 288
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

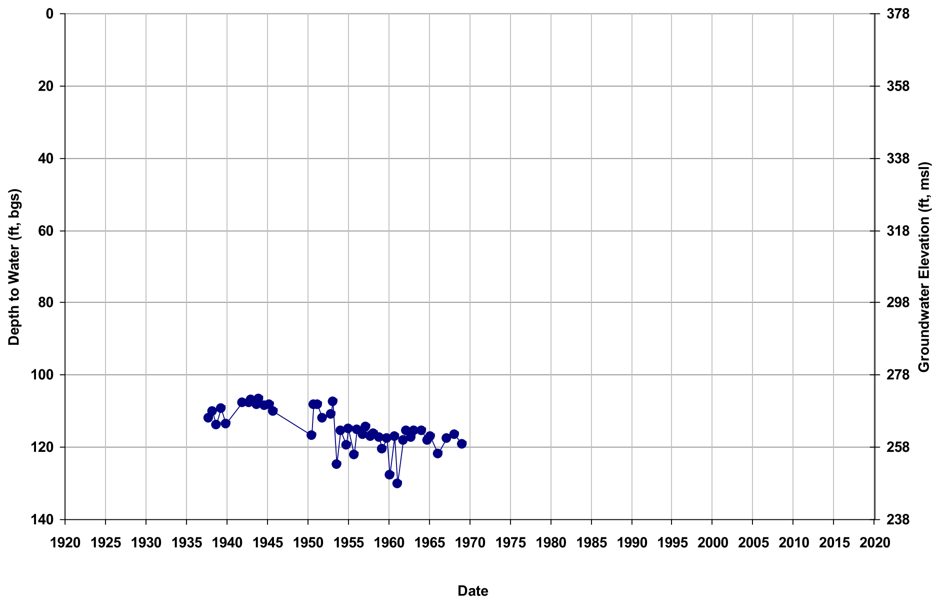

Well ID: 12S20E04K001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 387
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 12S20E05P001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 368
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 12S20E07B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 357
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

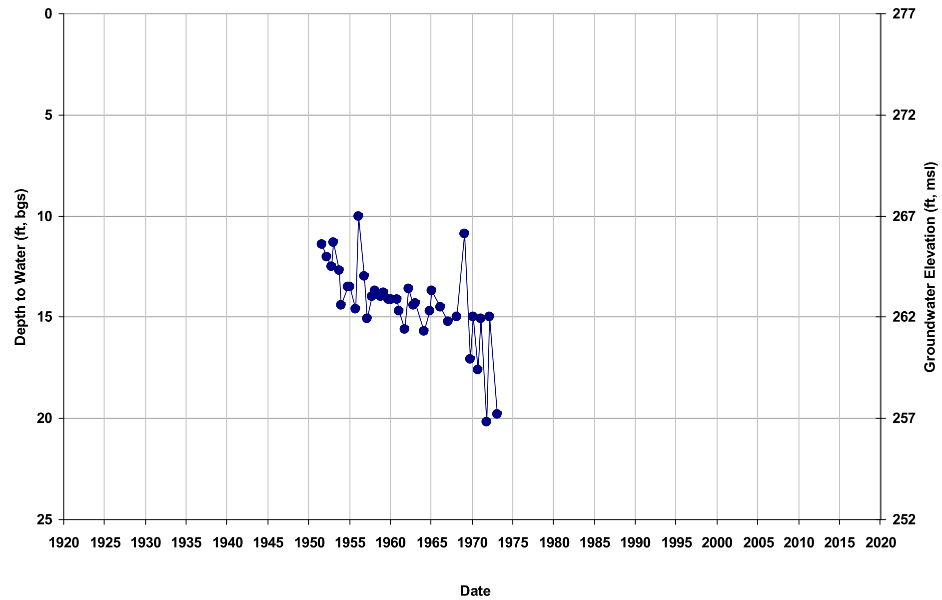
Well ID: 12S20E09C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 378
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



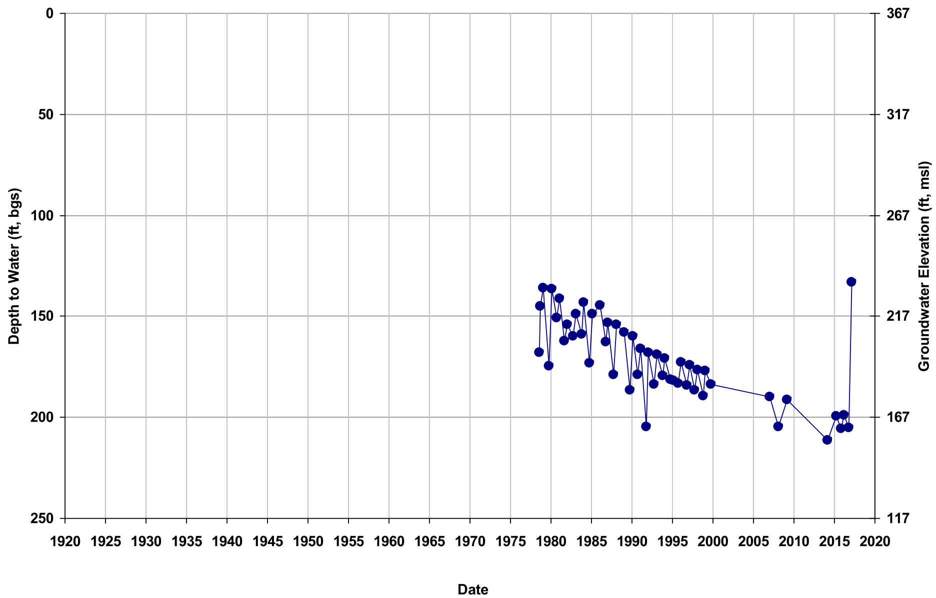
Well ID: 12S20E16Q001M
Depth Zone: Upper, Shallow GW; Ou
Subbasin: Madera

GSE (ft, msl): 277
Total Depth (ft): 38
Perf Top (ft): NA
Perf Bottom (ft): NA



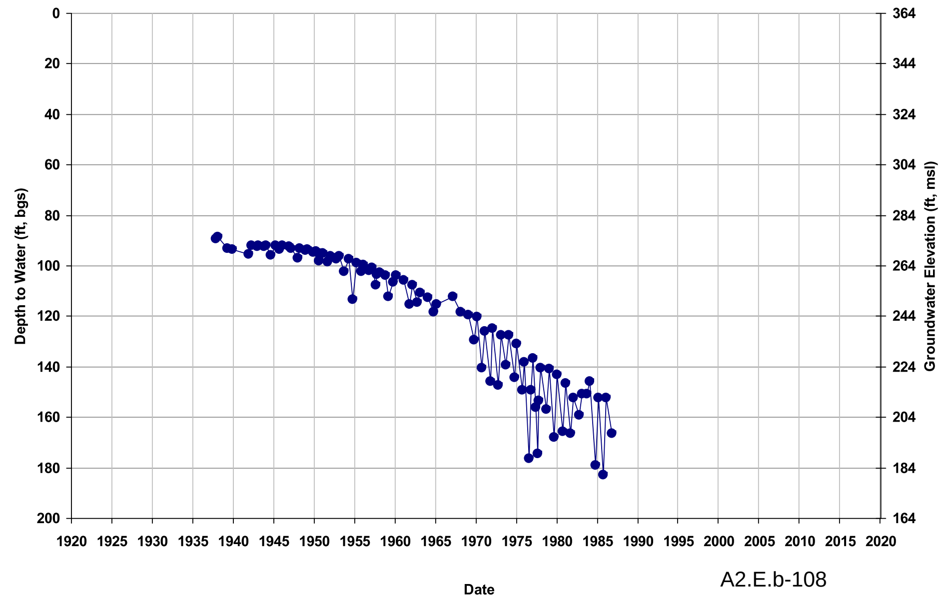
Well ID: 12S20E17A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 367
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



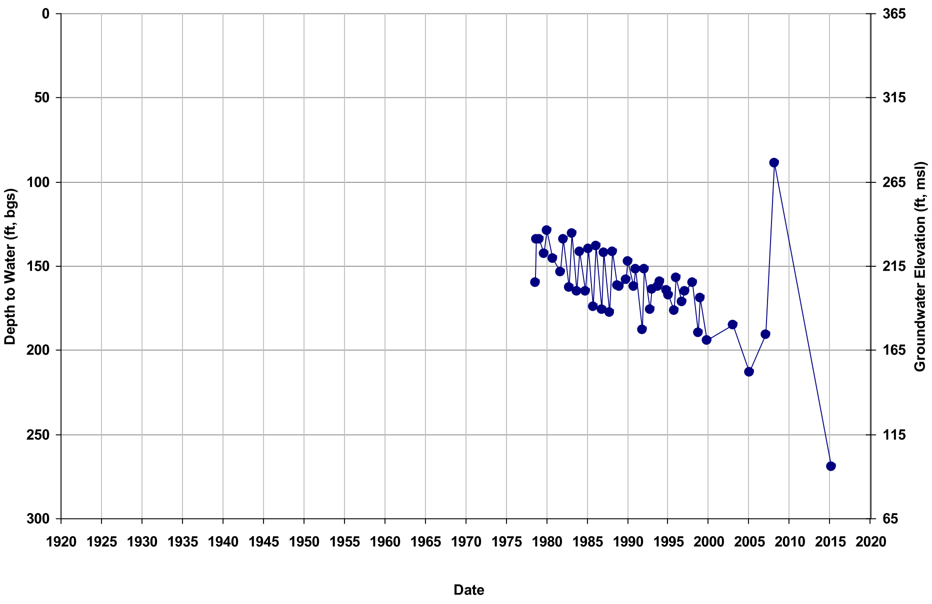
Well ID: 12S20E17H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 364
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



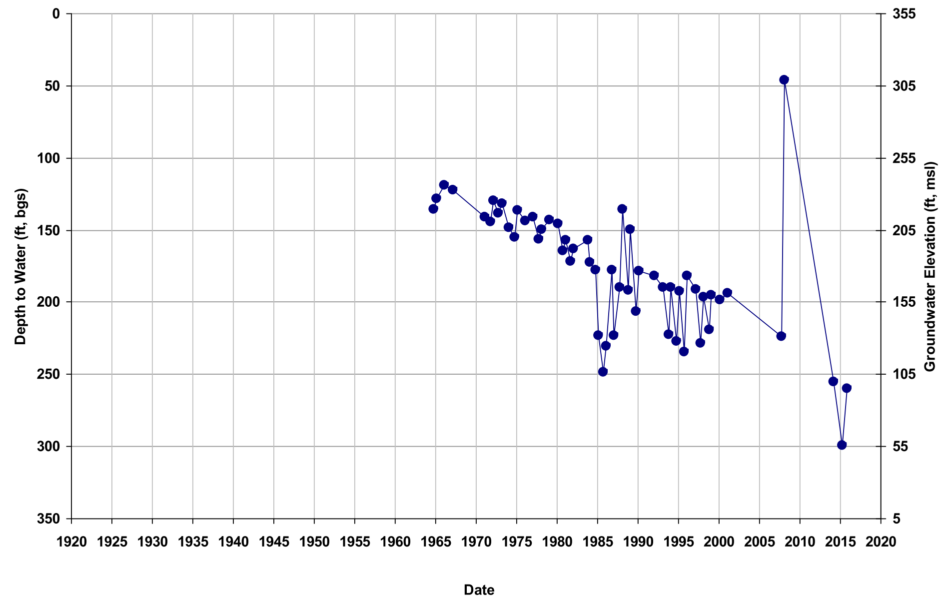
Well ID: 12S20E17H002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 365
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



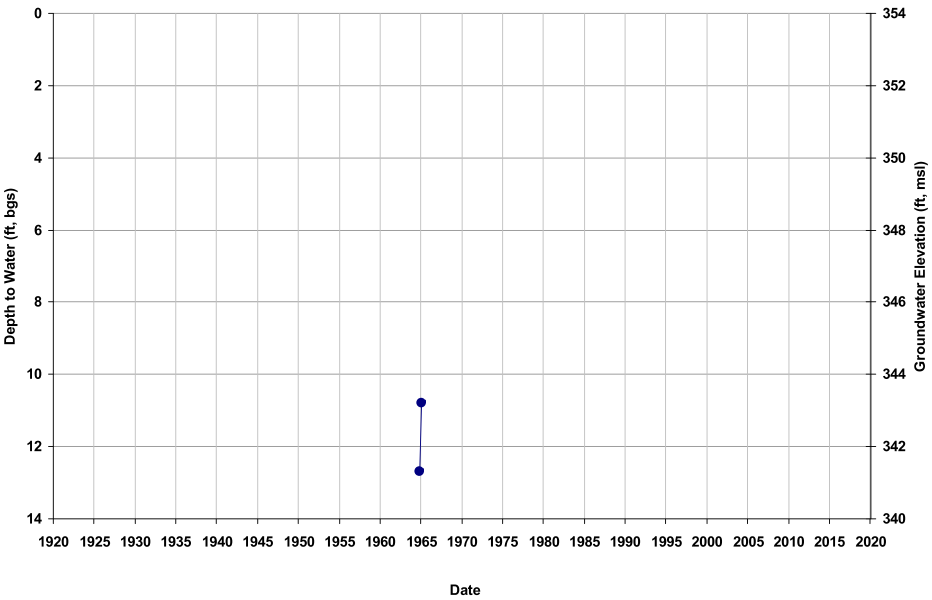
Well ID: 12S20E18B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 354
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



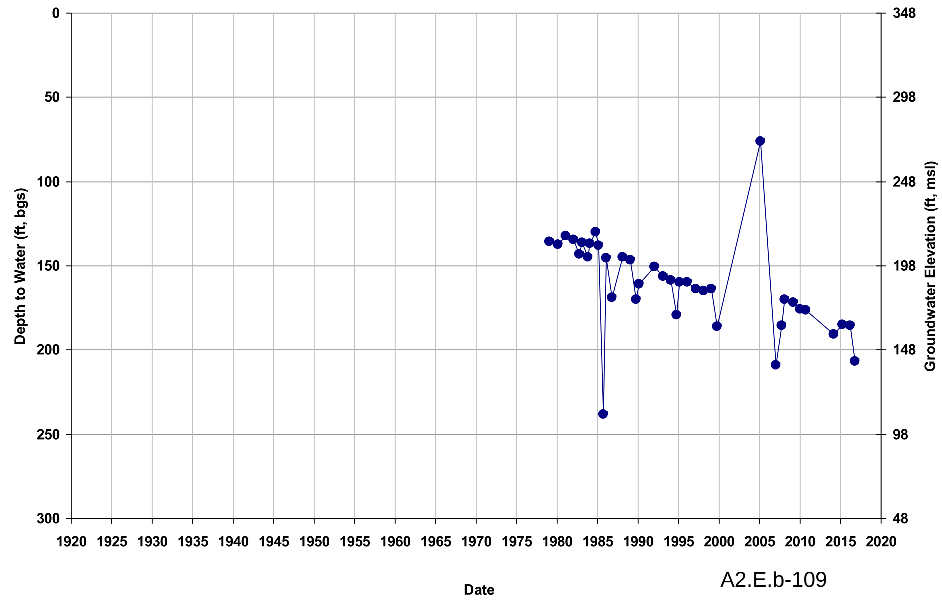
Well ID: 12S20E18B002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

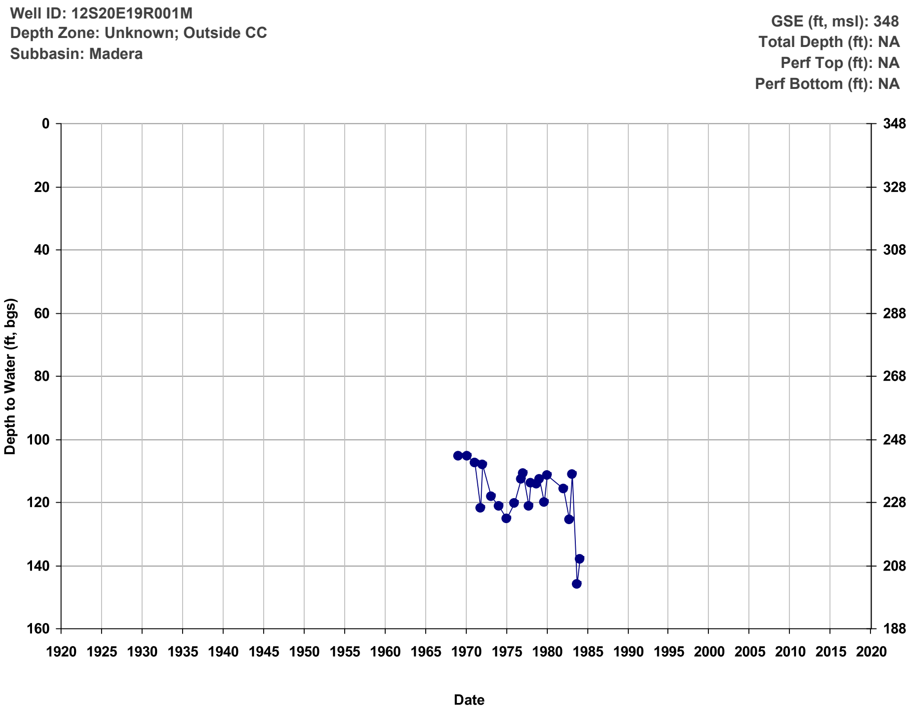
GSE (ft, msl): 354
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA

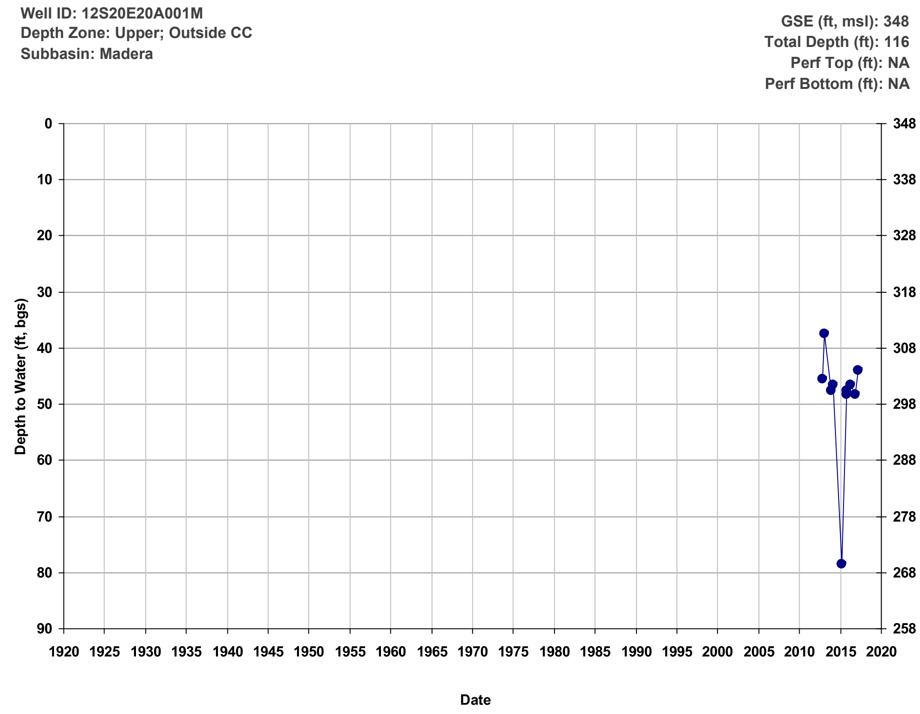


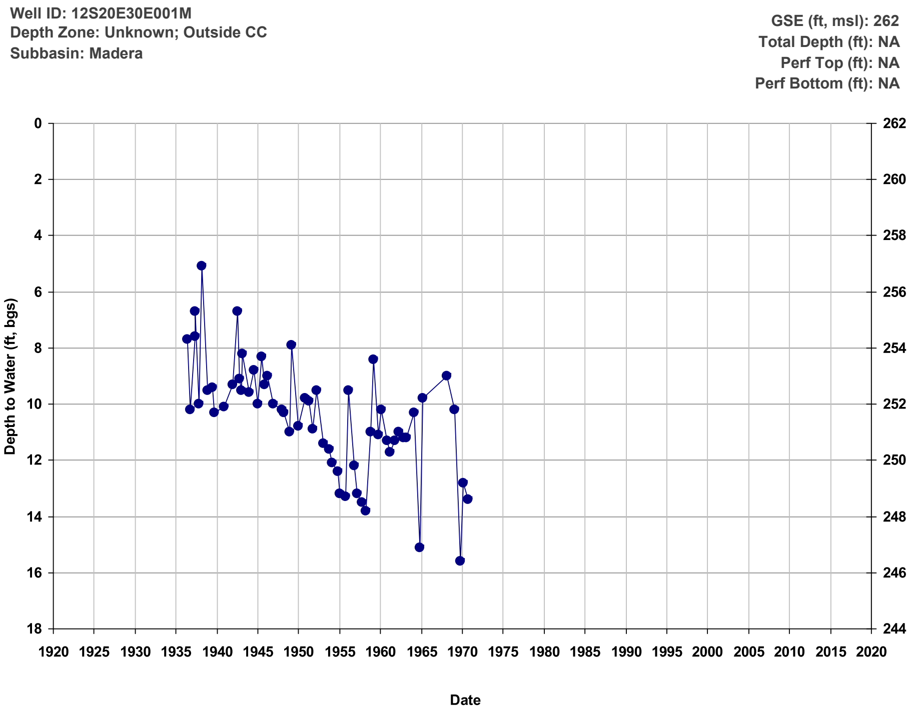
Well ID: 12S20E18N001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

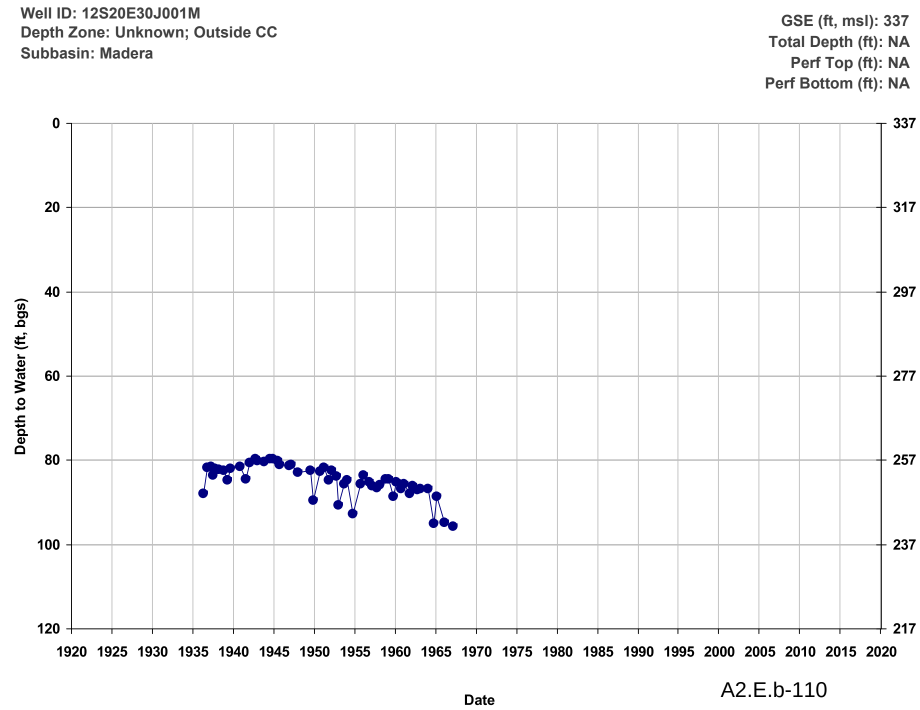
GSE (ft, msl): 347
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA




Well ID: 12S20E19R001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 348
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

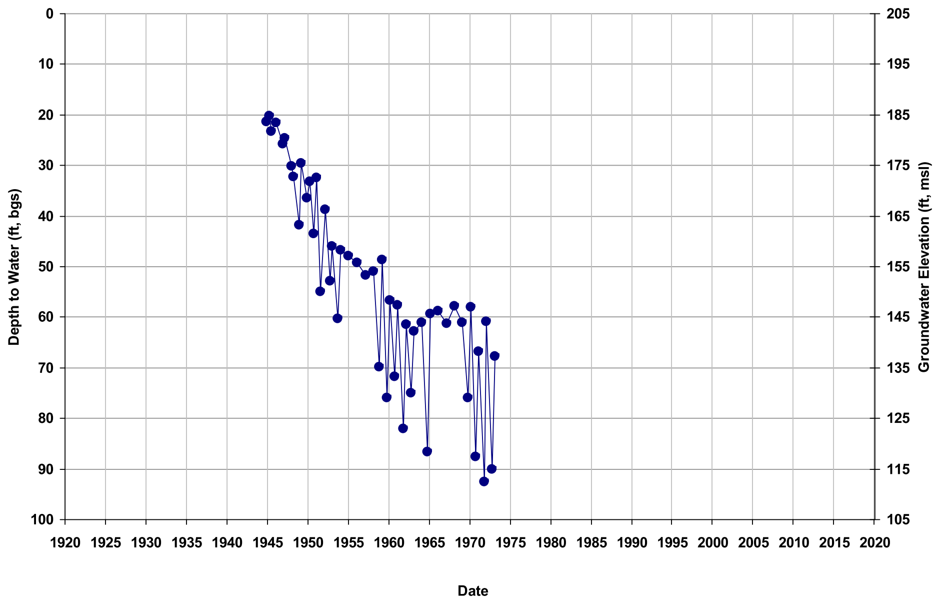

Well ID: 12S20E20A001M
Depth Zone: Upper; Outside CC
Subbasin: Madera
GSE (ft, msl): 348
Total Depth (ft): 116
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 12S20E30E001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 262
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: 12S20E30J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 337
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

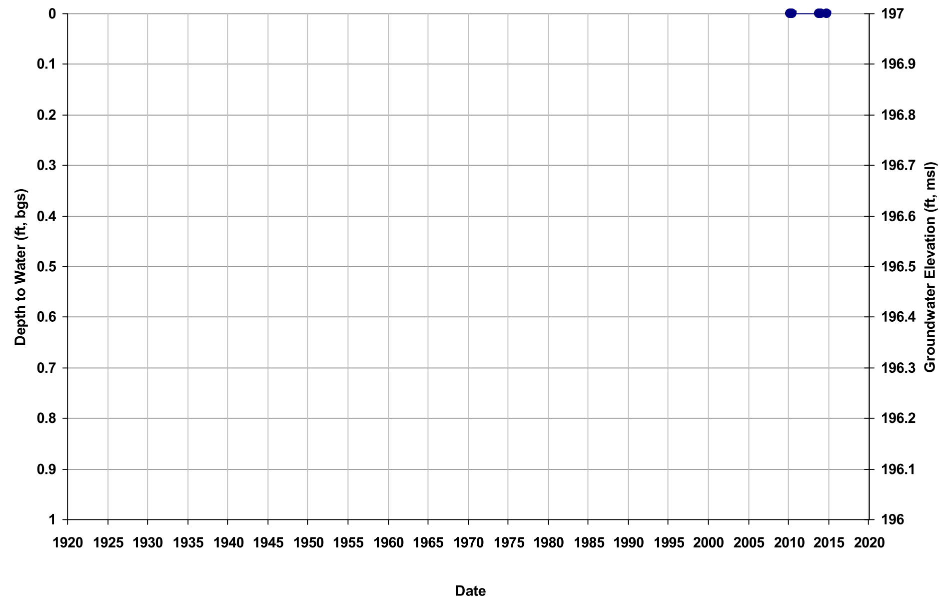
Well ID: 13S16E01A001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 205
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



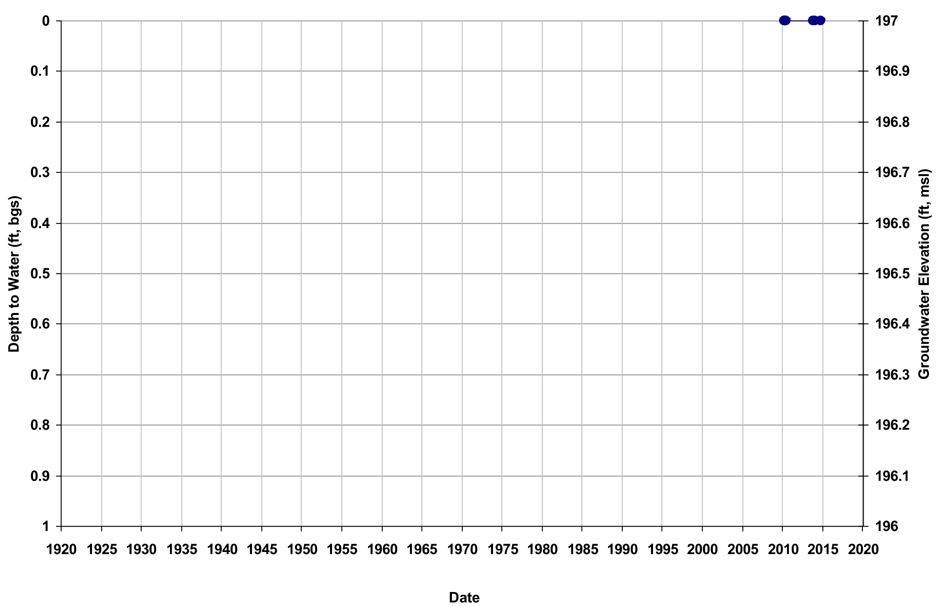
Well ID: 13S16E02C001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 197
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



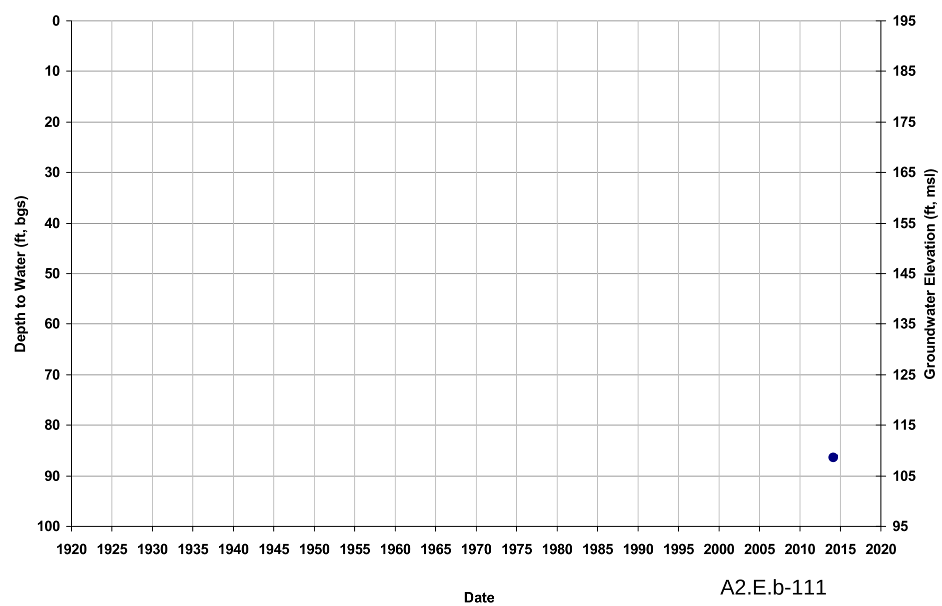
Well ID: 13S16E02C003M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 197
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



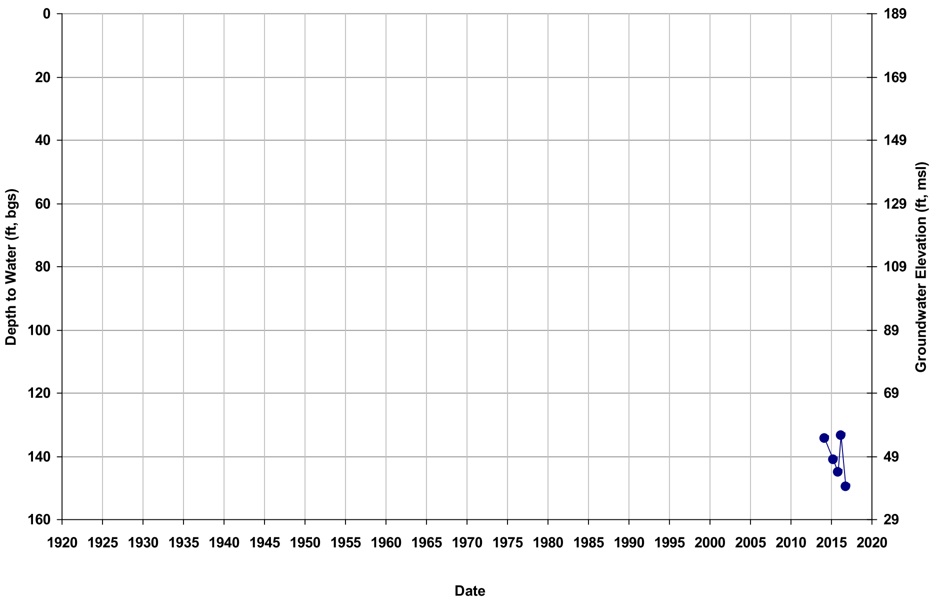
Well ID: 13S16E02F001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 195
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



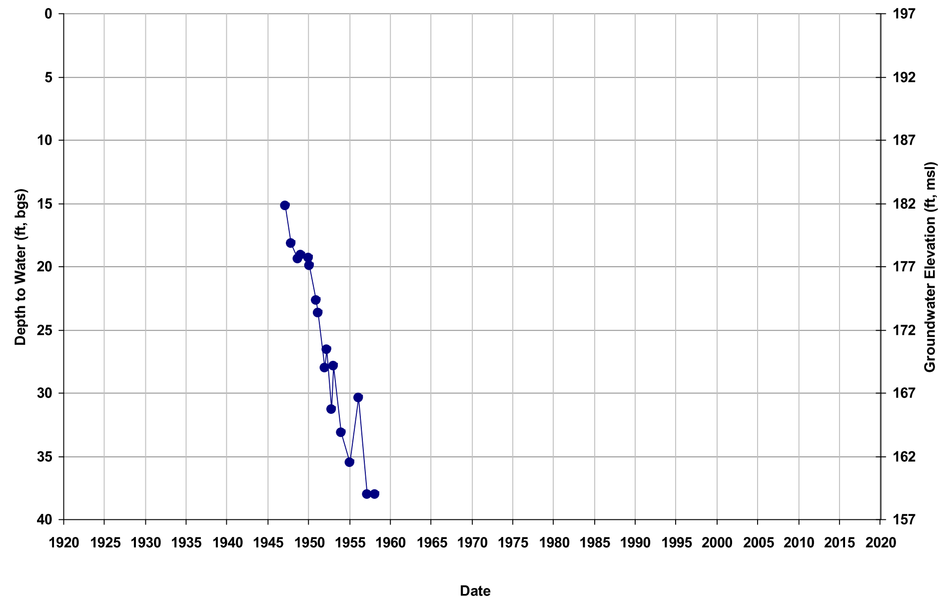
Well ID: 13S16E03L001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 189
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



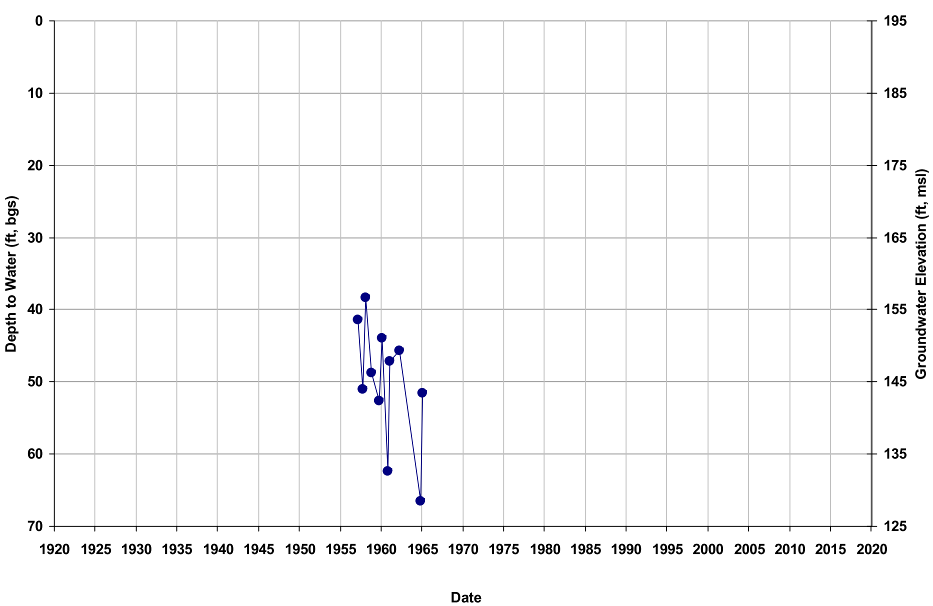
Well ID: 13S16E11C001M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 197
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



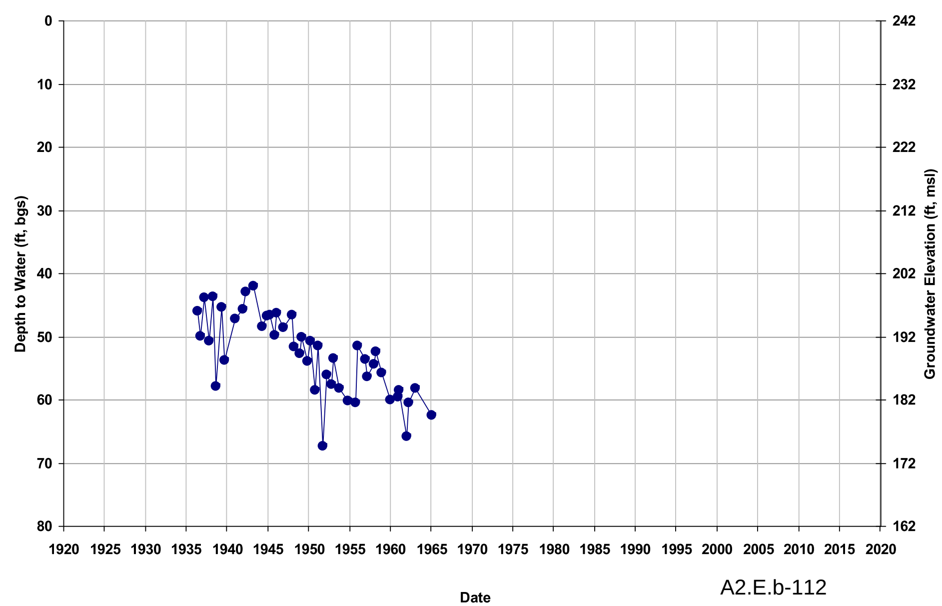
Well ID: 13S16E11C002M
Depth Zone: Unknown; Within CC
Subbasin: Madera

GSE (ft, msl): 195
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



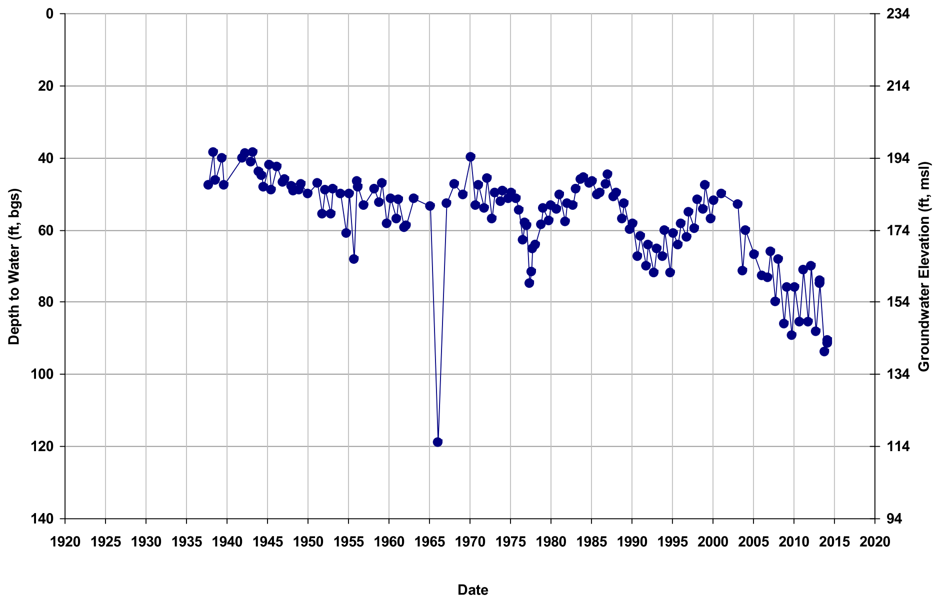
Well ID: 13S17E01D001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 242
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



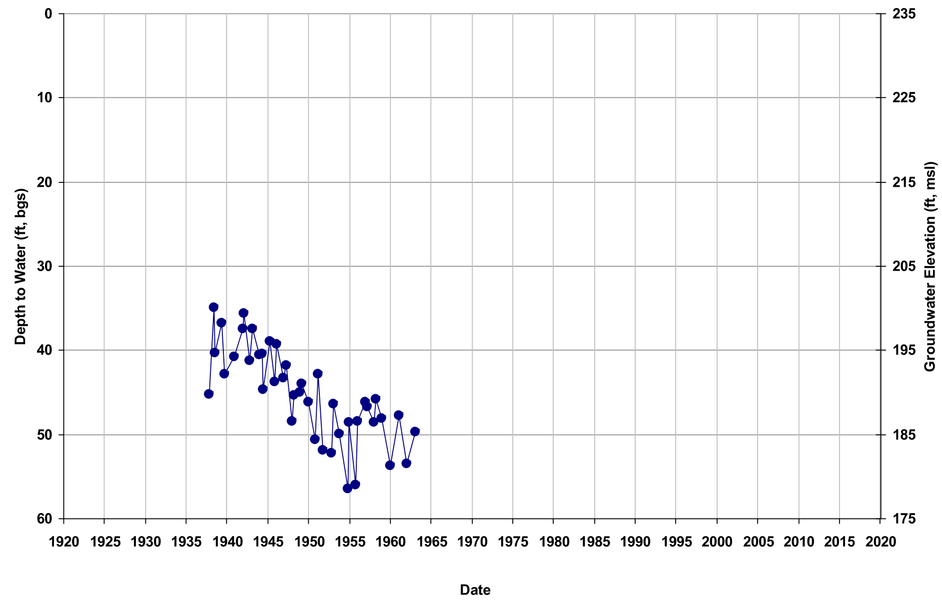
Well ID: 13S17E03H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 233
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



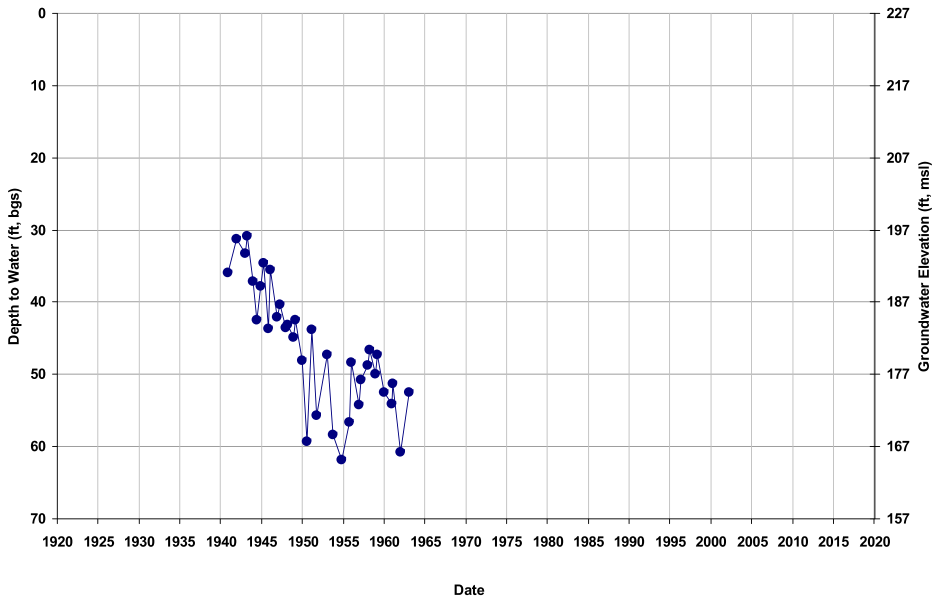
Well ID: 13S17E03J002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 234
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



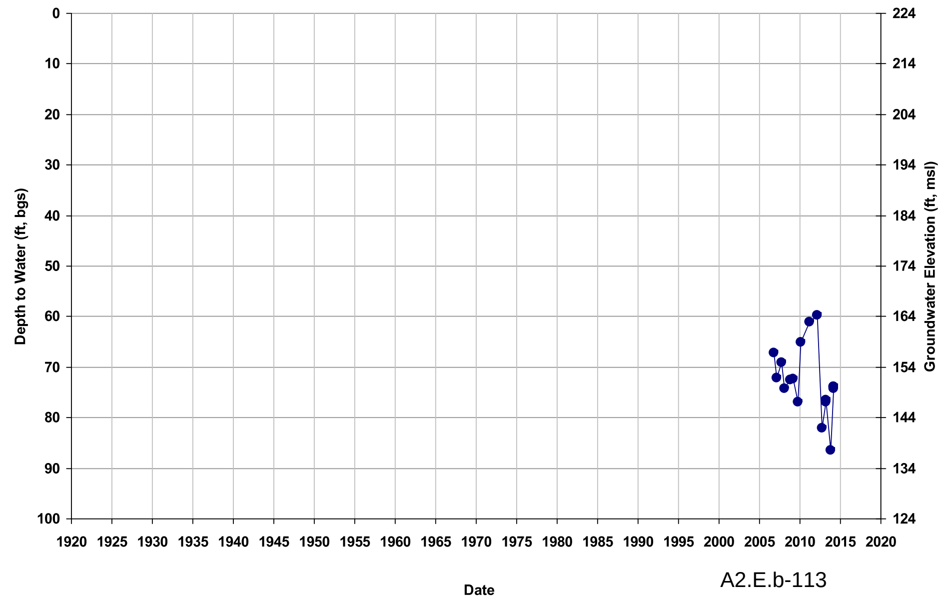
Well ID: 13S17E04A002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 226
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



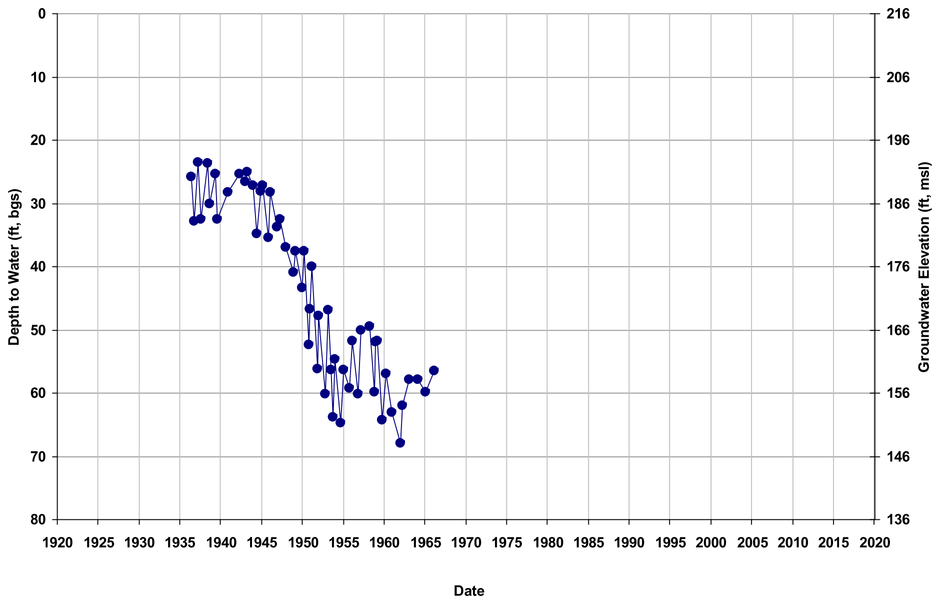
Well ID: 13S17E04R001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 224
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



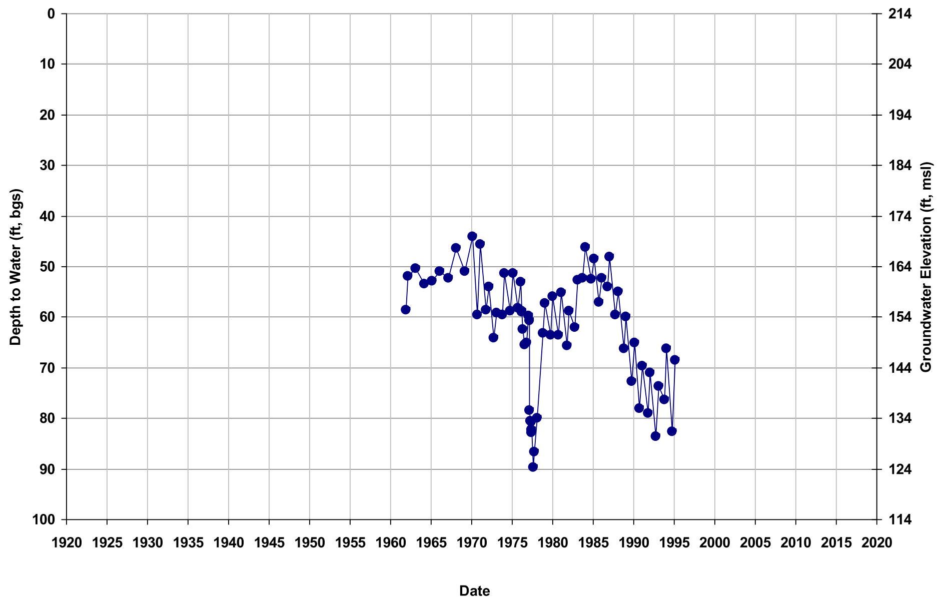
Well ID: 13S17E05C001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 216
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



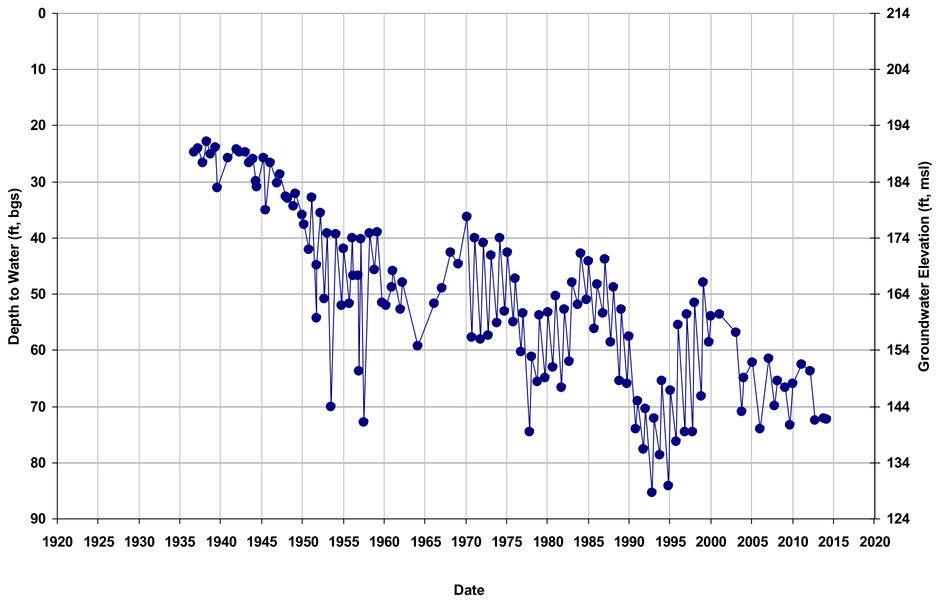
Well ID: 13S17E05L002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 214
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



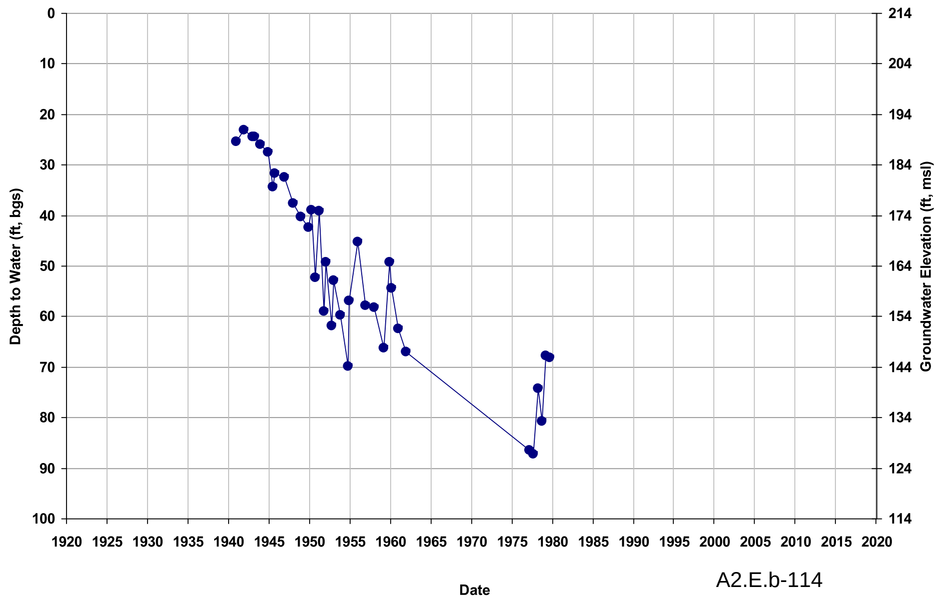
Well ID: 13S17E05P002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 214
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



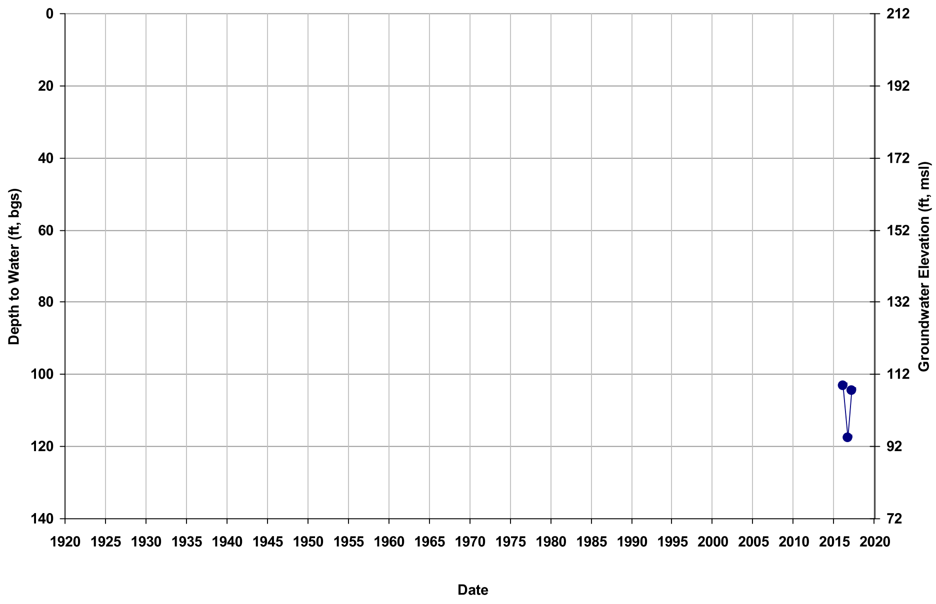
Well ID: 13S17E06A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 214
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



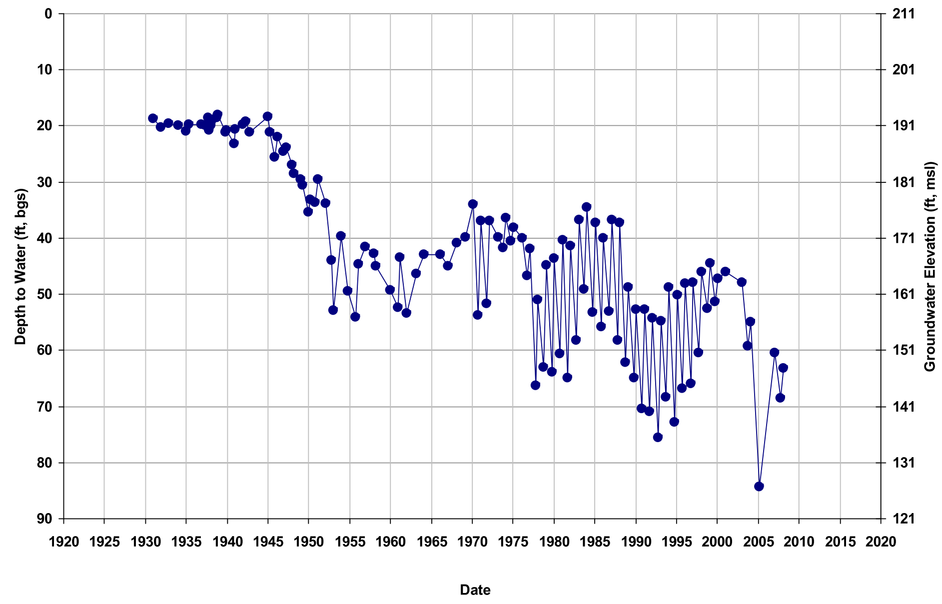
Well ID: 13S17E06H001M
Depth Zone: Upper; Outside CC
Subbasin: Madera

GSE (ft, msl): 212
Total Depth (ft): 260
Perf Top (ft): NA
Perf Bottom (ft): NA



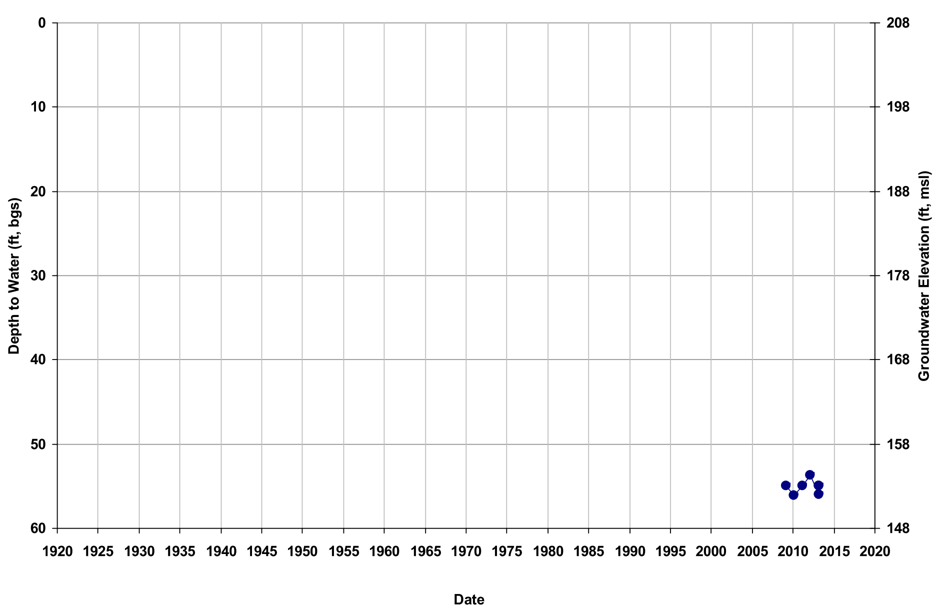
Well ID: 13S17E07A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 211
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



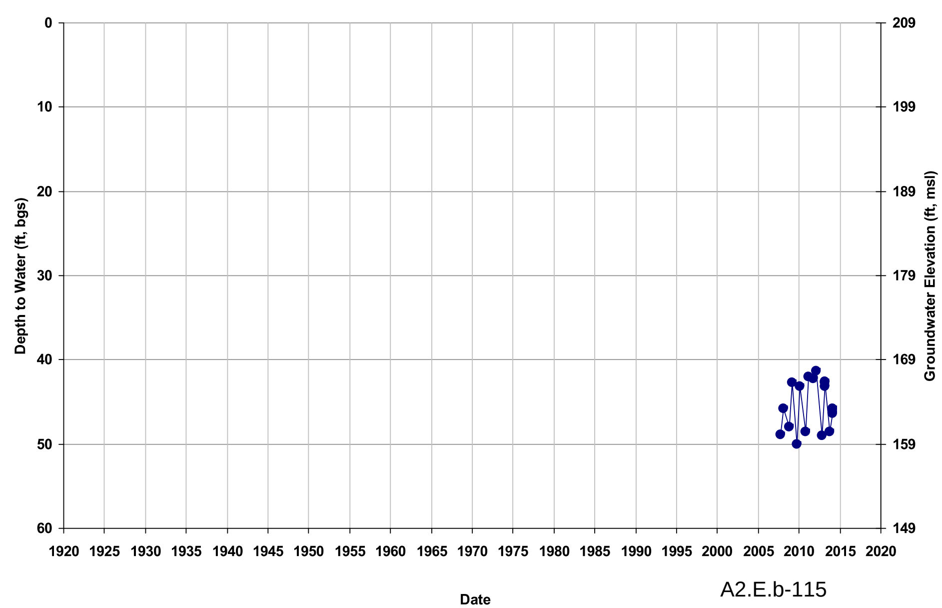
Well ID: 13S17E07J003M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 208
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



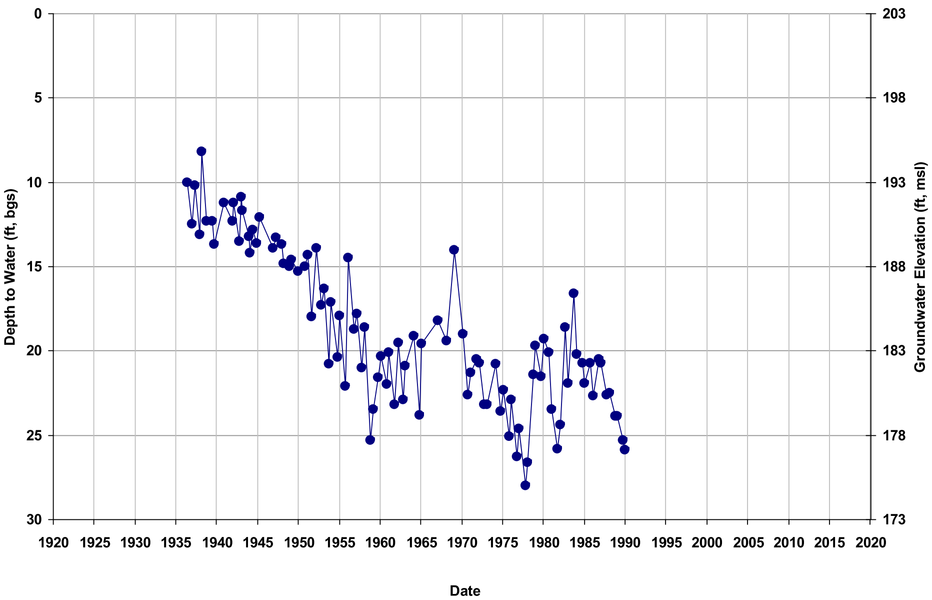
Well ID: 13S17E08L001M
Depth Zone: Upper; Outside CC
Subbasin: Madera

GSE (ft, msl): 209
Total Depth (ft): 112
Perf Top (ft): NA
Perf Bottom (ft): NA



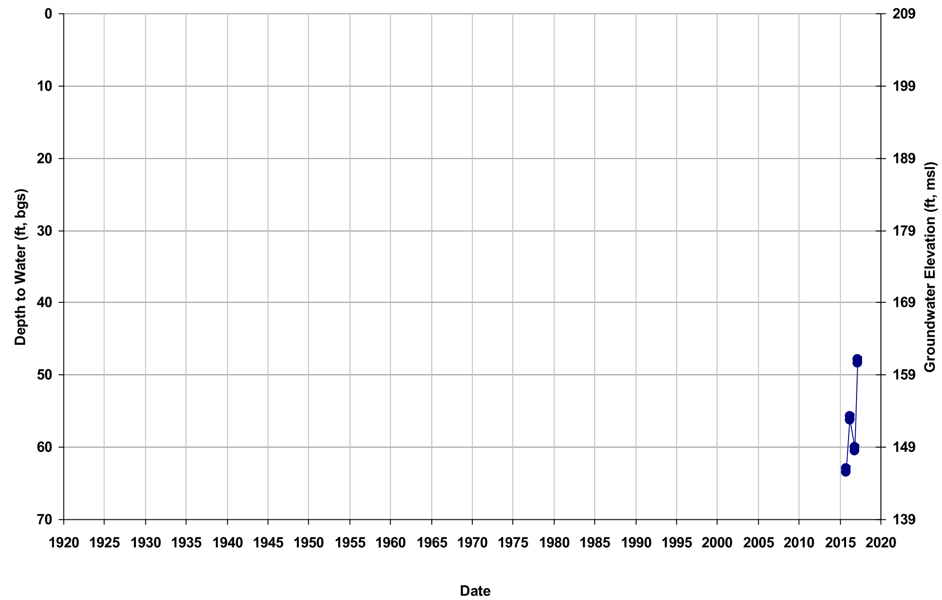
Well ID: 13S17E08N001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 203
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



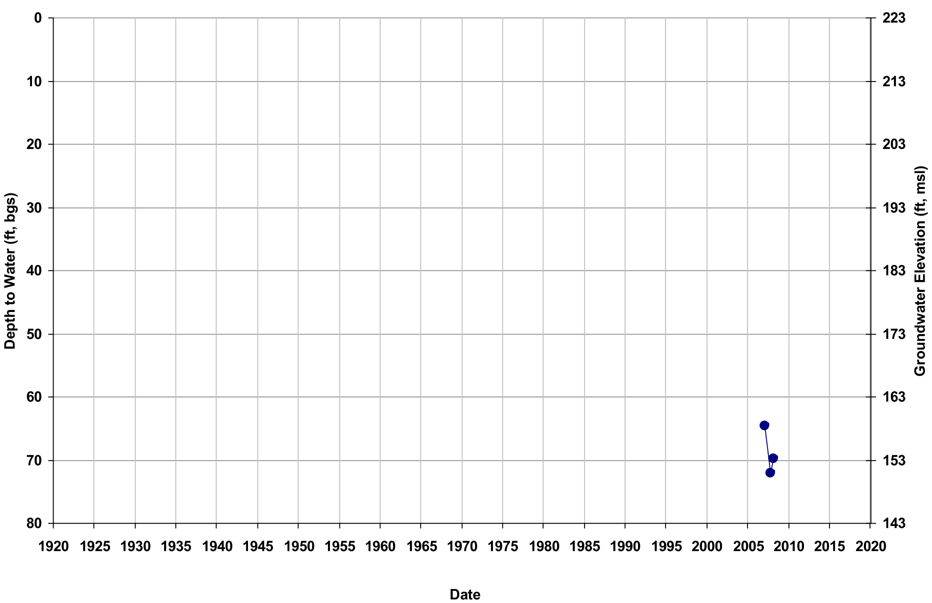
Well ID: 13S17E08P001M
Depth Zone: Upper; Outside CC
Subbasin: Madera

GSE (ft, msl): 208
Total Depth (ft): 320
Perf Top (ft): 160
Perf Bottom (ft): 320



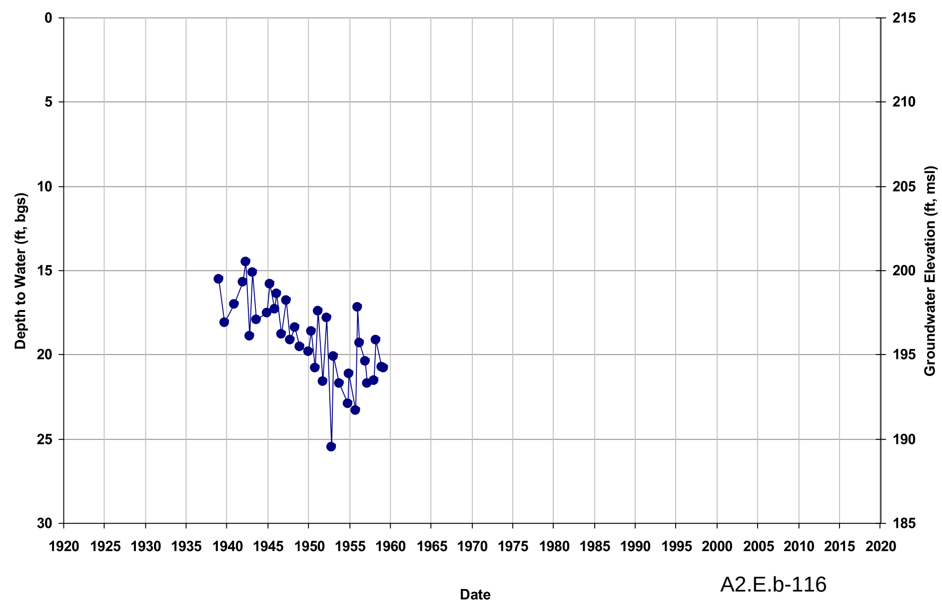
Well ID: 13S17E09A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 222
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



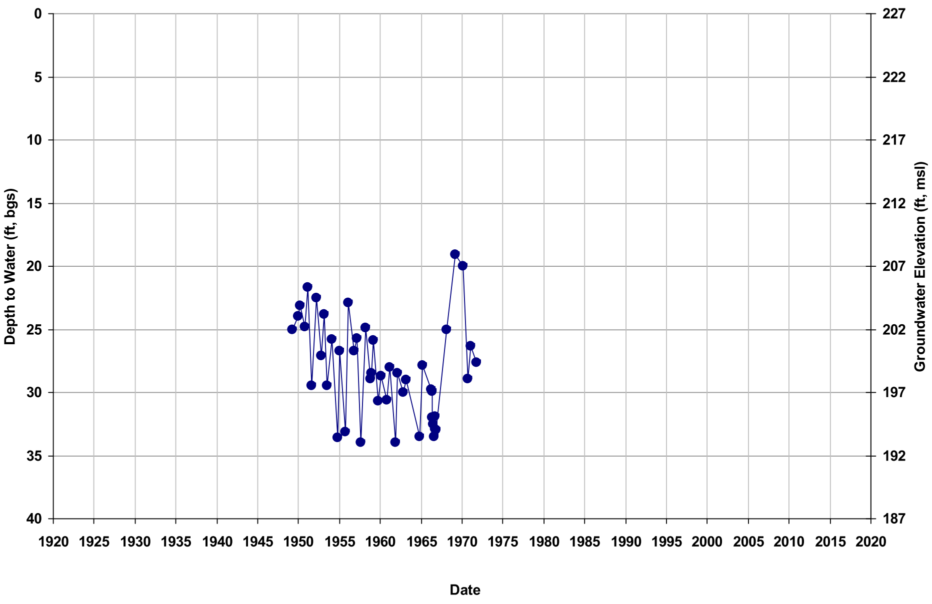
Well ID: 13S17E09H001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 214
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



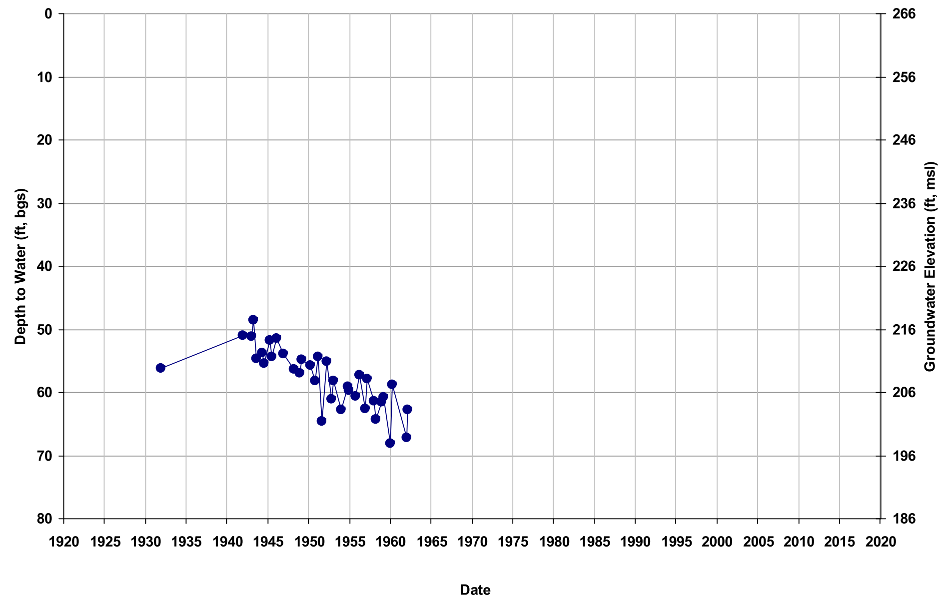
Well ID: 13S17E10A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 227
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



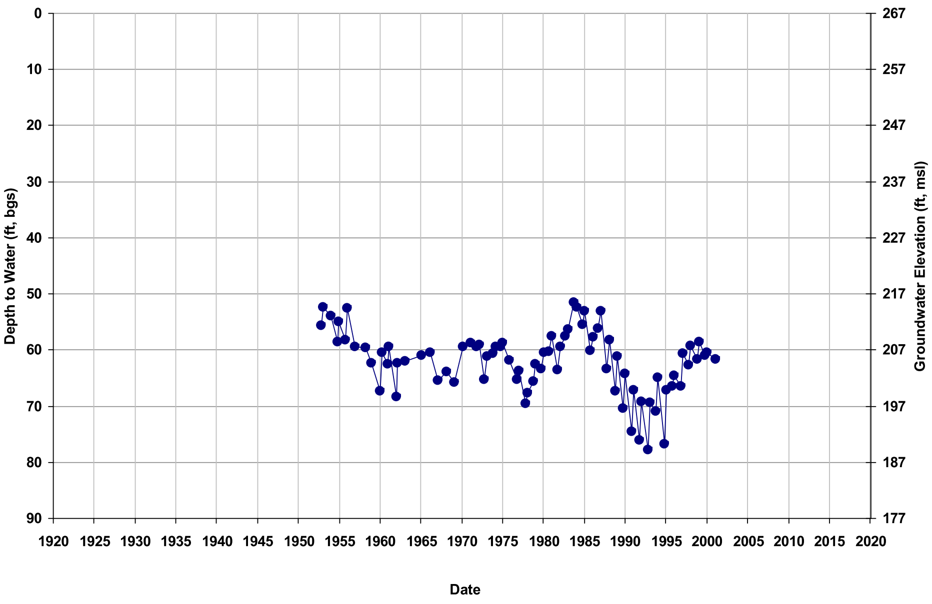
Well ID: 13S18E03B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 265
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



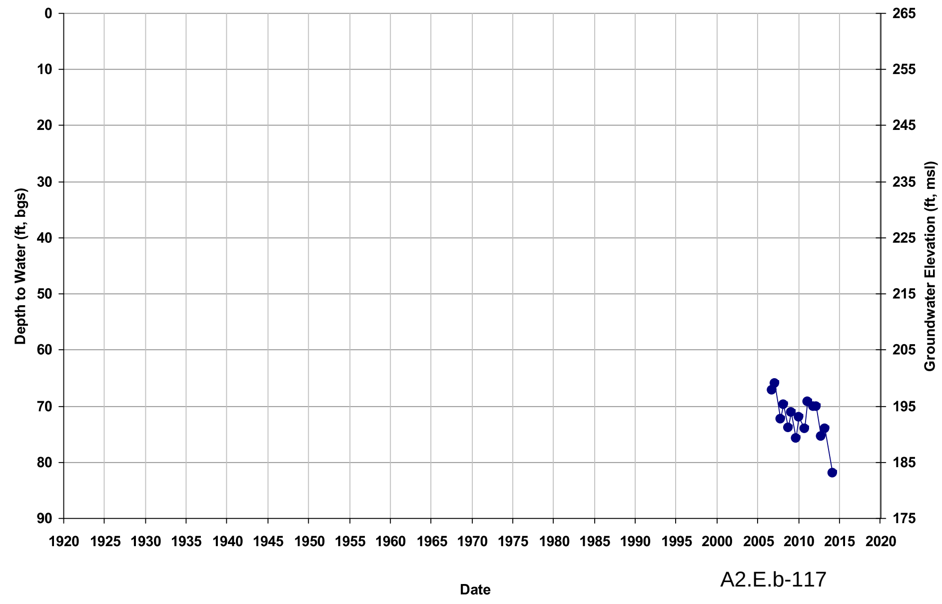
Well ID: 13S18E03C002M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 267
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



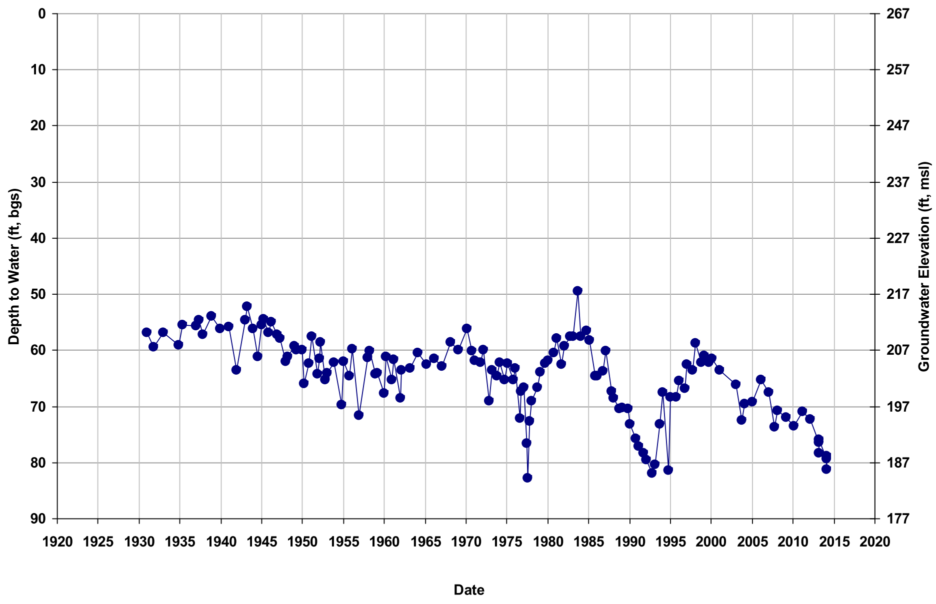
Well ID: 13S18E04A001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 264
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



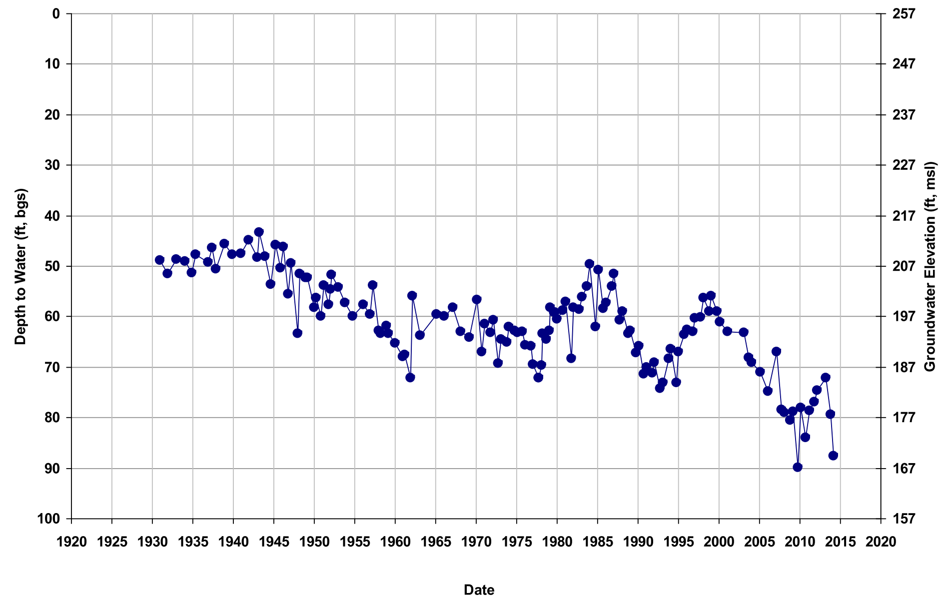
Well ID: 13S18E04B001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 266
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



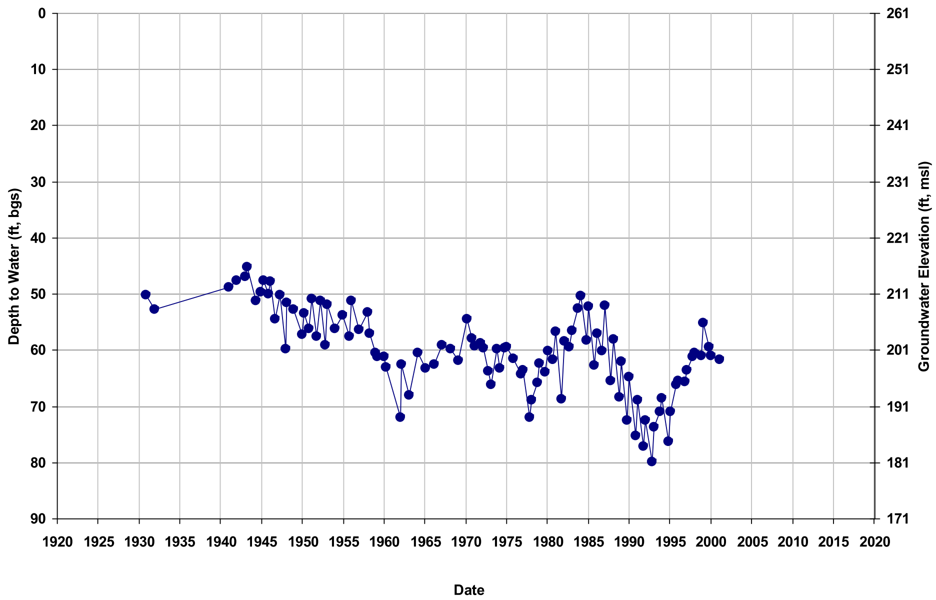
Well ID: 13S18E05E001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 257
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



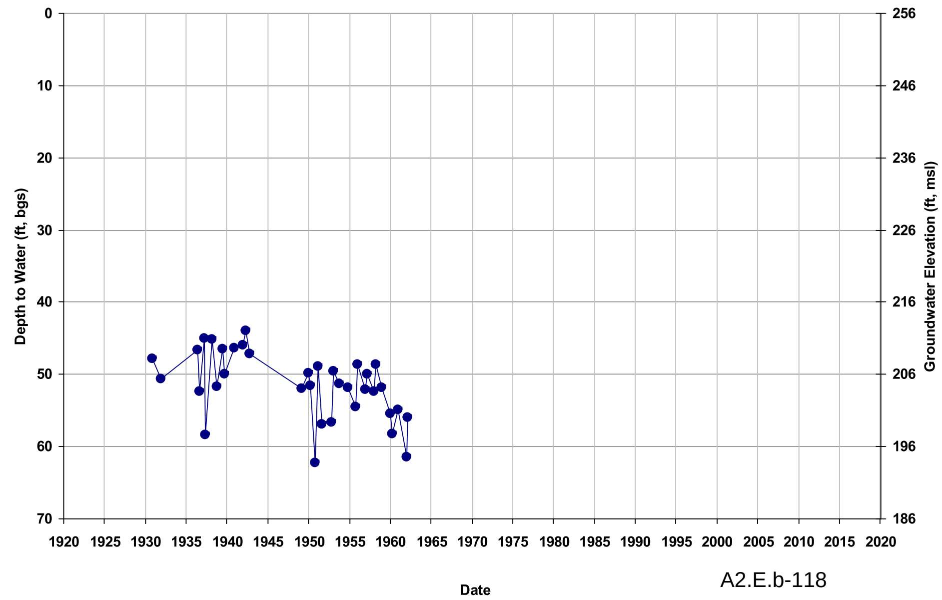
Well ID: 13S18E05J001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 261
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



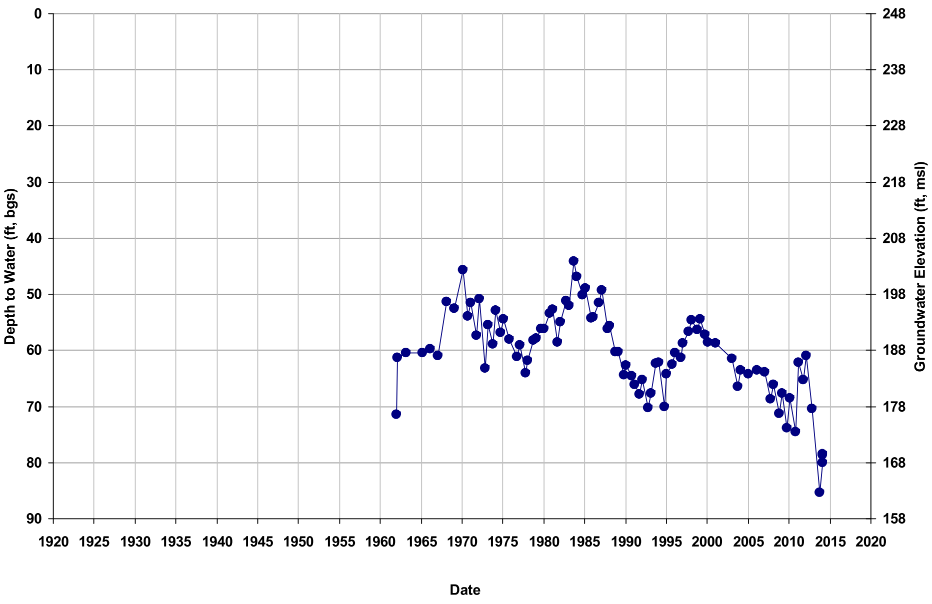
Well ID: 13S18E05Q001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 256
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



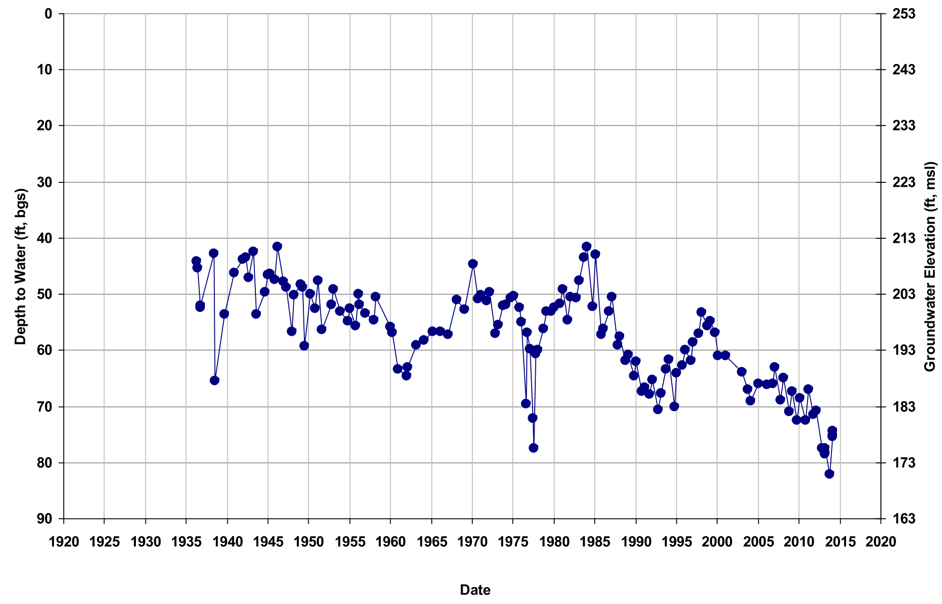
Well ID: 13S18E06F001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 248
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



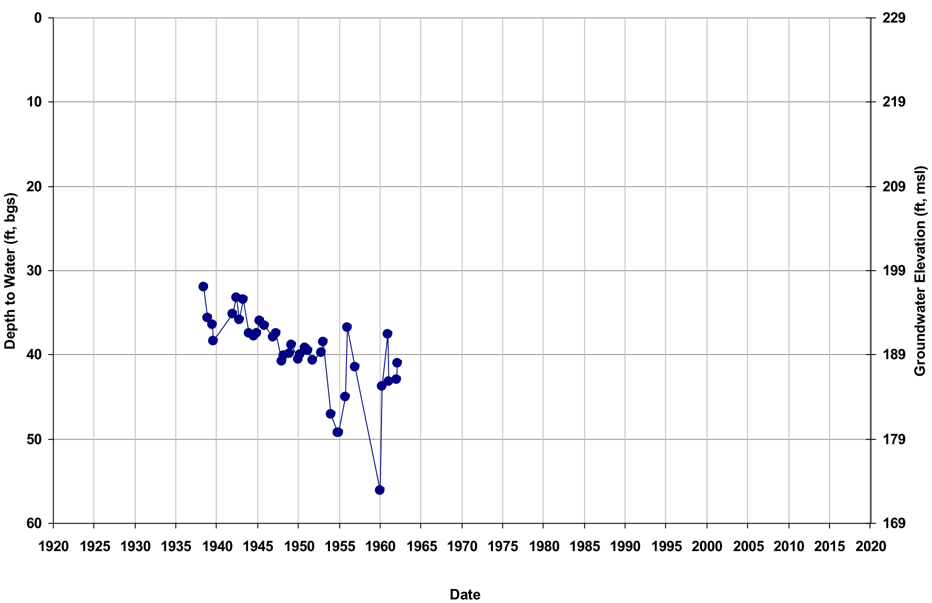
Well ID: 13S18E06K001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 253
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



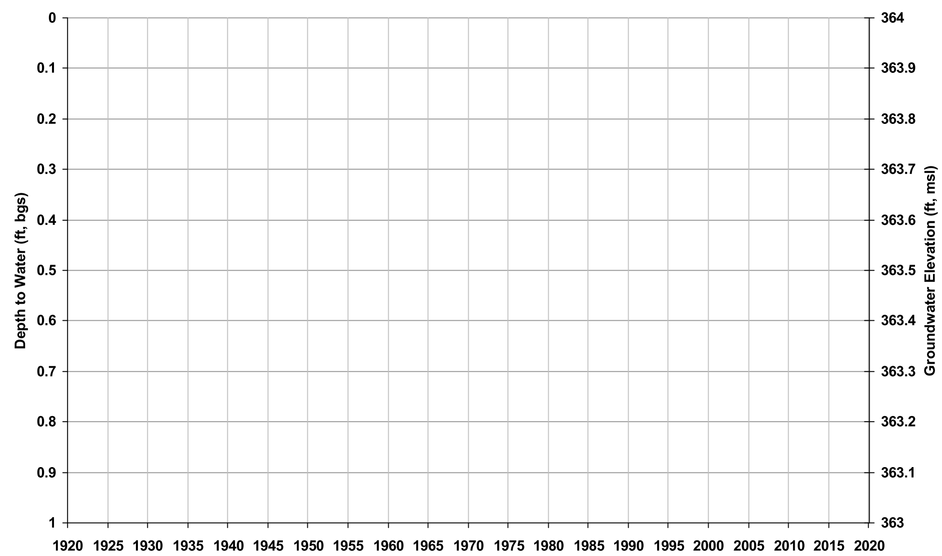
Well ID: 13S18E06N001M
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 228
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



Well ID: 369073N1198180W001
Depth Zone: Unknown; Outside CC
Subbasin: Madera

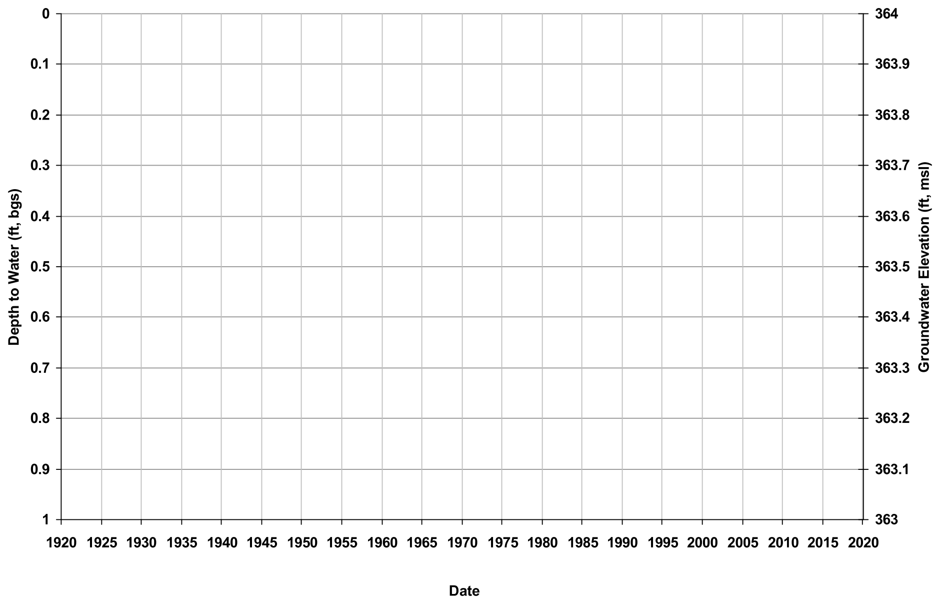
GSE (ft, msl): 363
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



Date

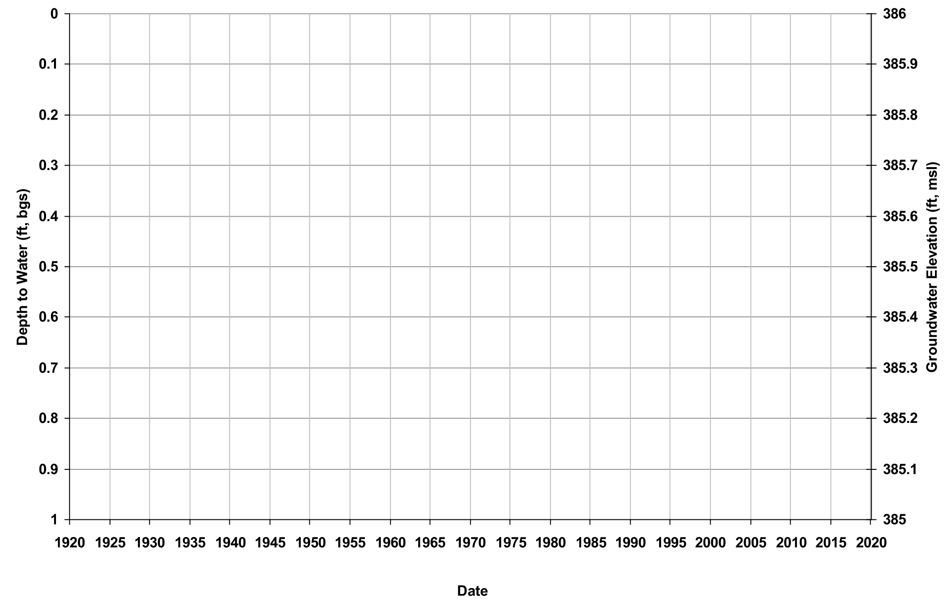
Well ID: 369107N1198121W001
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 363
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



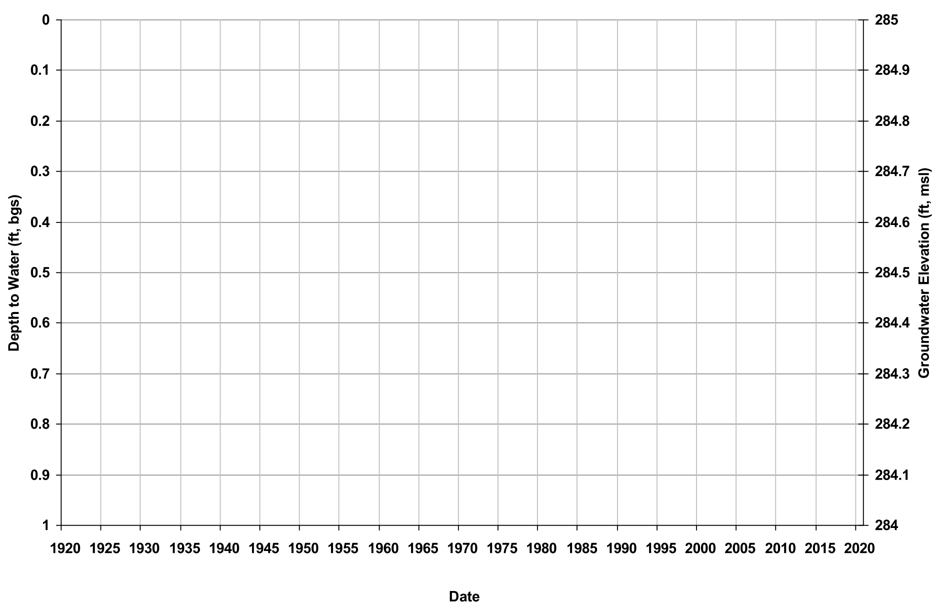
Well ID: 369375N1198168W001
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 386
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



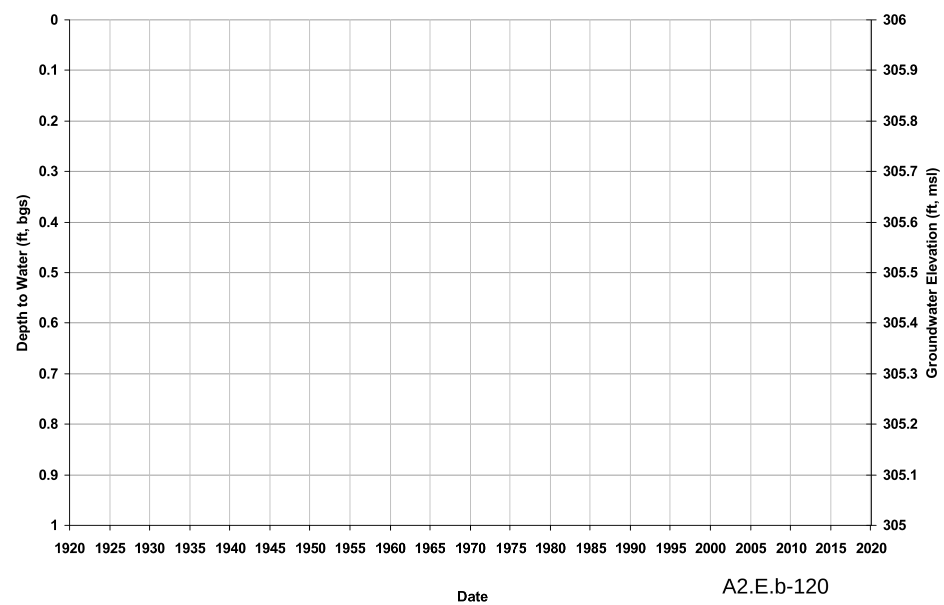
Well ID: 369634N1200185W001
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 284
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



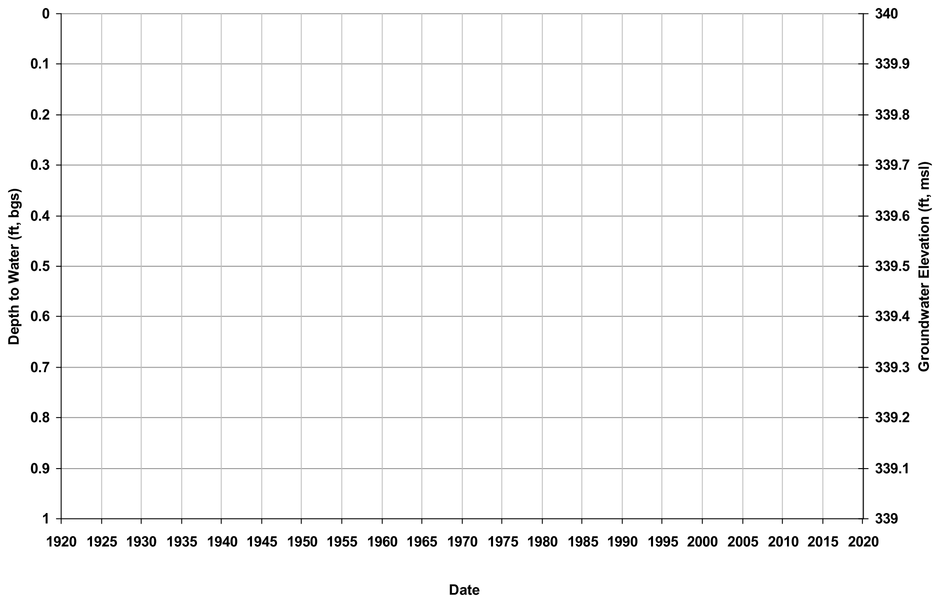
Well ID: 370196N1200526W001
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 306
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



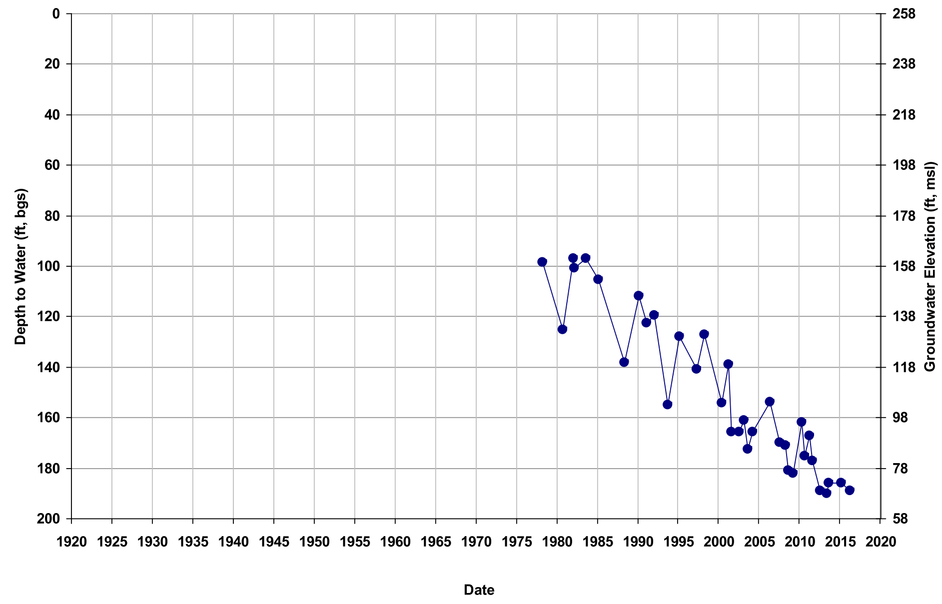
Well ID: 371271N1200563W001
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 339
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA



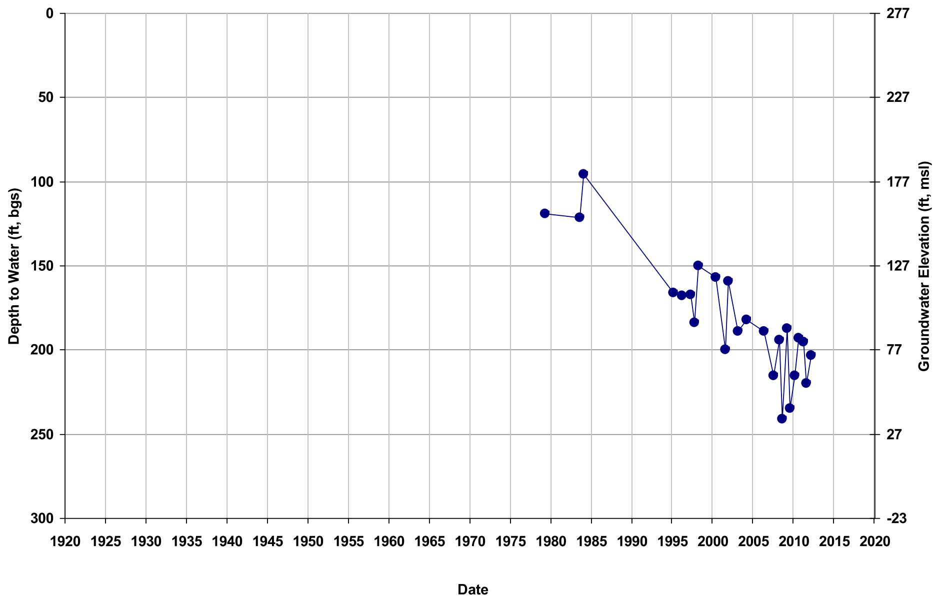
Well ID: City_of_Madera_15
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 258
Total Depth (ft): 465
Perf Top (ft): 195
Perf Bottom (ft): 465



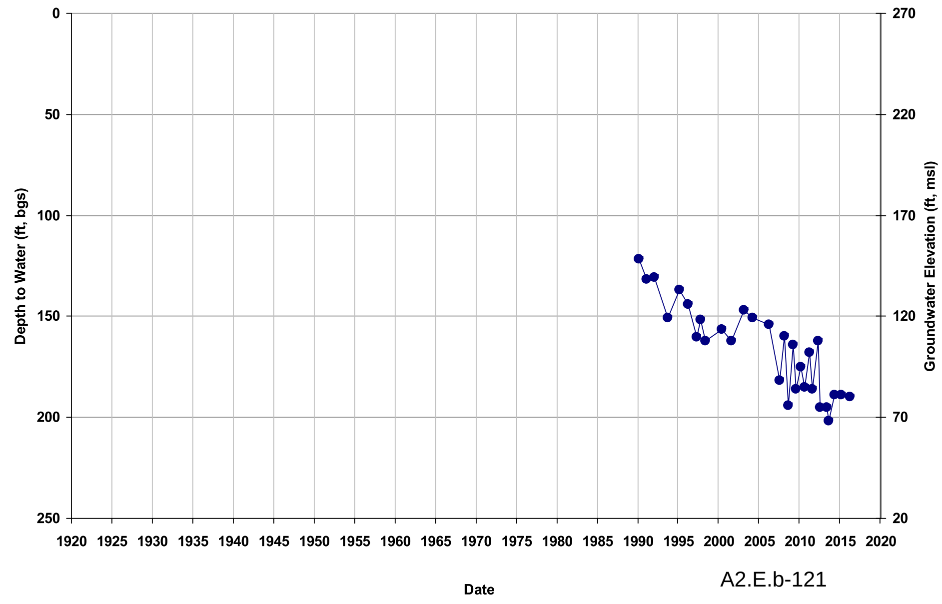
Well ID: City_of_Madera_16
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 276
Total Depth (ft): 520
Perf Top (ft): 190
Perf Bottom (ft): 504



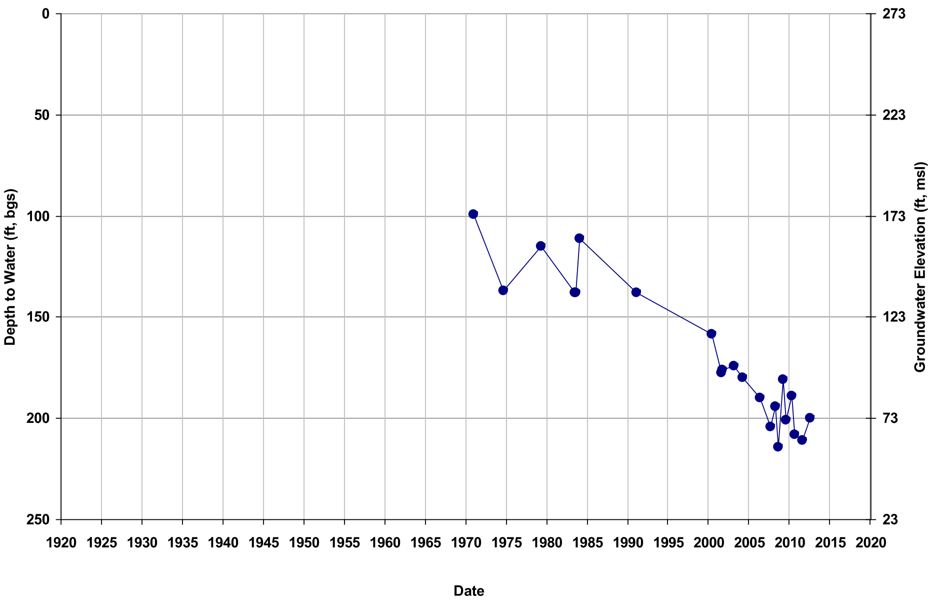
Well ID: City_of_Madera_17
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 270
Total Depth (ft): 620
Perf Top (ft): 260
Perf Bottom (ft): 620



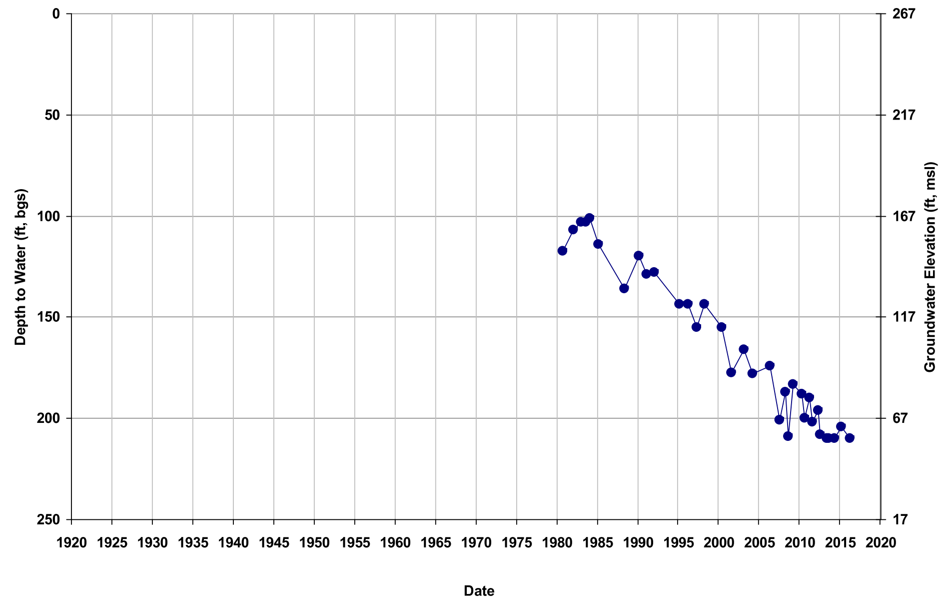
Well ID: City_of_Madera_18
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 272
Total Depth (ft): 610
Perf Top (ft): 285
Perf Bottom (ft): 605



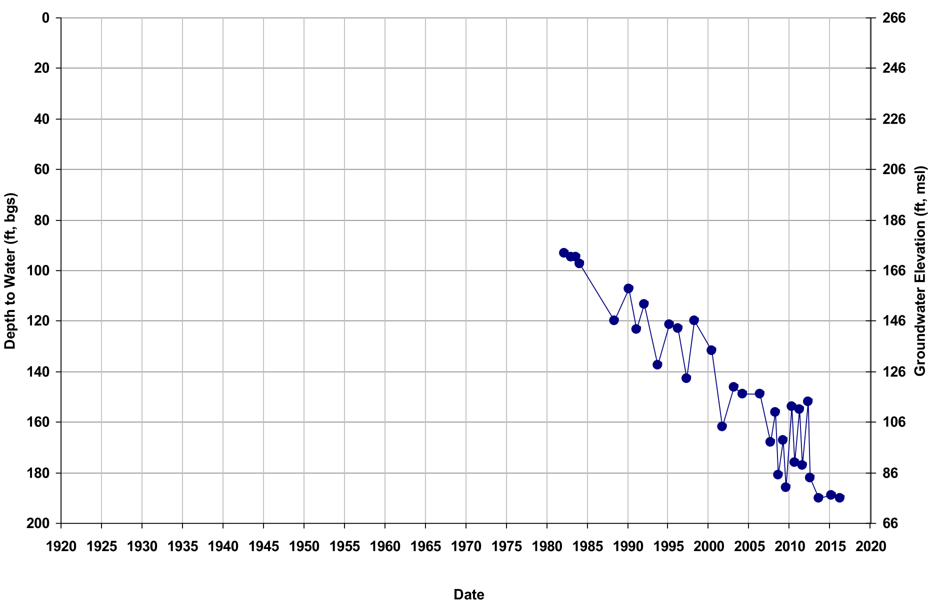
Well ID: City_of_Madera_20
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 267
Total Depth (ft): 600
Perf Top (ft): 201
Perf Bottom (ft): 576



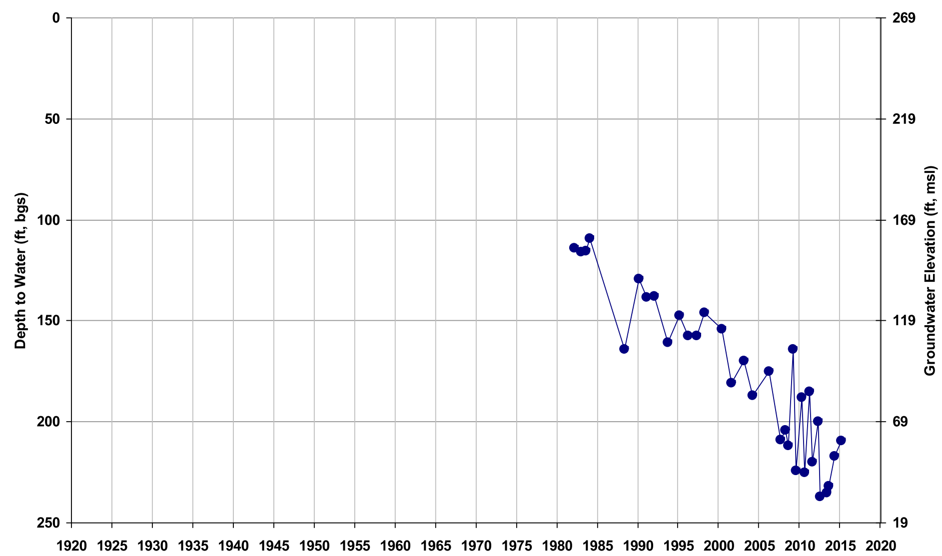
Well ID: City_of_Madera_21
Depth Zone: Unknown; Outside CC
Subbasin: Madera

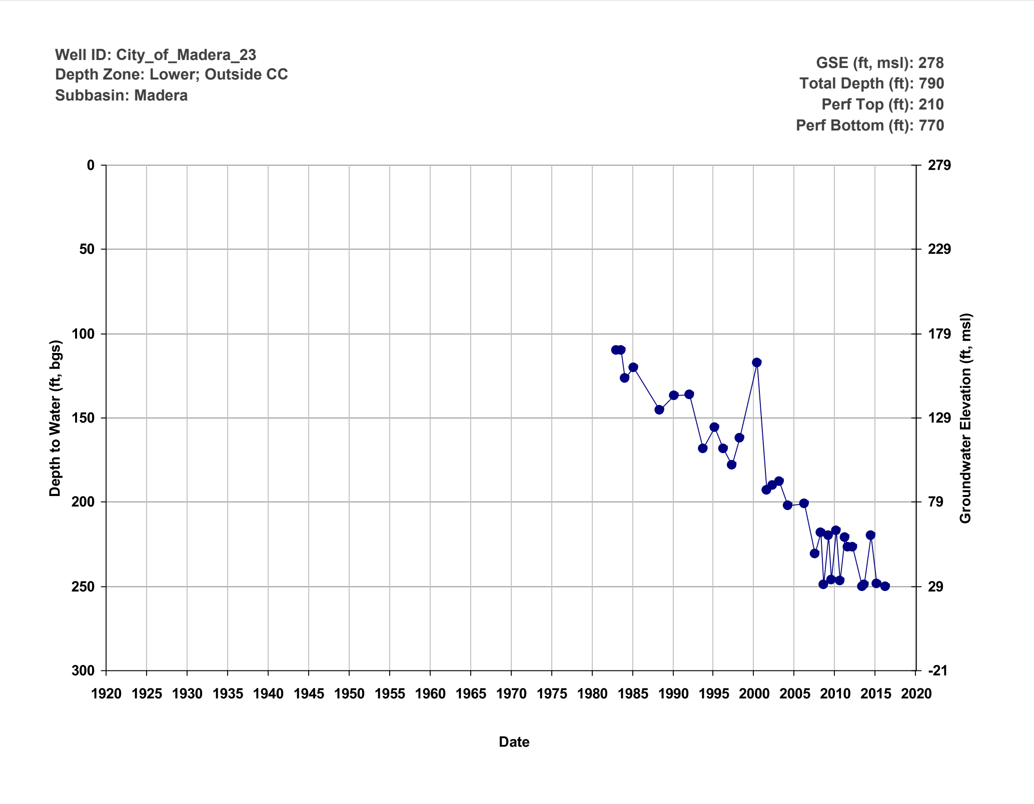
GSE (ft, msl): 265
Total Depth (ft): 600
Perf Top (ft): 230
Perf Bottom (ft): 600

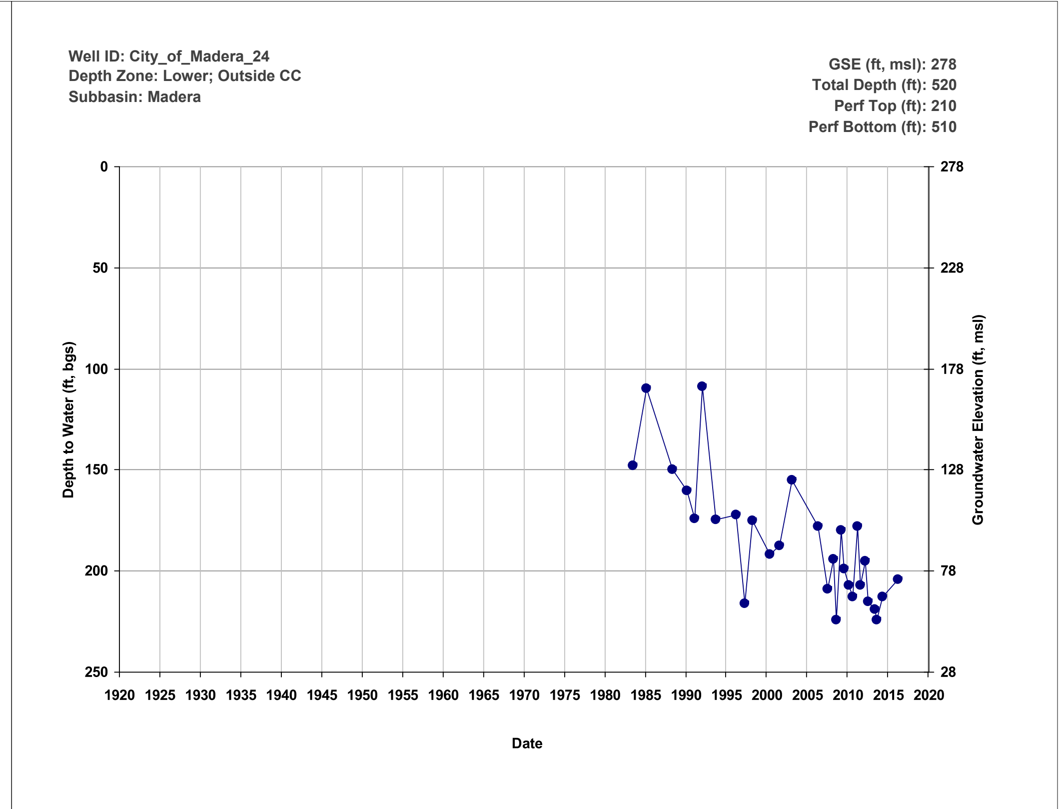


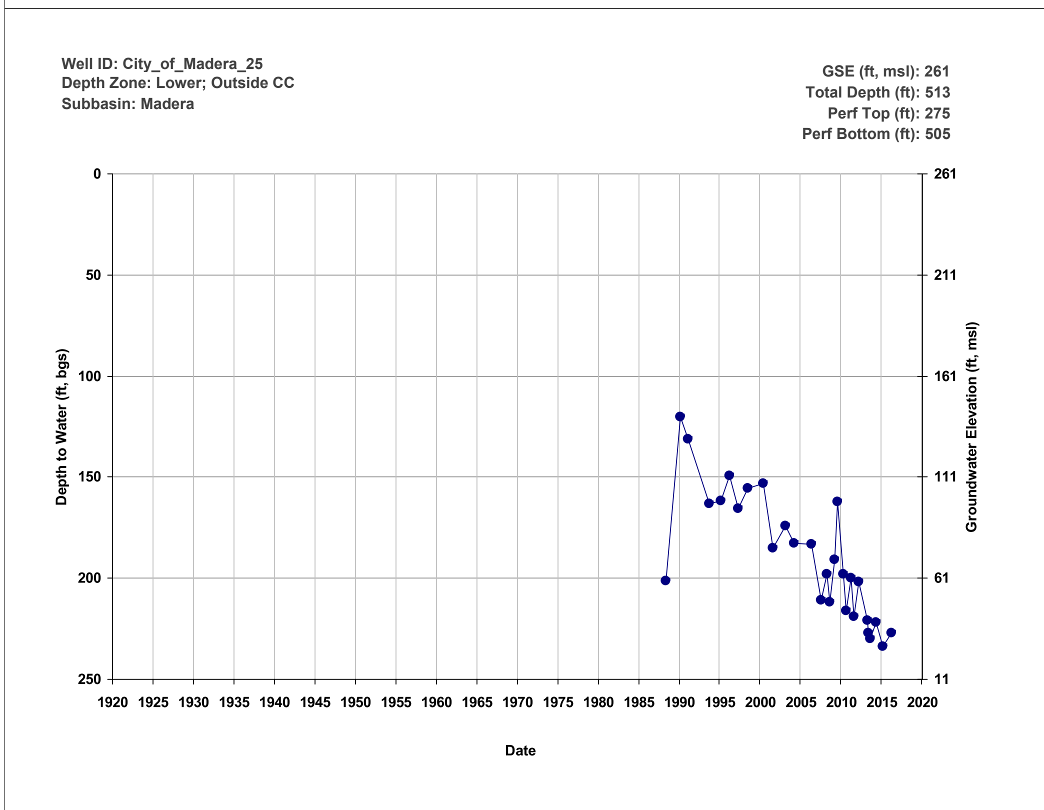
Well ID: City_of_Madera_22
Depth Zone: Unknown; Outside CC
Subbasin: Madera

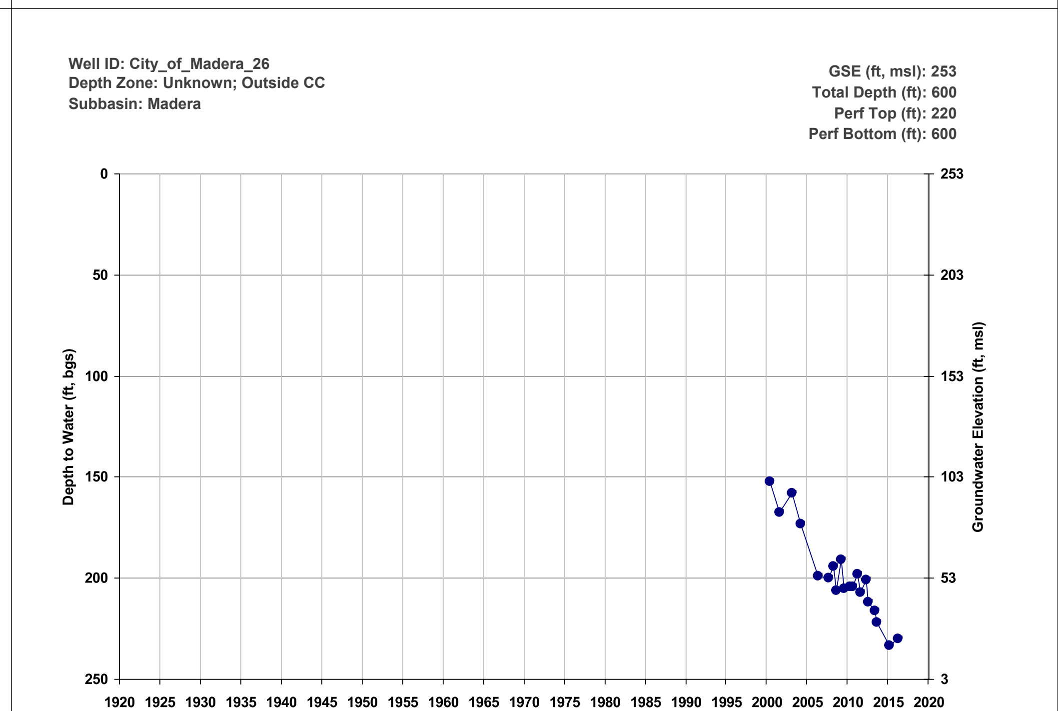
GSE (ft, msl): 268
Total Depth (ft): 520
Perf Top (ft): 240
Perf Bottom (ft): 520




Well ID: City_of_Madera_23
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 278
Total Depth (ft): 790
Perf Top (ft): 210
Perf Bottom (ft): 770
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
0
50
100
150
200
250
300
279
229
179
129
79
29
-21
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
Date

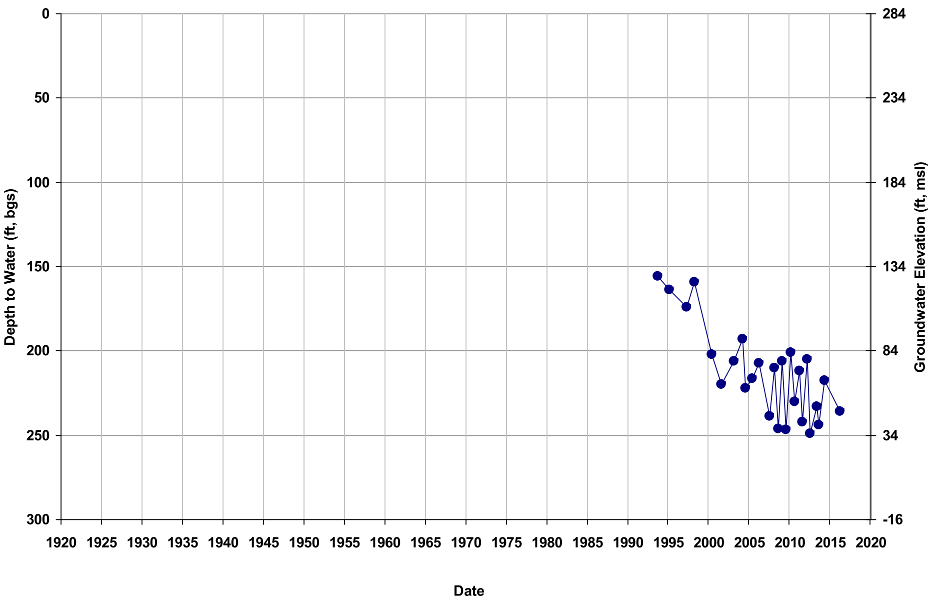

Well ID: City_of_Madera_24
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 278
Total Depth (ft): 520
Perf Top (ft): 210
Perf Bottom (ft): 510
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
0
50
100
150
200
250
278
228
178
128
78
28
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
Date


Well ID: City_of_Madera_25
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 261
Total Depth (ft): 513
Perf Top (ft): 275
Perf Bottom (ft): 505
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
0
50
100
150
200
250
261
211
161
111
61
11
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
Date


Well ID: City_of_Madera_26
Depth Zone: Unknown; Outside CC
Subbasin: Madera
GSE (ft, msl): 253
Total Depth (ft): 600
Perf Top (ft): 220
Perf Bottom (ft): 600
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
0
50
100
150
200
250
253
203
153
103
53
3
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
Date

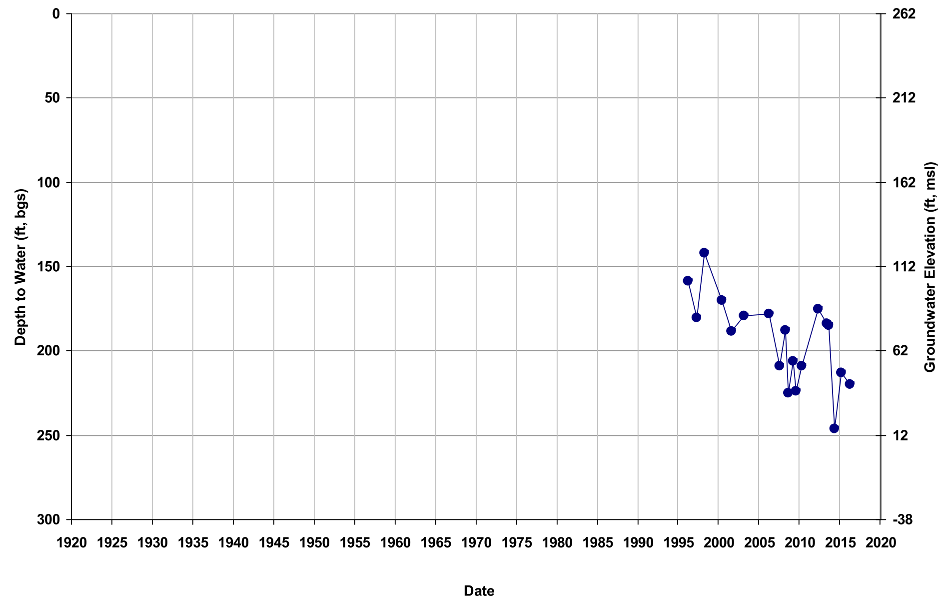
Well ID: City_of_Madera_28
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 284
Total Depth (ft): 522
Perf Top (ft): 270
Perf Bottom (ft): 540



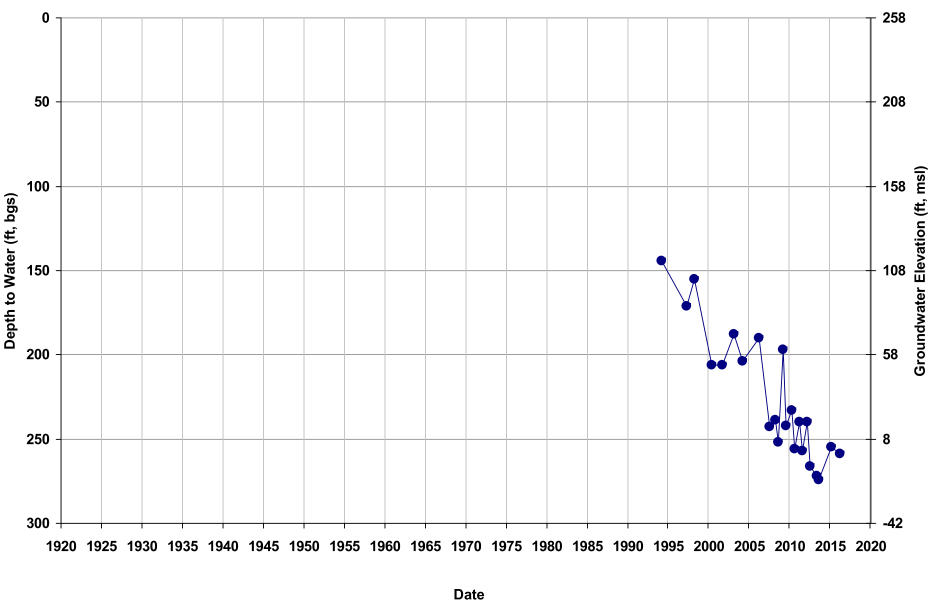
Well ID: City_of_Madera_29
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 262
Total Depth (ft): 589
Perf Top (ft): 370
Perf Bottom (ft): 590



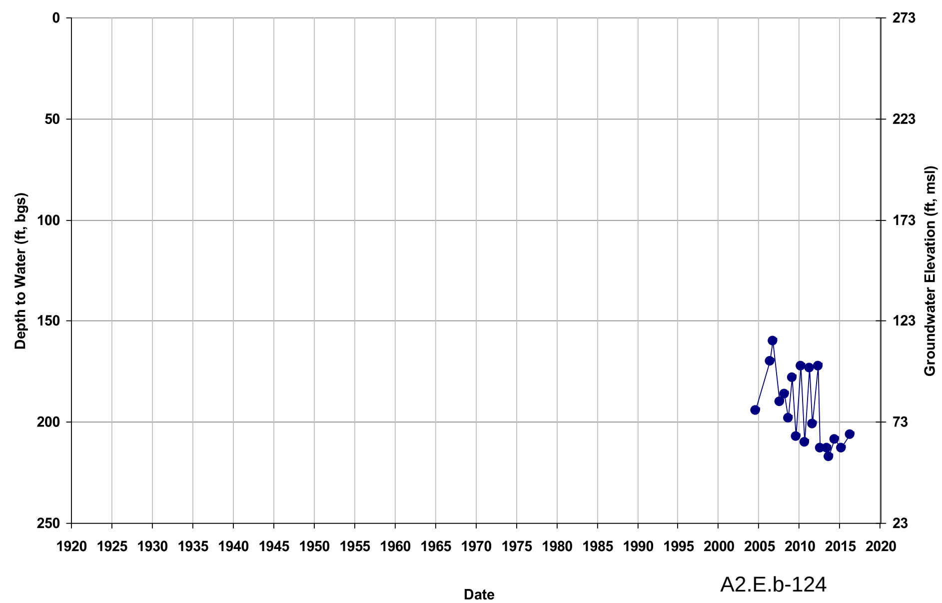
Well ID: City_of_Madera_30
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 257
Total Depth (ft): 720
Perf Top (ft): 430
Perf Bottom (ft): 720



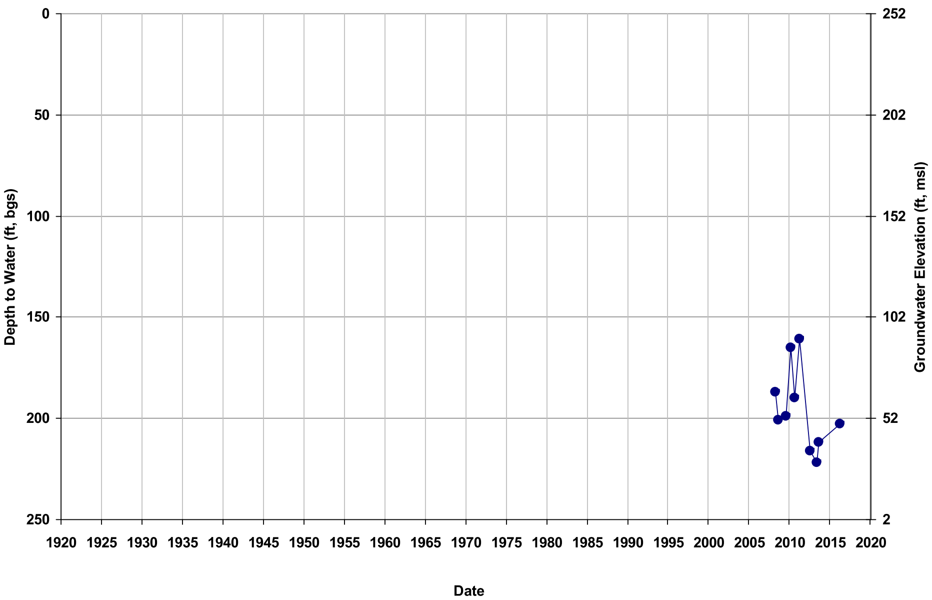
Well ID: City_of_Madera_31
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 273
Total Depth (ft): 520
Perf Top (ft): 265
Perf Bottom (ft): 500



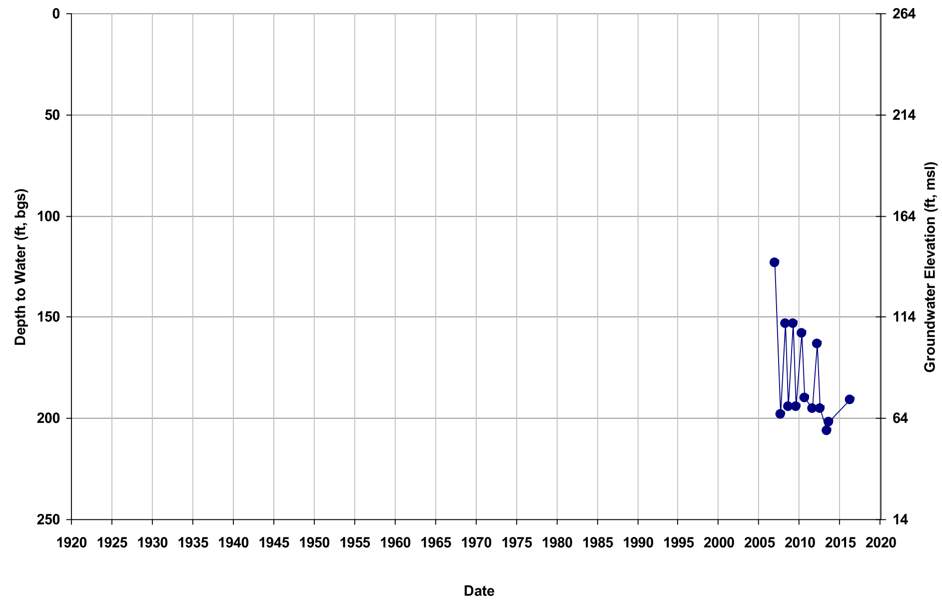
Well ID: City_of_Madera_32
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 252
Total Depth (ft): 700
Perf Top (ft): 320
Perf Bottom (ft): 680



Well ID: City_of_Madera_33
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 264
Total Depth (ft): 620
Perf Top (ft): 310
Perf Bottom (ft): 600

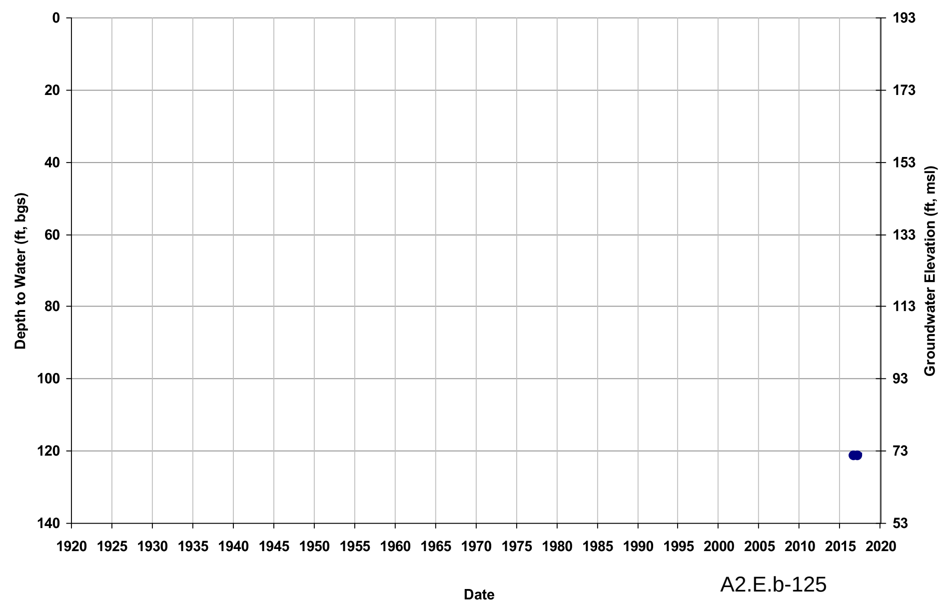


Well ID: City_of_Madera_34
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 267
Total Depth (ft): 588
Perf Top (ft): 433
Perf Bottom (ft): 568

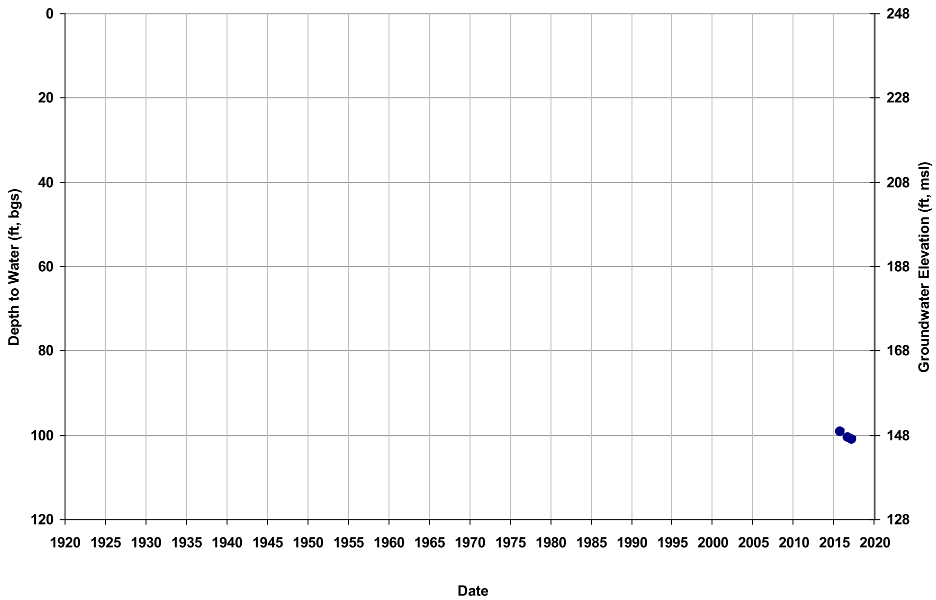
Well ID: Emmert 1
Depth Zone: Upper; Within CC
Subbasin: Madera

GSE (ft, msl): 193
Total Depth (ft): 360
Perf Top (ft): 245
Perf Bottom (ft): 340



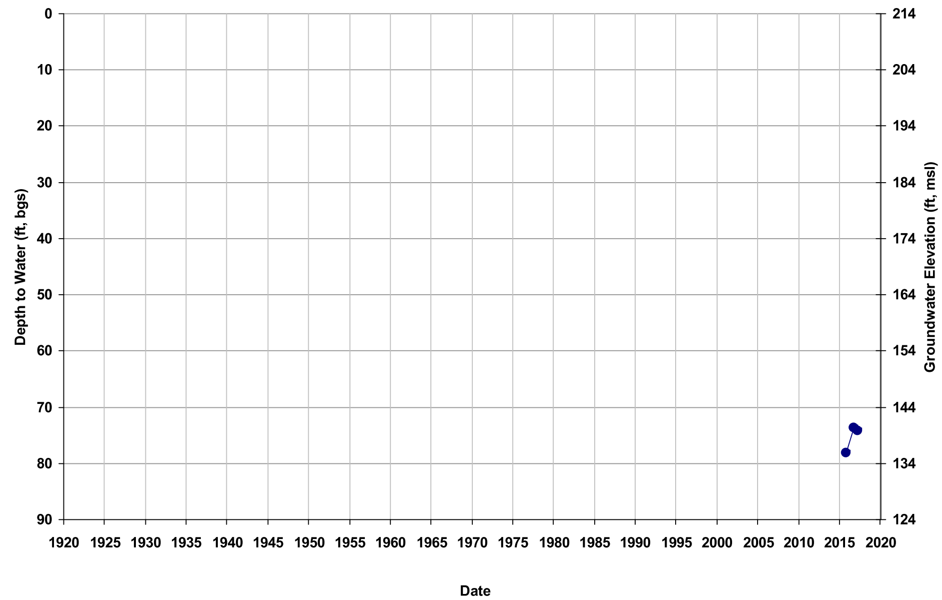
Well ID: Emmert 2
Depth Zone: Upper; Outside CC
Subbasin: Madera

GSE (ft, msl): 248
Total Depth (ft): 299
Perf Top (ft): 200
Perf Bottom (ft): 293



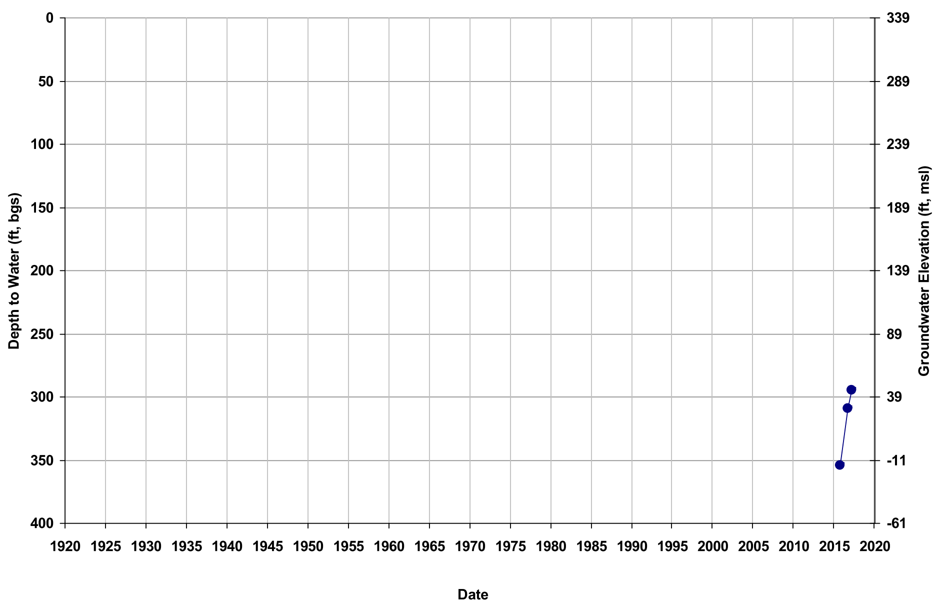
Well ID: Emmert 3
Depth Zone: Upper; Outside CC
Subbasin: Madera

GSE (ft, msl): 214
Total Depth (ft): 310
Perf Top (ft): 202
Perf Bottom (ft): 300



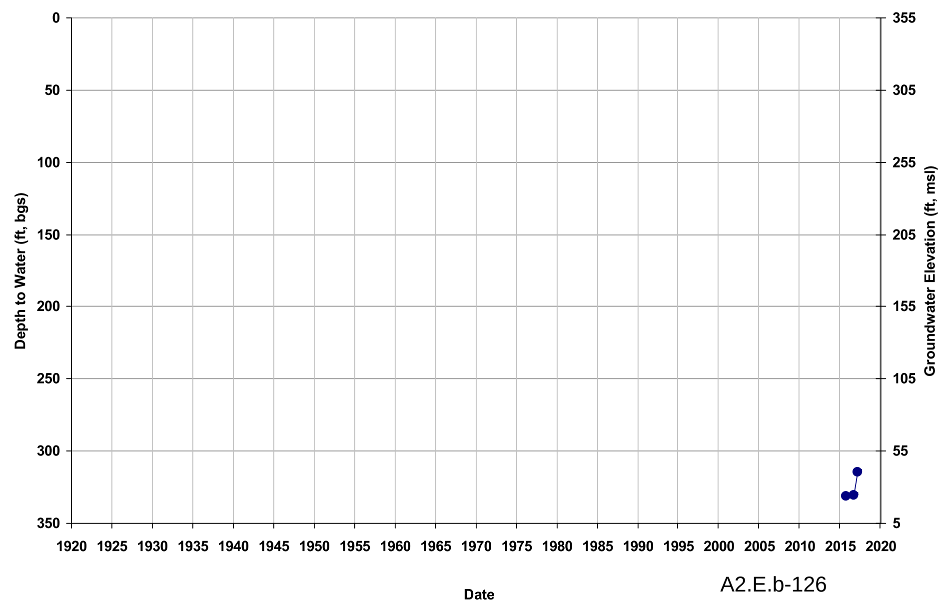
Well ID: MD10A Charlton
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 339
Total Depth (ft): 610
Perf Top (ft): 250
Perf Bottom (ft): 600



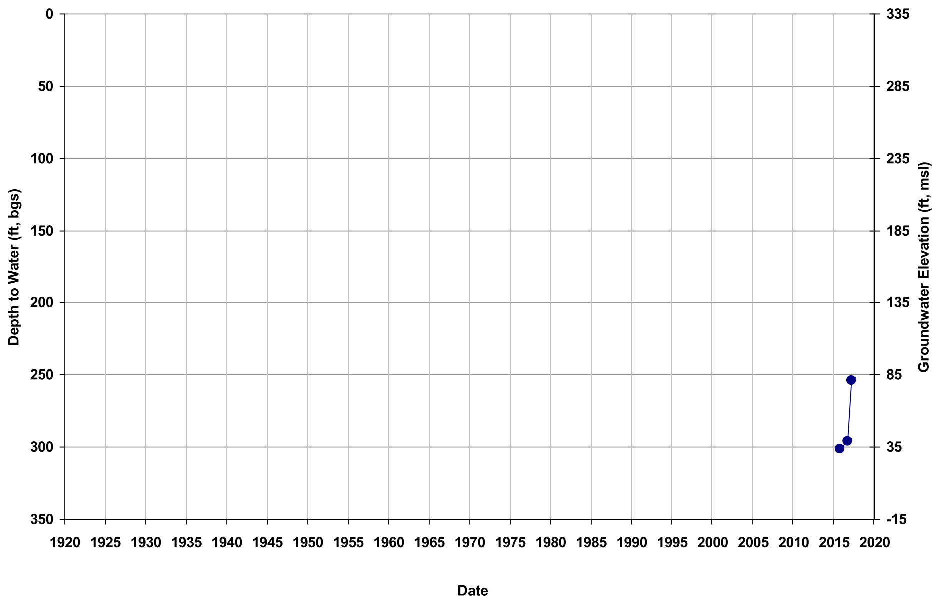
Well ID: MD10A Dublin
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 355
Total Depth (ft): 545
Perf Top (ft): 454
Perf Bottom (ft): 540



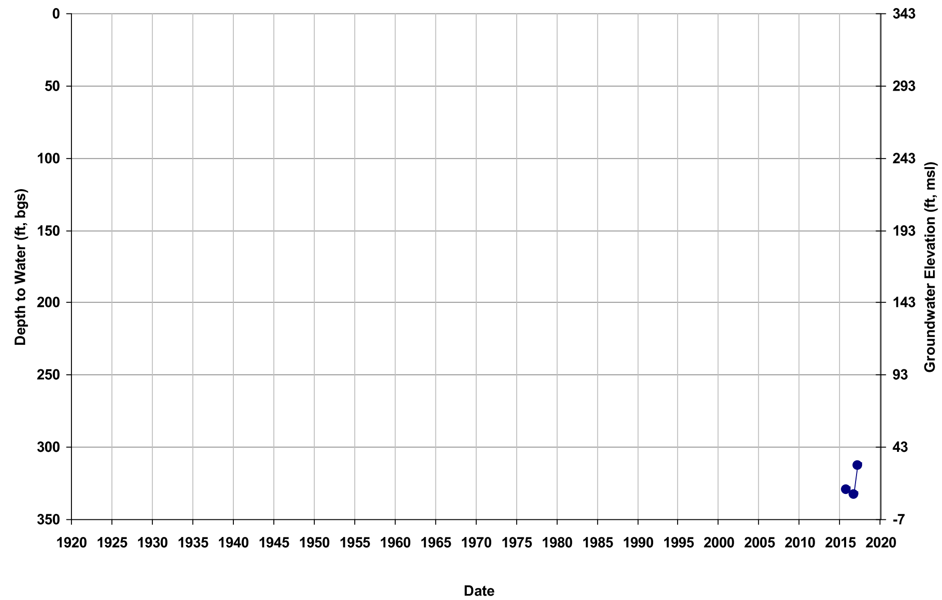
Well ID: MD10A Fender
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 335
Total Depth (ft): 670
Perf Top (ft): 275
Perf Bottom (ft): 660



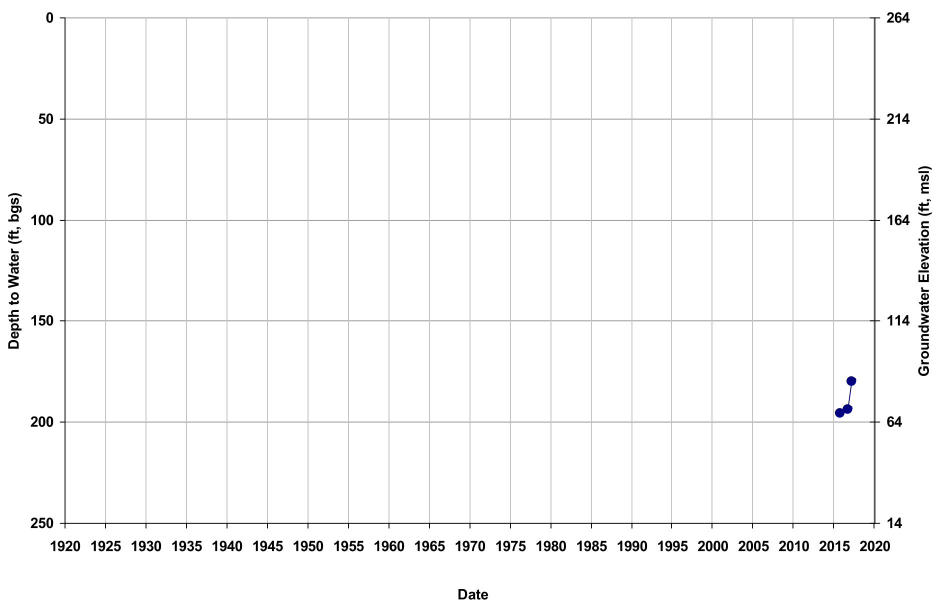
Well ID: MD10A Kensington
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 343
Total Depth (ft): 535
Perf Top (ft): 405
Perf Bottom (ft): 525



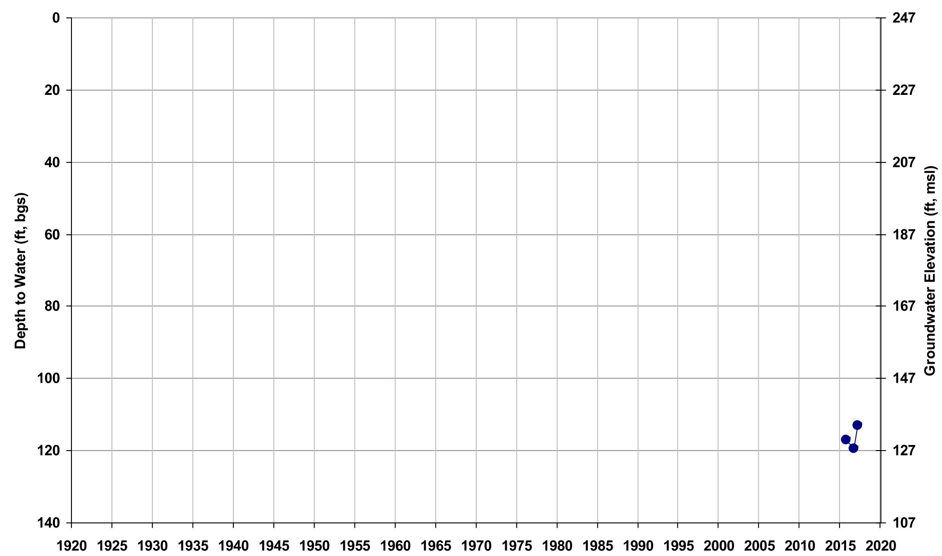
Well ID: MD19A #3 Parkwood
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 264
Total Depth (ft): 456
Perf Top (ft): 240
Perf Bottom (ft): 456



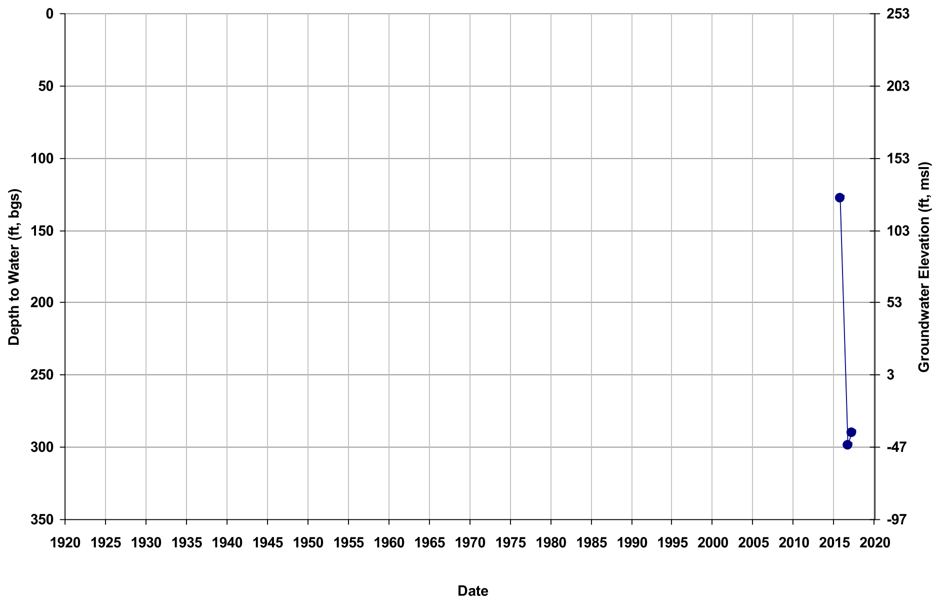
Well ID: MD28 Ripperdan
Depth Zone: Lower; Outside CC
Subbasin: Madera

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



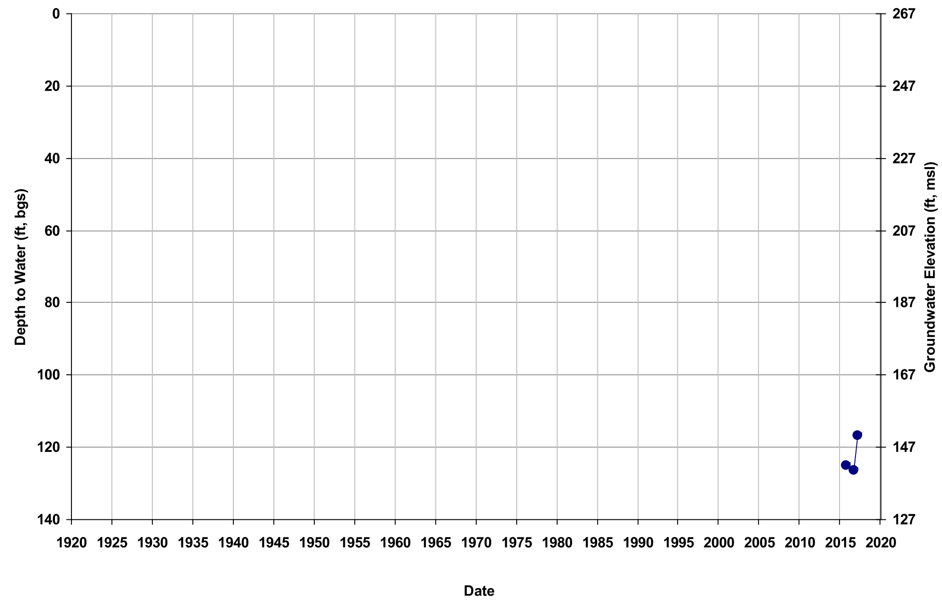
Well ID: MD33 Fairmead
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 253
Total Depth (ft): 552
Perf Top (ft): 240
Perf Bottom (ft): 552



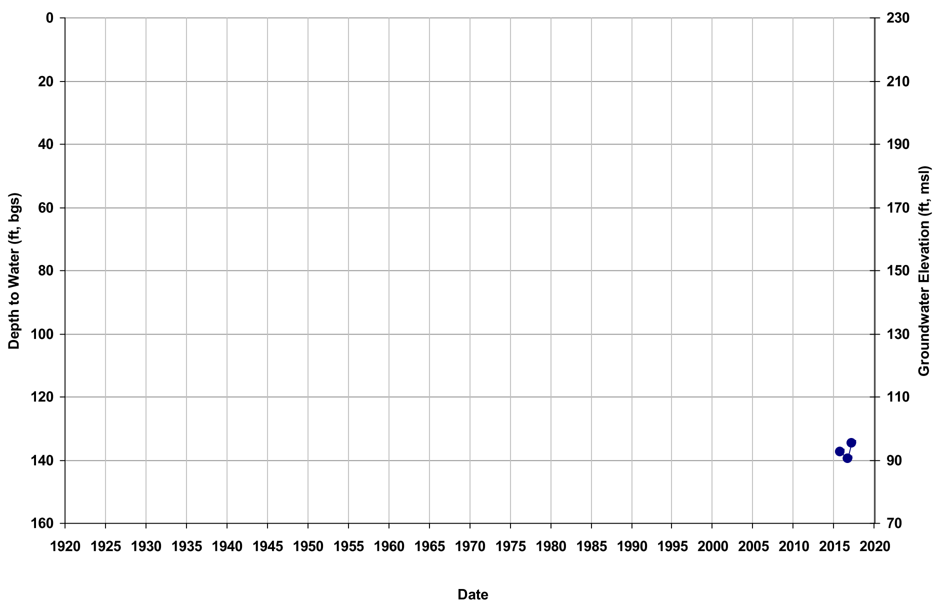
Well ID: MD36 Eastin Arcola
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 267
Total Depth (ft): 360
Perf Top (ft): 280
Perf Bottom (ft): 360



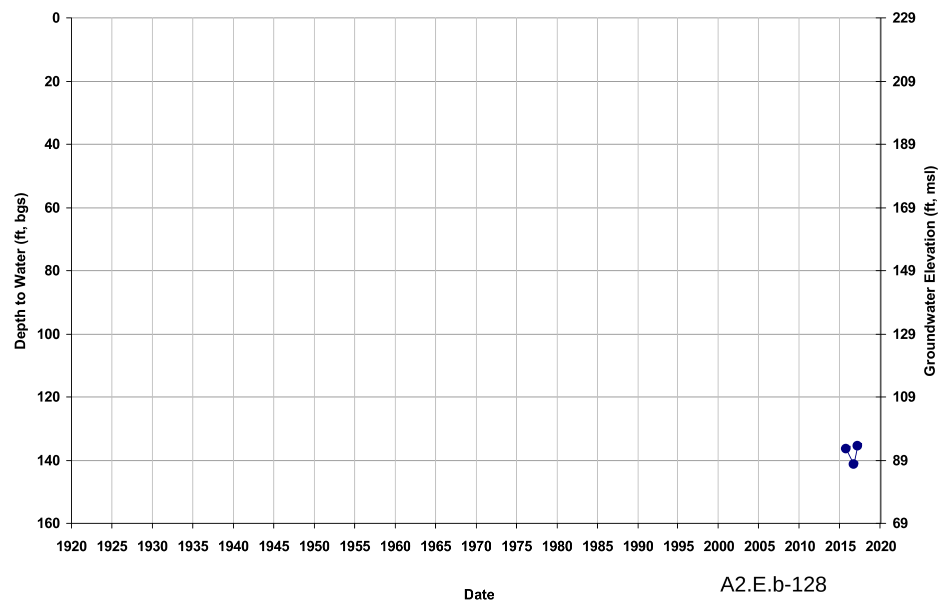
Well ID: MD37 EAST La Vina
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 230
Total Depth (ft): 392
Perf Top (ft): 320
Perf Bottom (ft): 392



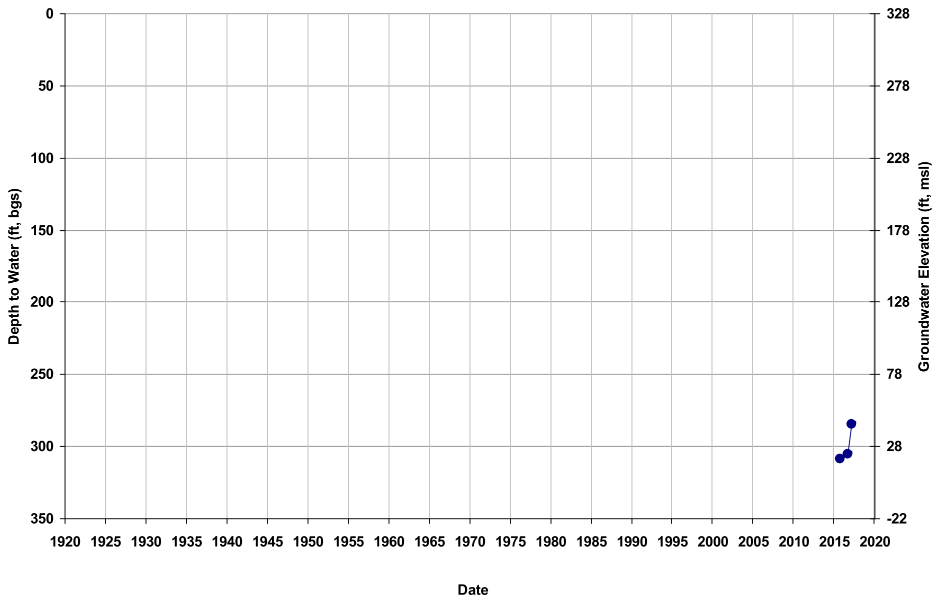
Well ID: MD37 WEST La Vina
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 229
Total Depth (ft): 393
Perf Top (ft): 297
Perf Bottom (ft): 393



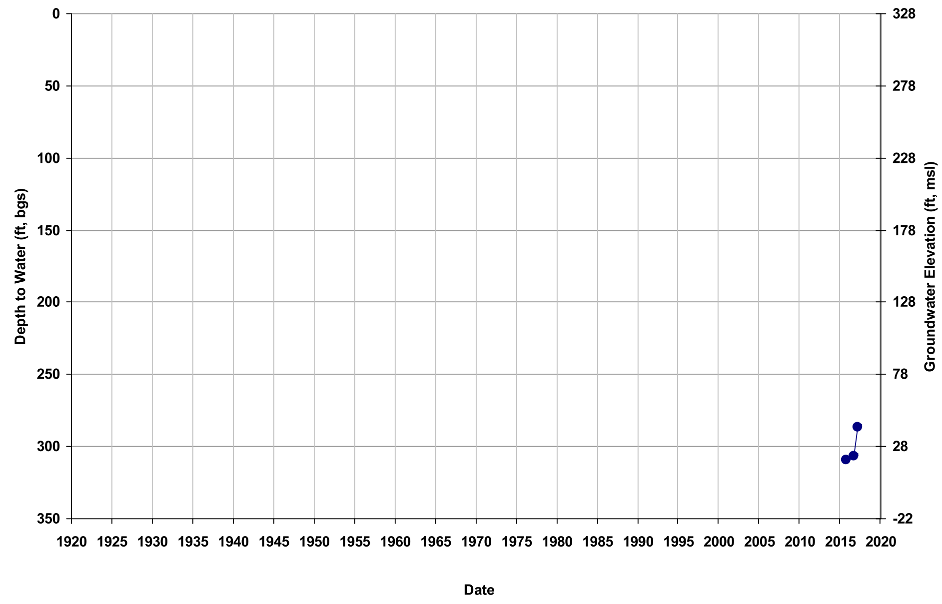
Well ID: MD95 Cont. Est. #1
Depth Zone: Lower; Outside CC
Subbasin: Madera

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



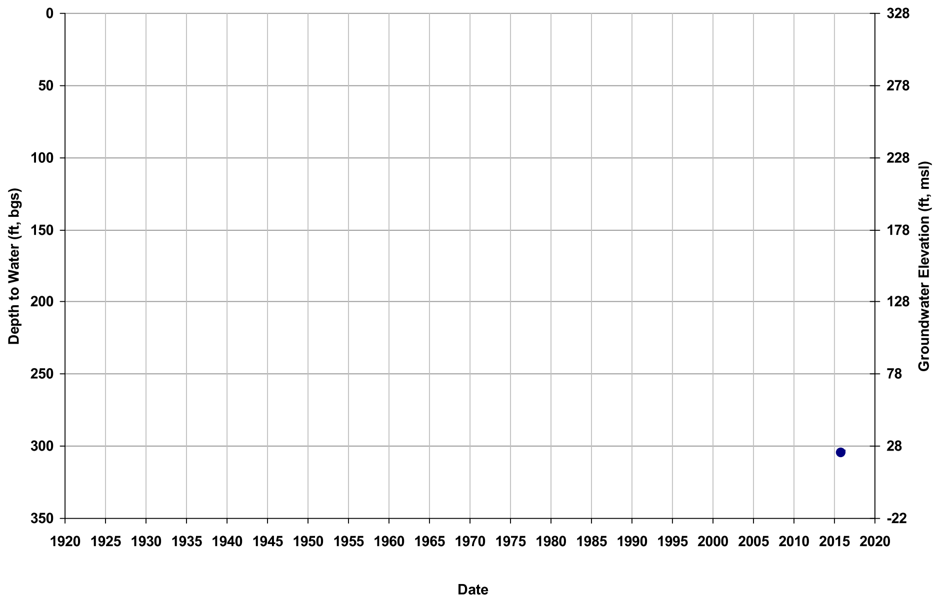
Well ID: MD95 Cont. Est. #4
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 328
Total Depth (ft): 559
Perf Top (ft): 449
Perf Bottom (ft): 554



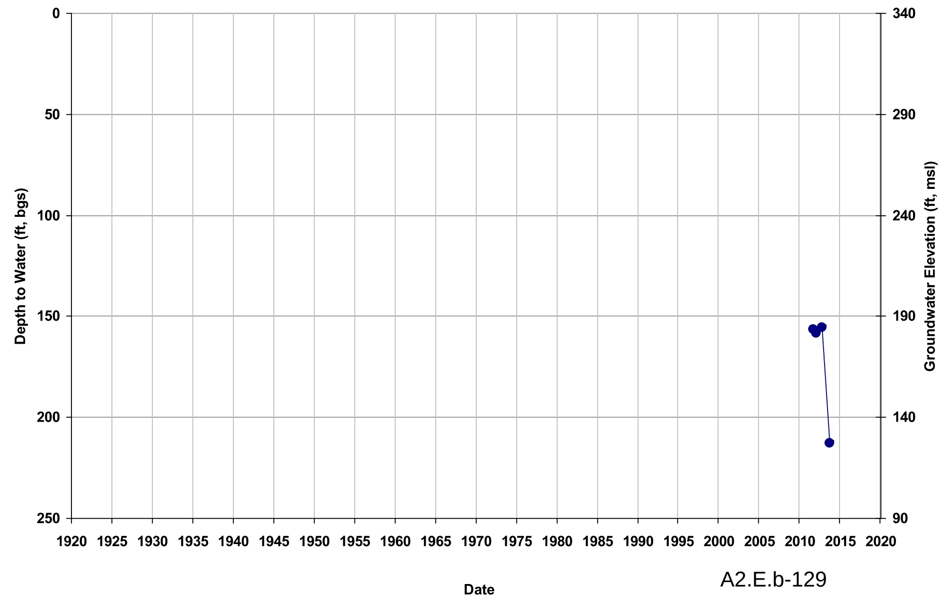
Well ID: MD95 Emergency
Depth Zone: Lower; Outside CC
Subbasin: Madera

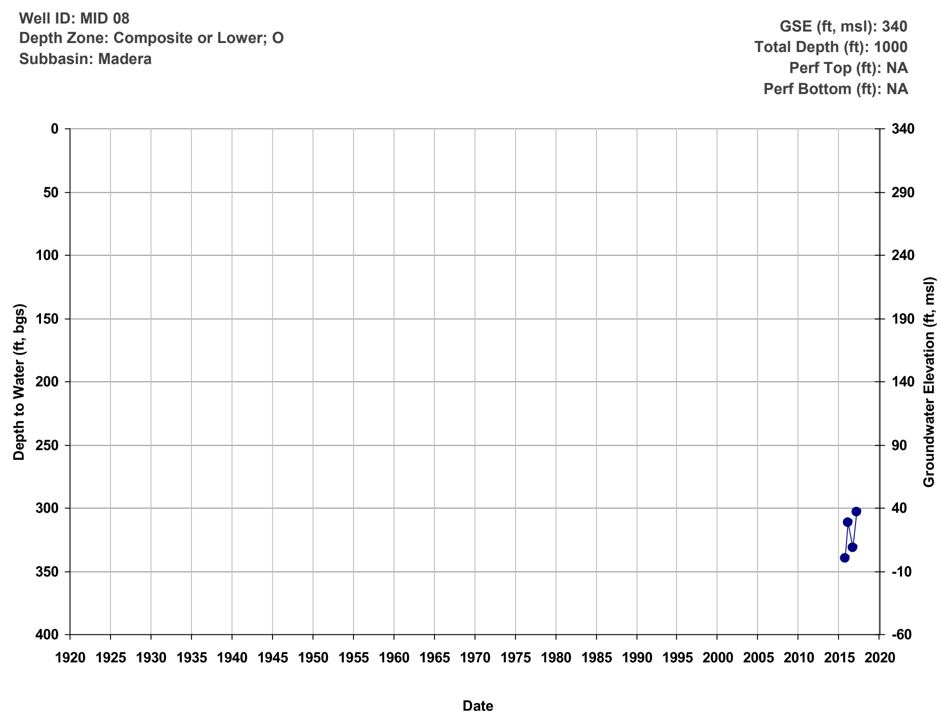
GSE (ft, msl): 328
Total Depth (ft): 547
Perf Top (ft): 447
Perf Bottom (ft): 547

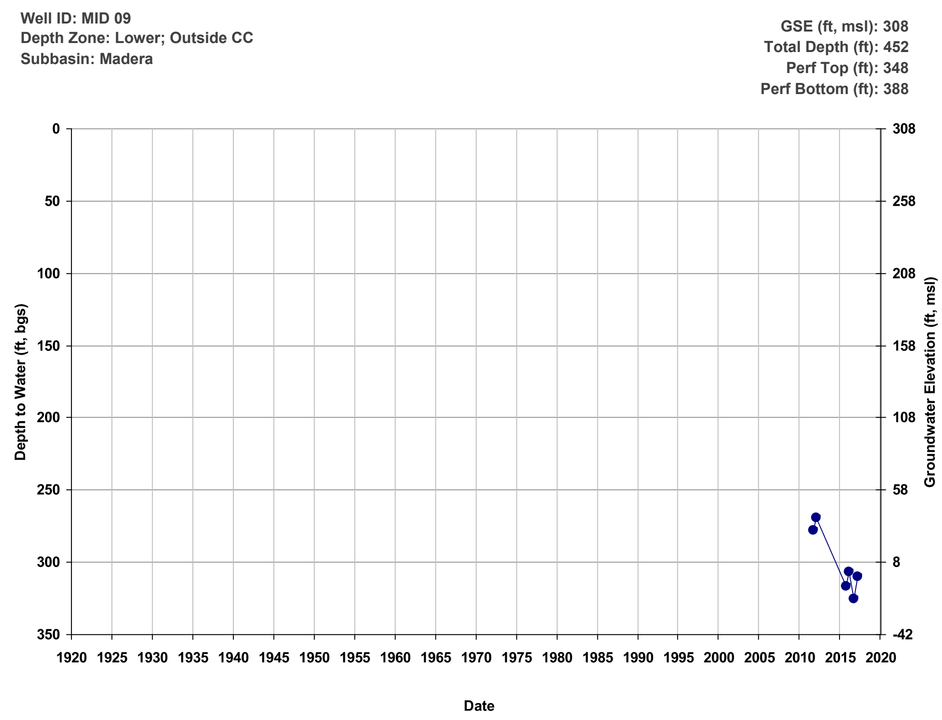


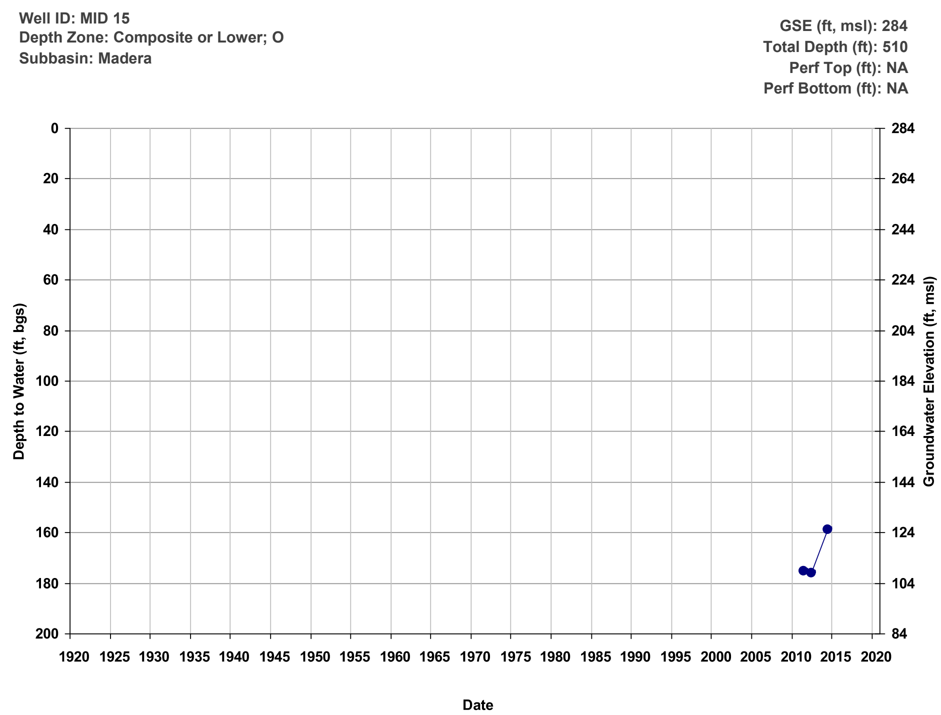
Well ID: MID 02
Depth Zone: Lower; Outside CC
Subbasin: Madera

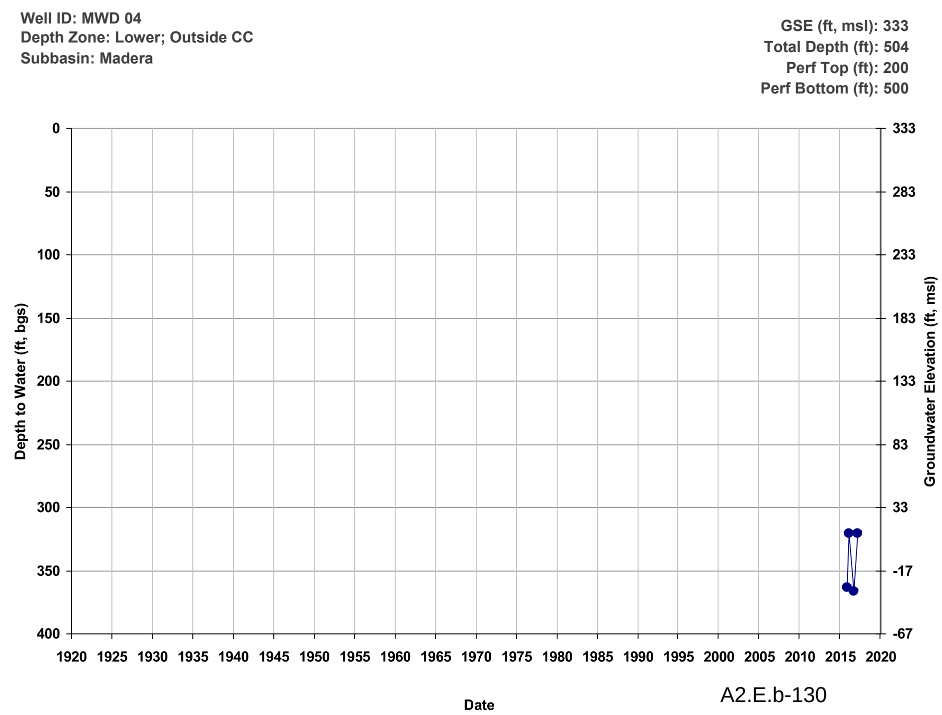
GSE (ft, msl): 339
Total Depth (ft): 818
Perf Top (ft): 300
Perf Bottom (ft): 818




Well ID: MID 08
Depth Zone: Composite or Lower; O
Subbasin: Madera
GSE (ft, msl): 340
Total Depth (ft): 1000
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

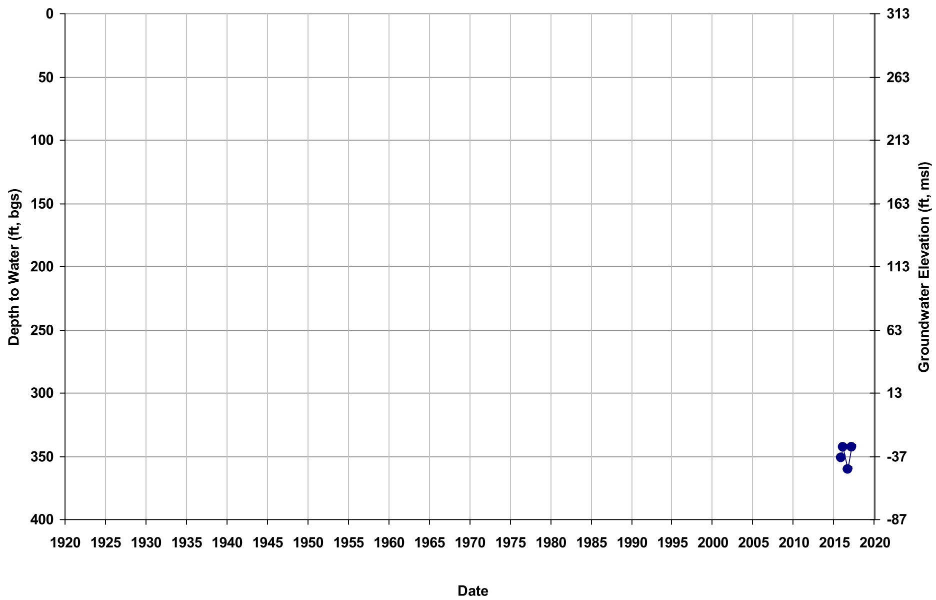

Well ID: MID 09
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 308
Total Depth (ft): 452
Perf Top (ft): 348
Perf Bottom (ft): 388
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: MID 15
Depth Zone: Composite or Lower; O
Subbasin: Madera
GSE (ft, msl): 284
Total Depth (ft): 510
Perf Top (ft): NA
Perf Bottom (ft): NA
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: MWD 04
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 333
Total Depth (ft): 504
Perf Top (ft): 200
Perf Bottom (ft): 500
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

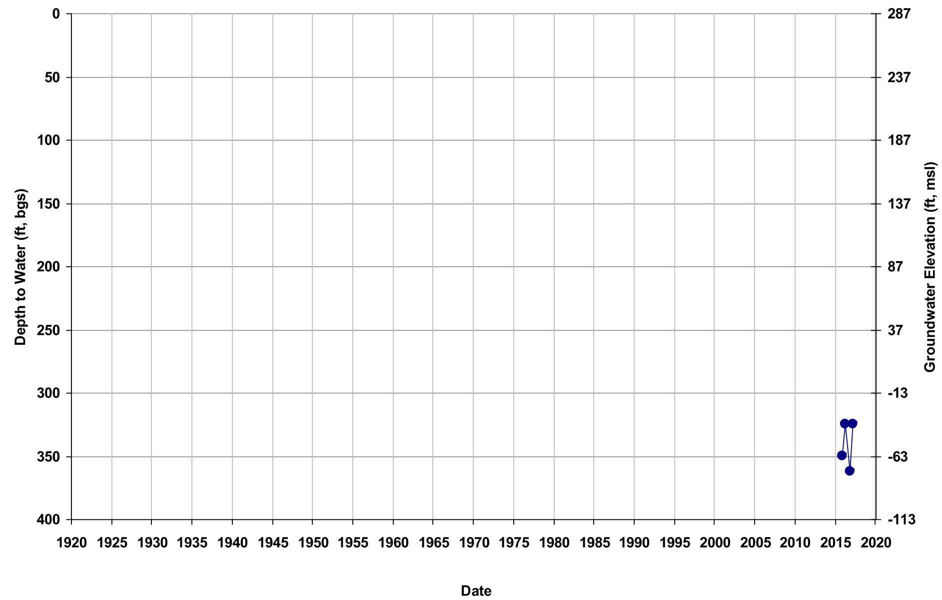
Well ID: MWD 08
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 313
Total Depth (ft): 537
Perf Top (ft): 200
Perf Bottom (ft): 537



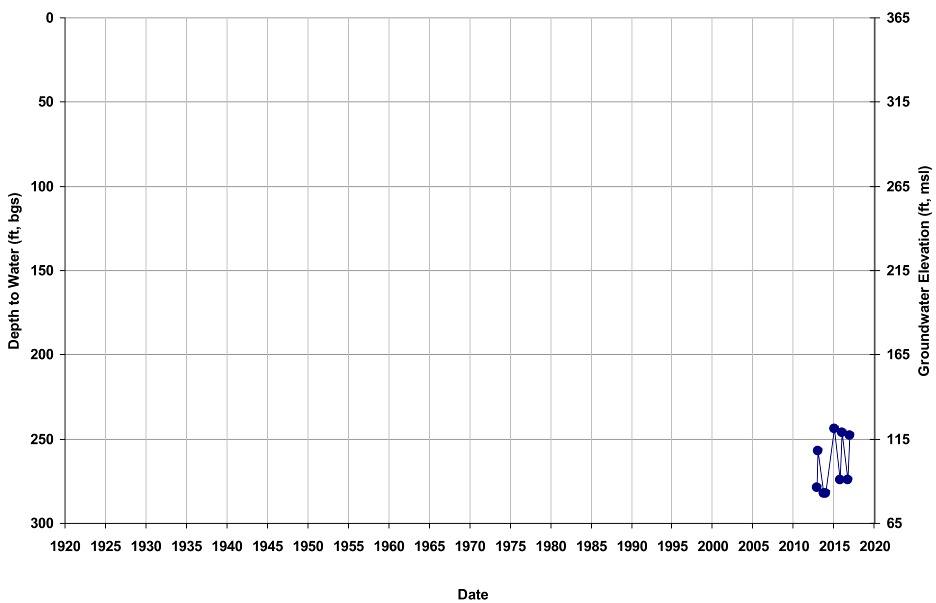
Well ID: MWD 20
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 287
Total Depth (ft): 720
Perf Top (ft): 460
Perf Bottom (ft): 720



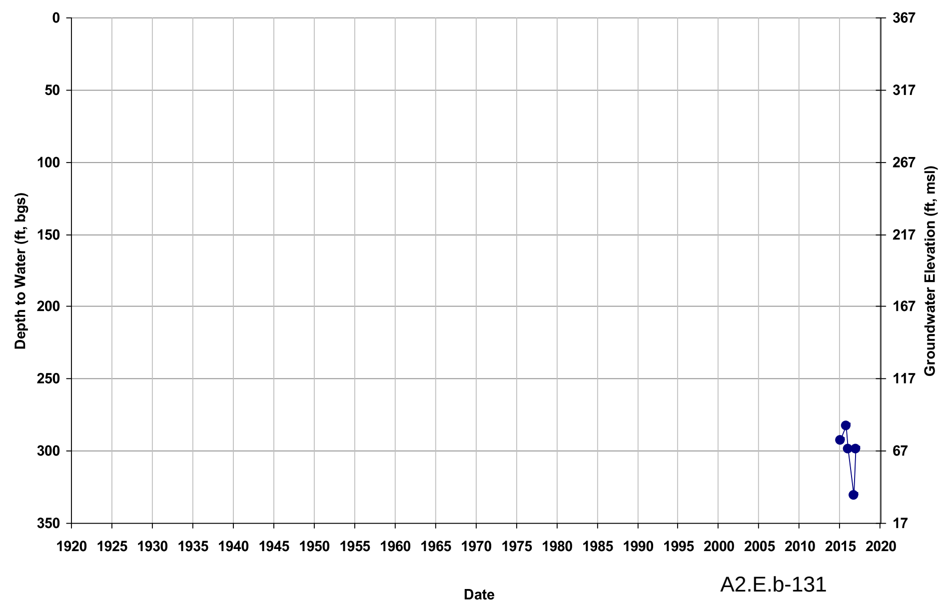
Well ID: RCWD 105
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 365
Total Depth (ft): 476
Perf Top (ft): 212
Perf Bottom (ft): 476



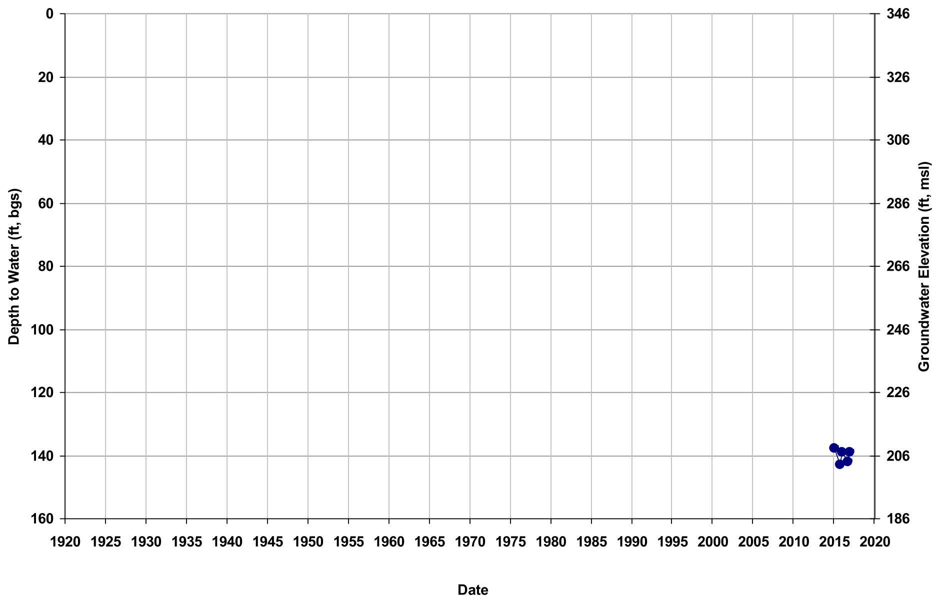
Well ID: RCWD 142
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 367
Total Depth (ft): 521
Perf Top (ft): 309
Perf Bottom (ft): 517



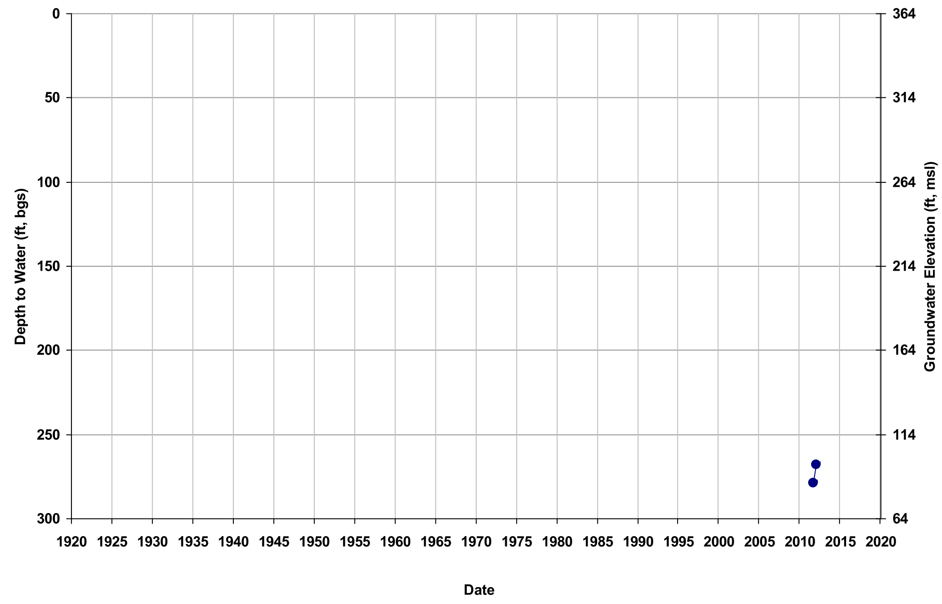
Well ID: RCWD 23
Depth Zone: Upper; Outside CC
Subbasin: Madera

GSE (ft, msl): 346
Total Depth (ft): 236
Perf Top (ft): 160
Perf Bottom (ft): 228



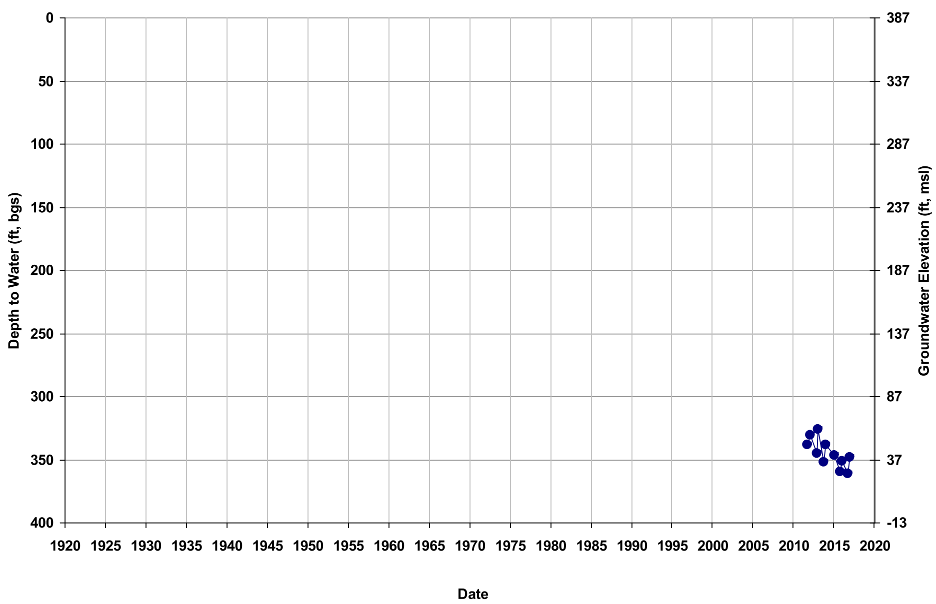
Well ID: RCWD 65
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 363
Total Depth (ft): 496
Perf Top (ft): 290
Perf Bottom (ft): 400



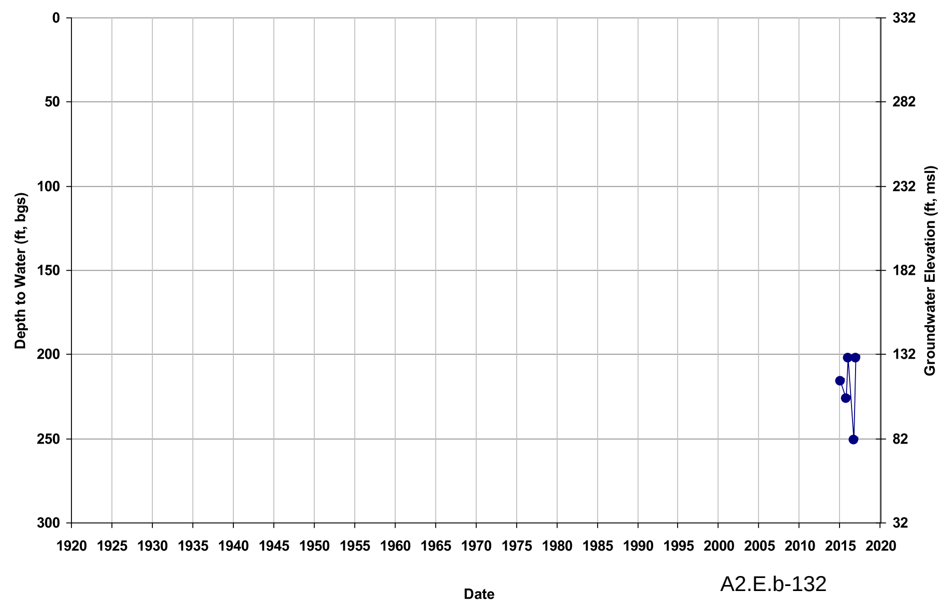
Well ID: RCWD 73
Depth Zone: Lower; Outside CC
Subbasin: Madera

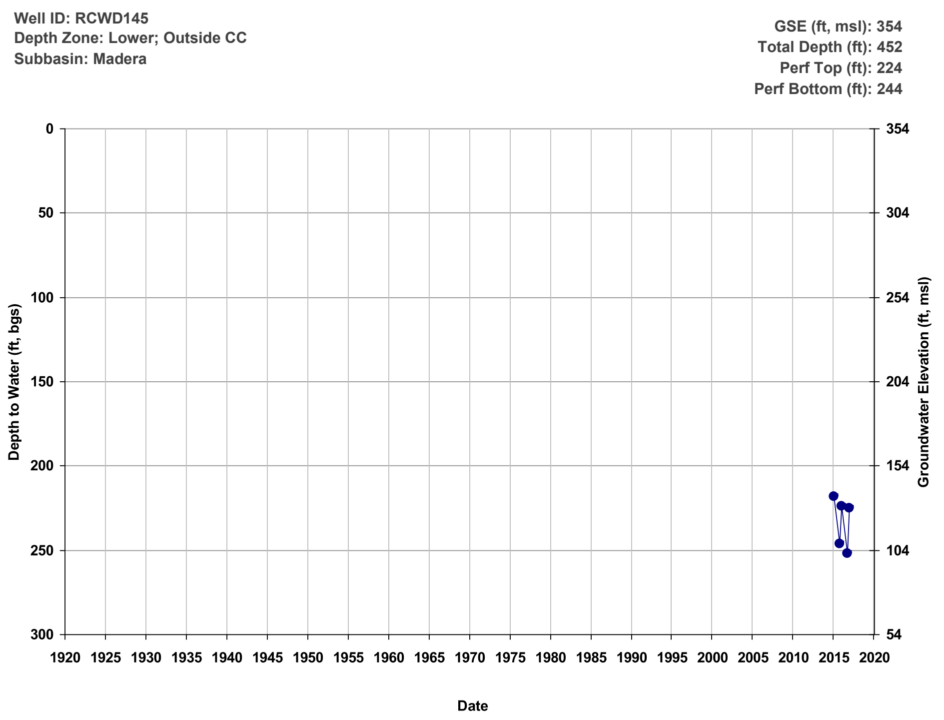
GSE (ft, msl): 387
Total Depth (ft): 470
Perf Top (ft): 260
Perf Bottom (ft): 440

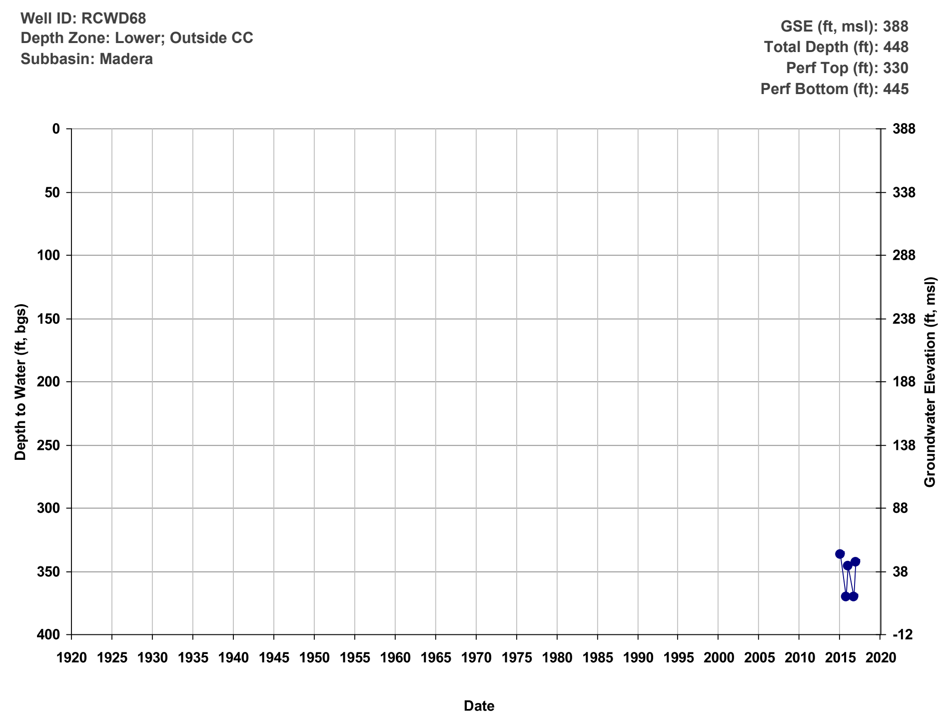


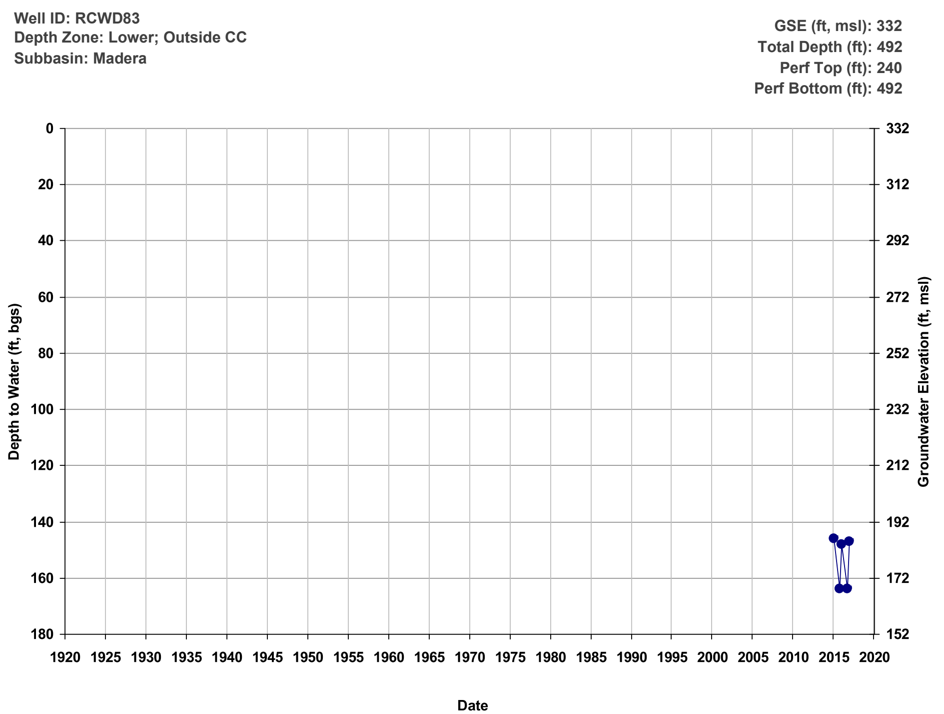
Well ID: RCWD 76
Depth Zone: Lower; Outside CC
Subbasin: Madera

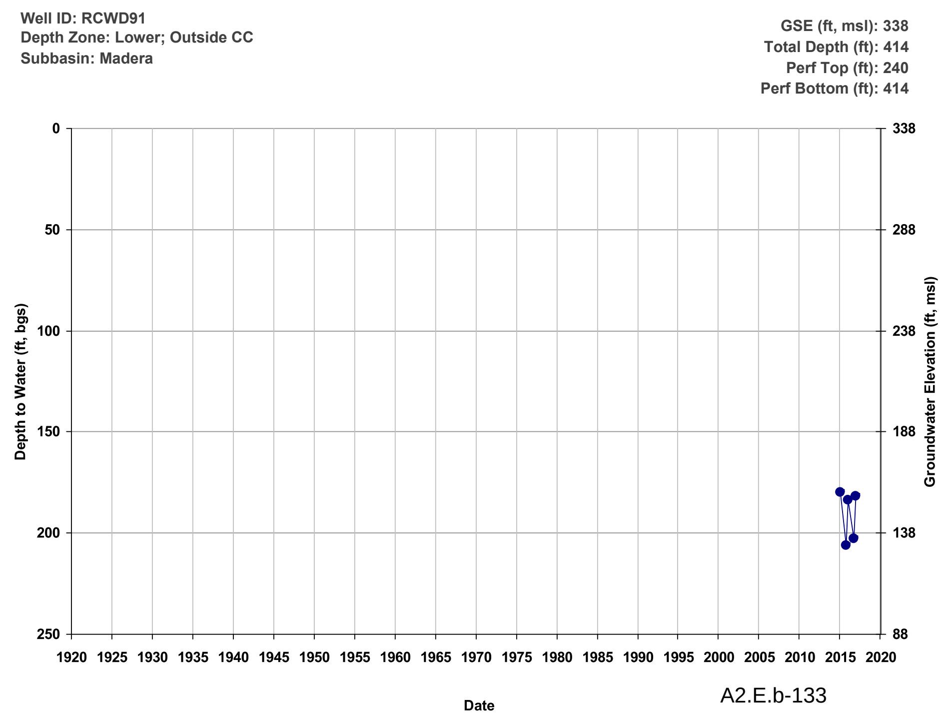
GSE (ft, msl): 332
Total Depth (ft): 636
Perf Top (ft): 232
Perf Bottom (ft): 628




Well ID: RCWD145
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 354
Total Depth (ft): 452
Perf Top (ft): 224
Perf Bottom (ft): 244
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

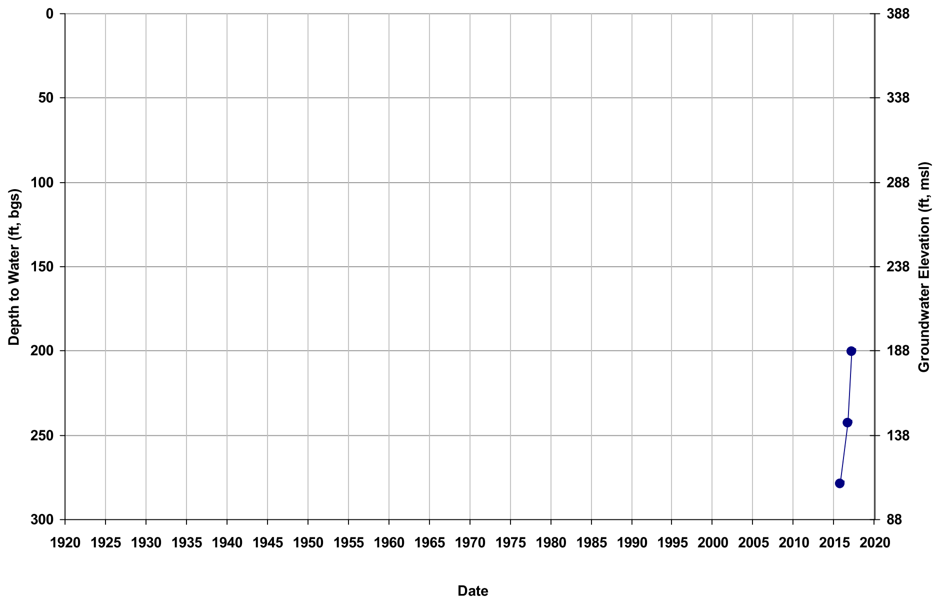

Well ID: RCWD68
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 388
Total Depth (ft): 448
Perf Top (ft): 330
Perf Bottom (ft): 445
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: RCWD83
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 332
Total Depth (ft): 492
Perf Top (ft): 240
Perf Bottom (ft): 492
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: RCWD91
Depth Zone: Lower; Outside CC
Subbasin: Madera
GSE (ft, msl): 338
Total Depth (ft): 414
Perf Top (ft): 240
Perf Bottom (ft): 414
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

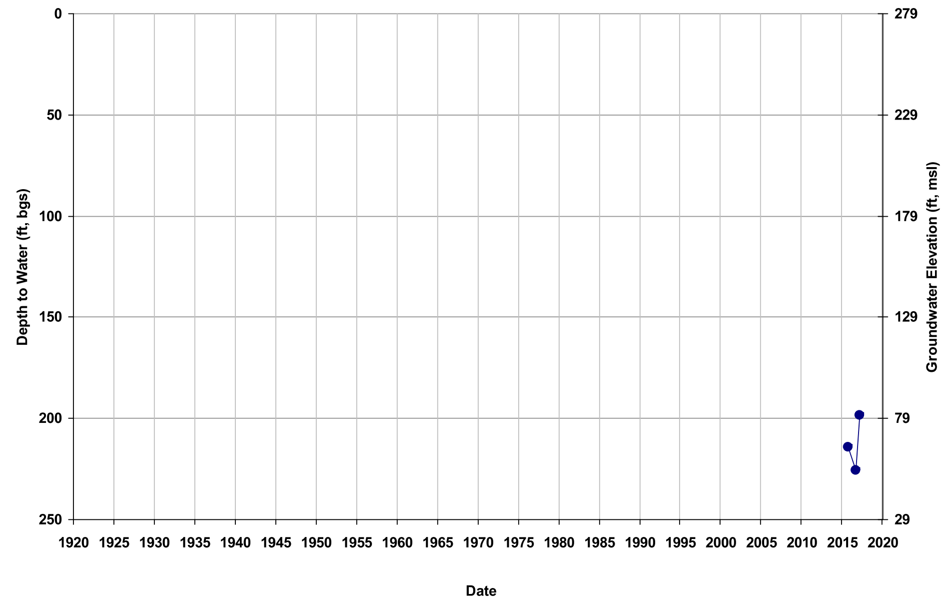
Well ID: SA19 Rolling Hills
Depth Zone: Lower; Outside CC
Subbasin: Madera

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



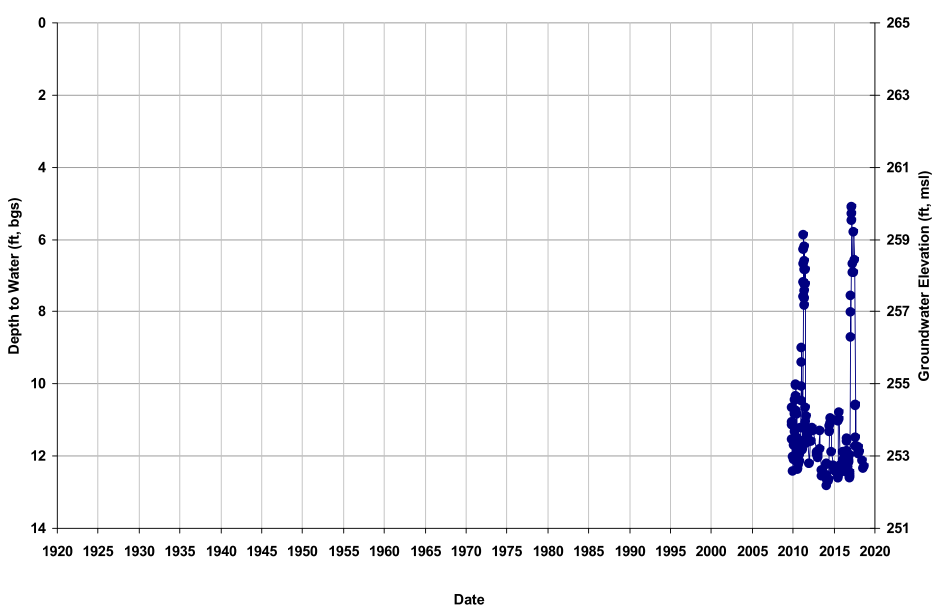
Well ID: SA3 Parksdale
Depth Zone: Lower; Outside CC
Subbasin: Madera

GSE (ft, msl): 279
Total Depth (ft): 480
Perf Top (ft): 216
Perf Bottom (ft): 480



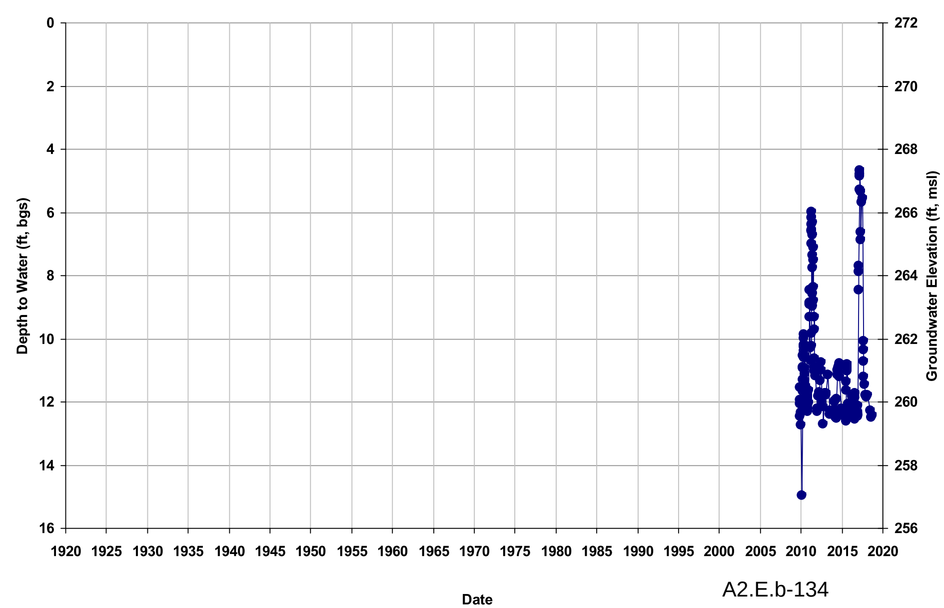
Well ID: SJRRP_MW-09-1
Depth Zone: Upper, Shallow GW; Ou
Subbasin: Madera

GSE (ft, msl): 265
Total Depth (ft): 37.1
Perf Top (ft): 17
Perf Bottom (ft): 37



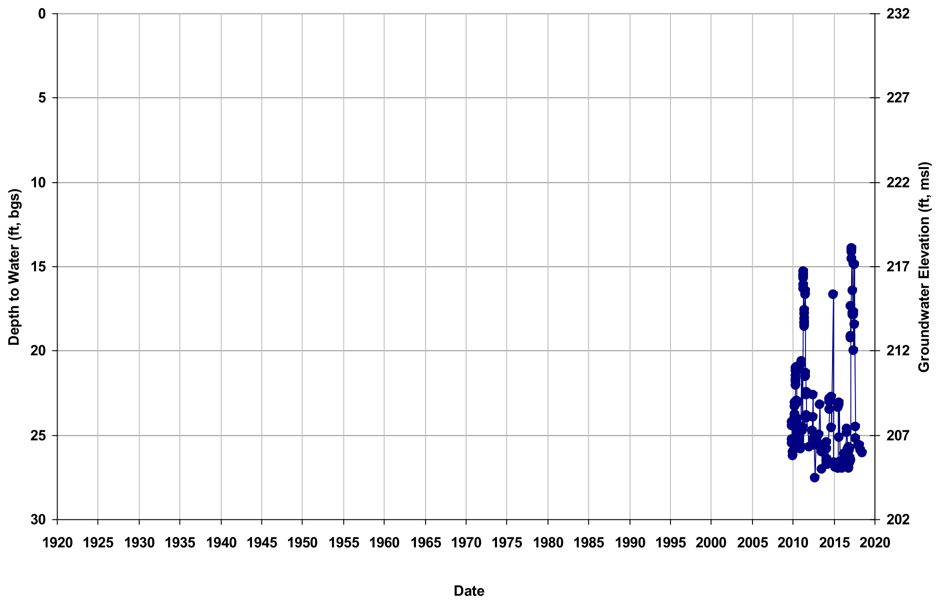
Well ID: SJRRP_MW-09-2
Depth Zone: Upper, Shallow GW; Ou
Subbasin: Madera

GSE (ft, msl): 271
Total Depth (ft): 28.6
Perf Top (ft): 8
Perf Bottom (ft): 28



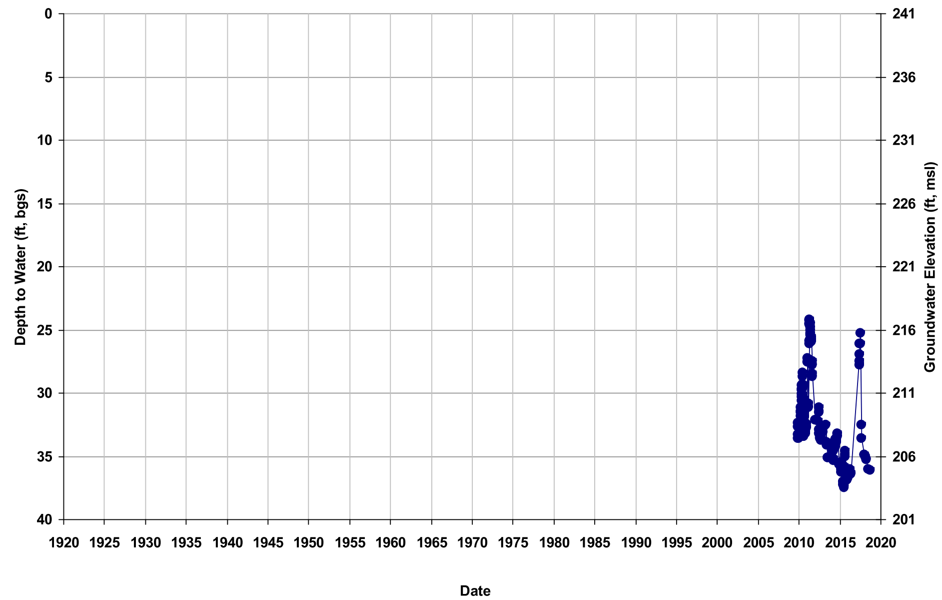
Well ID: SJRRP_MW-09-25
Depth Zone: Upper, Shallow GW; Ou
Subbasin: Madera

GSE (ft, msl): 232
Total Depth (ft): 47
Perf Top (ft): 26.5
Perf Bottom (ft): 46.5



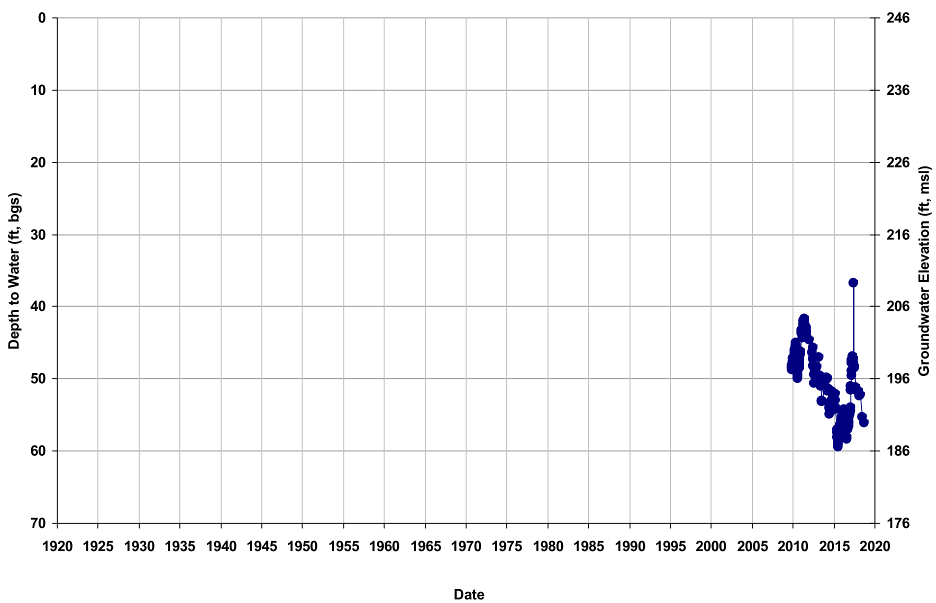
Well ID: SJRRP_MW-09-26
Depth Zone: Upper; Outside CC
Subbasin: Madera

GSE (ft, msl): 241
Total Depth (ft): 57.5
Perf Top (ft): 37
Perf Bottom (ft): 57



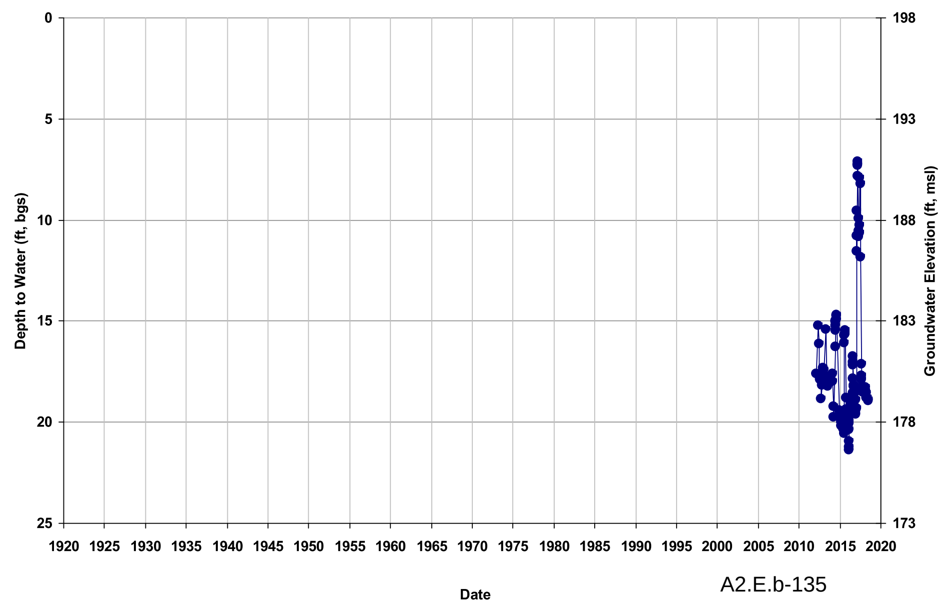
Well ID: SJRRP_MW-09-27
Depth Zone: Upper; Outside CC
Subbasin: Madera

GSE (ft, msl): 245
Total Depth (ft): 70
Perf Top (ft): 50
Perf Bottom (ft): 70



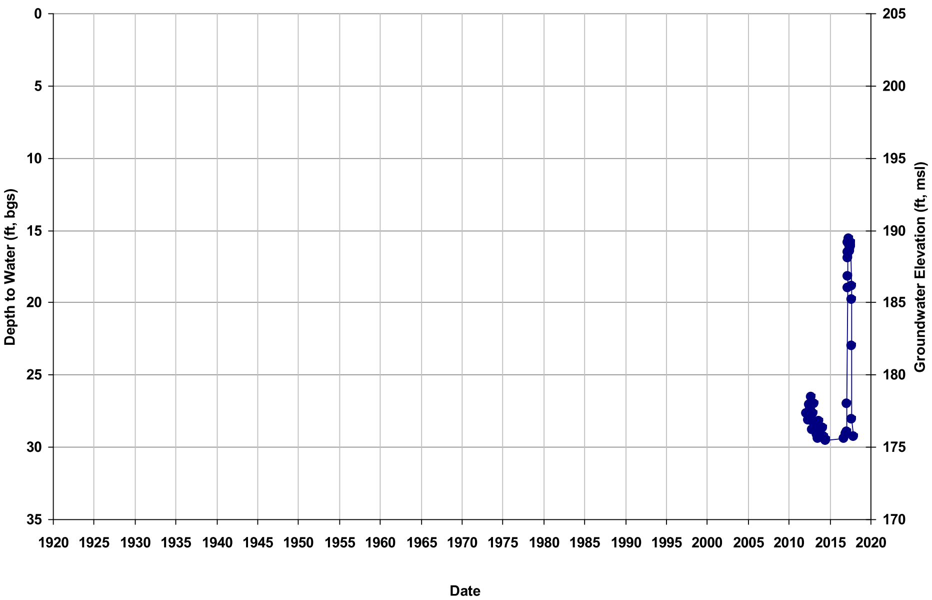
Well ID: SJRRP_MW-11-158
Depth Zone: Upper, Shallow GW; Ou
Subbasin: Madera

GSE (ft, msl): 197
Total Depth (ft): 30
Perf Top (ft): NA
Perf Bottom (ft): NA



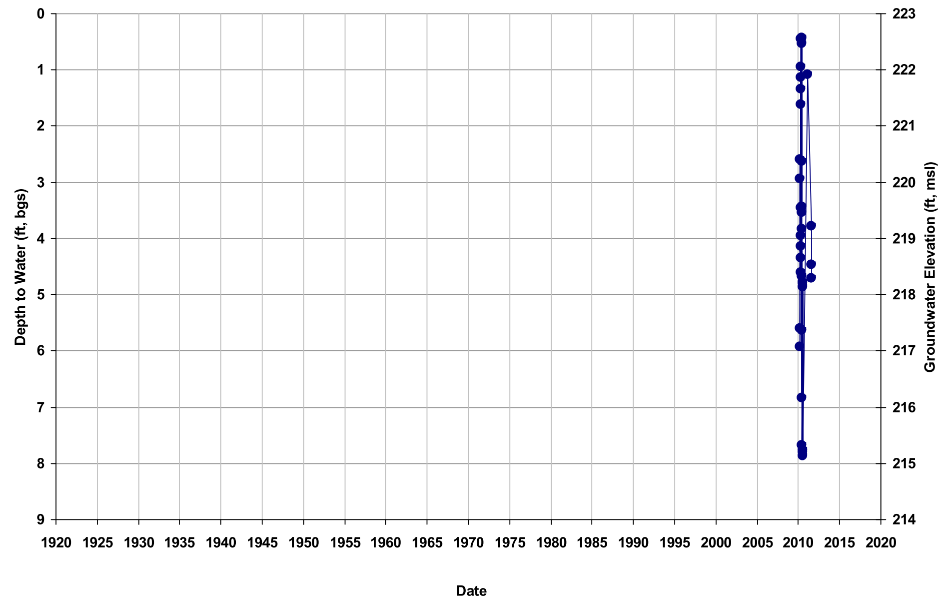
Well ID: SJRRP_MW-11-159
Depth Zone: Upper, Shallow GW; Ou
Subbasin: Madera

GSE (ft, msl): 204
Total Depth (ft): 30
Perf Top (ft): NA
Perf Bottom (ft): NA



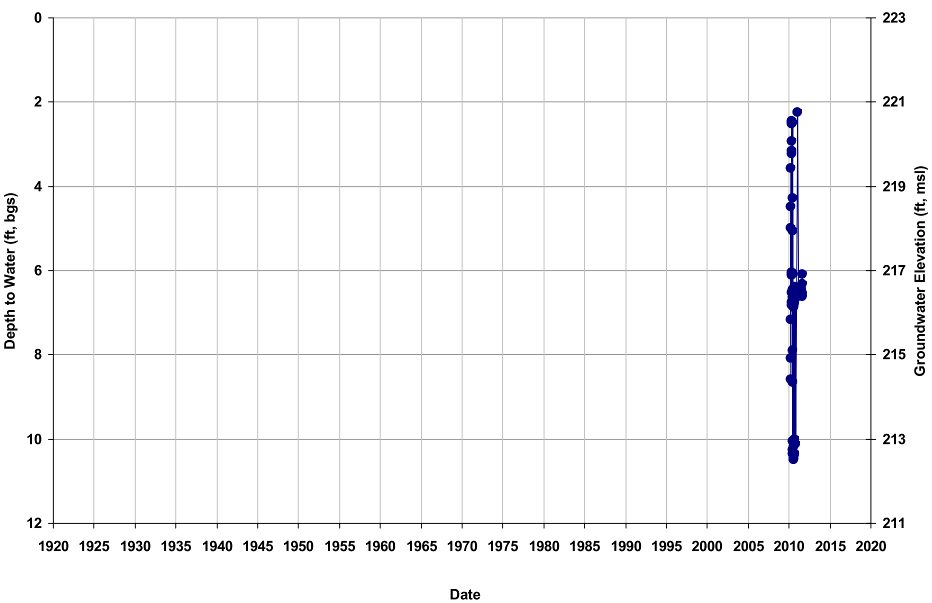
Well ID: SJRRP_R1-1
Depth Zone: Upper, Shallow GW; Ou
Subbasin: Madera

GSE (ft, msl): 222
Total Depth (ft): 5
Perf Top (ft): 2
Perf Bottom (ft): NA



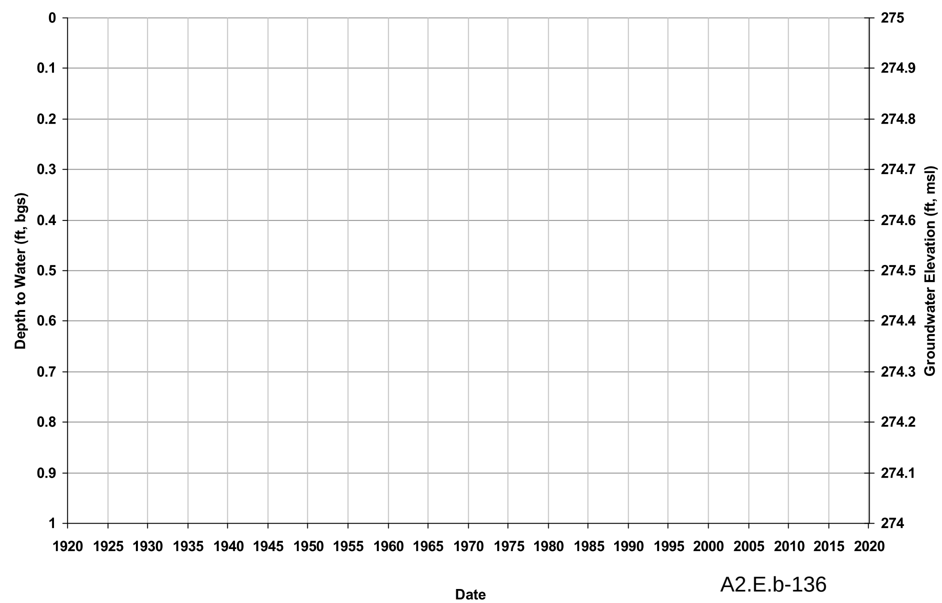
Well ID: SJRRP_R1-2
Depth Zone: Upper, Shallow GW; Ou
Subbasin: Madera

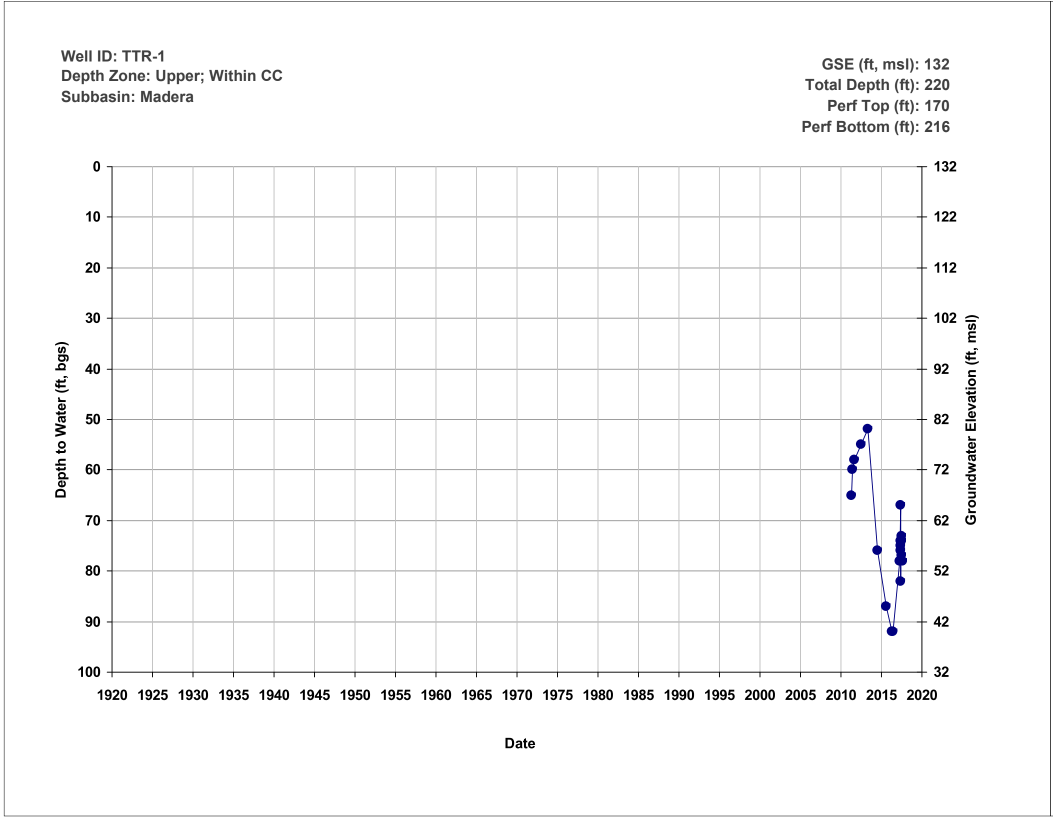
GSE (ft, msl): 222
Total Depth (ft): 9.5
Perf Top (ft): 6.5
Perf Bottom (ft): NA

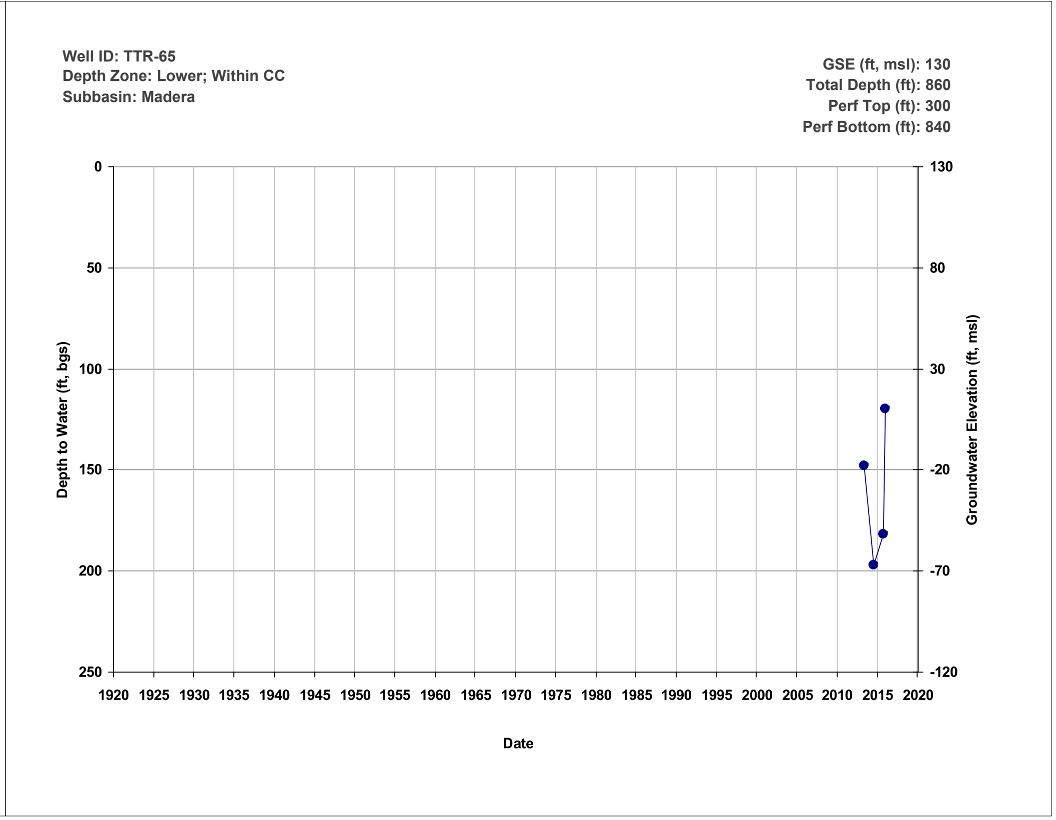


Well ID: SL0603921176 - MW-1
Depth Zone: Unknown; Outside CC
Subbasin: Madera

GSE (ft, msl): 274
Total Depth (ft): NA
Perf Top (ft): NA
Perf Bottom (ft): NA




Well ID: TTR-1
Depth Zone: Upper; Within CC
Subbasin: Madera
GSE (ft, msl): 132
Total Depth (ft): 220
Perf Top (ft): 170
Perf Bottom (ft): 216
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date


Well ID: TTR-65
Depth Zone: Lower; Within CC
Subbasin: Madera
GSE (ft, msl): 130
Total Depth (ft): 860
Perf Top (ft): 300
Perf Bottom (ft): 840
Depth to Water (ft, bgs)
Groundwater Elevation (ft, msl)
Date

APPENDIX 2.E. CURRENT AND HISTORICAL GROUNDWATER CONDITIONS

2.E.c. Groundwater Quality Maps

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

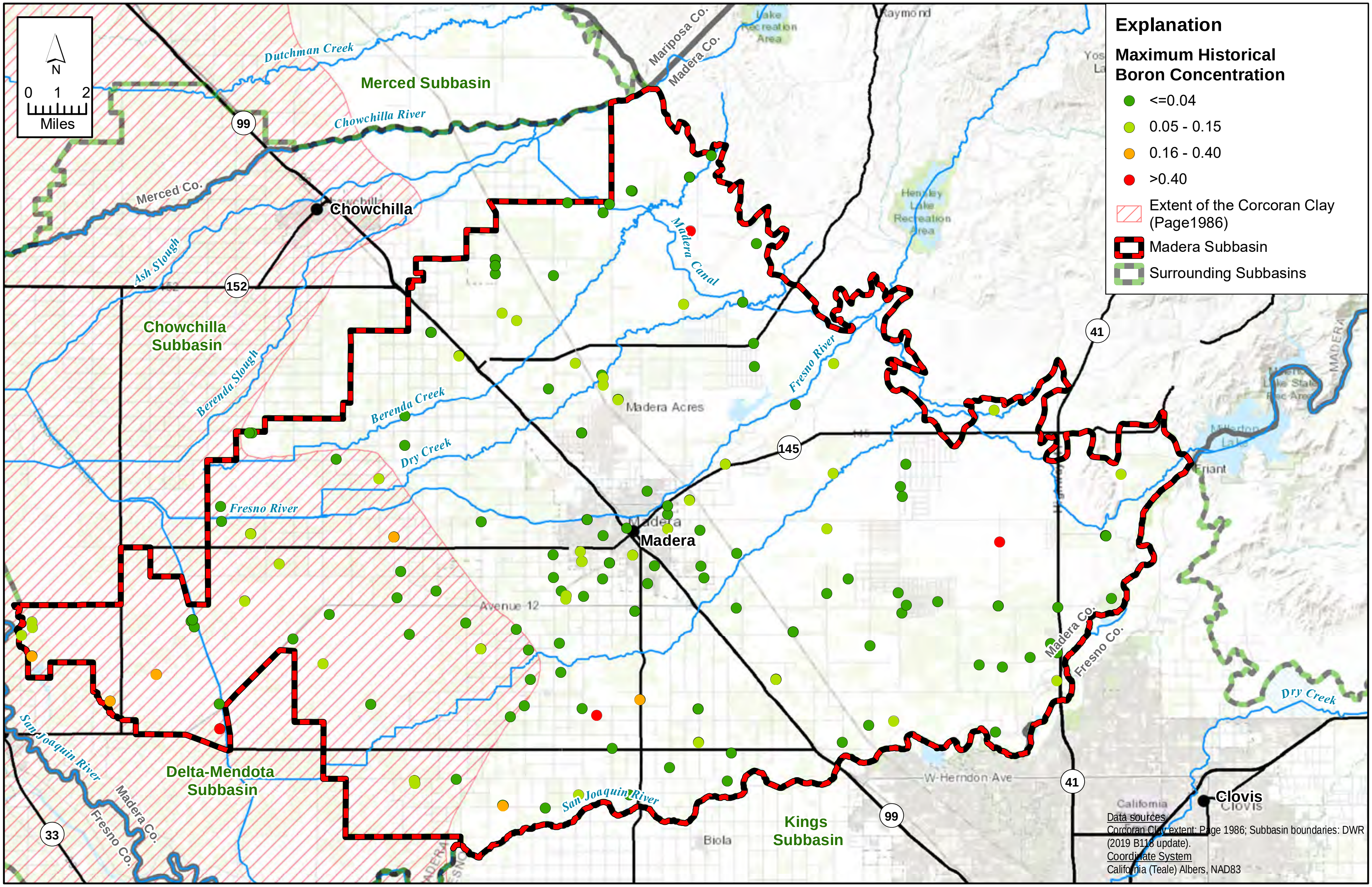
January 2020

GSP Team:

Davids Engineering, Inc
Luhdorff & Scalmanini
ERA Economics
Stillwater Sciences and
California State University, Sacramento

Groundwater Quality

Maps



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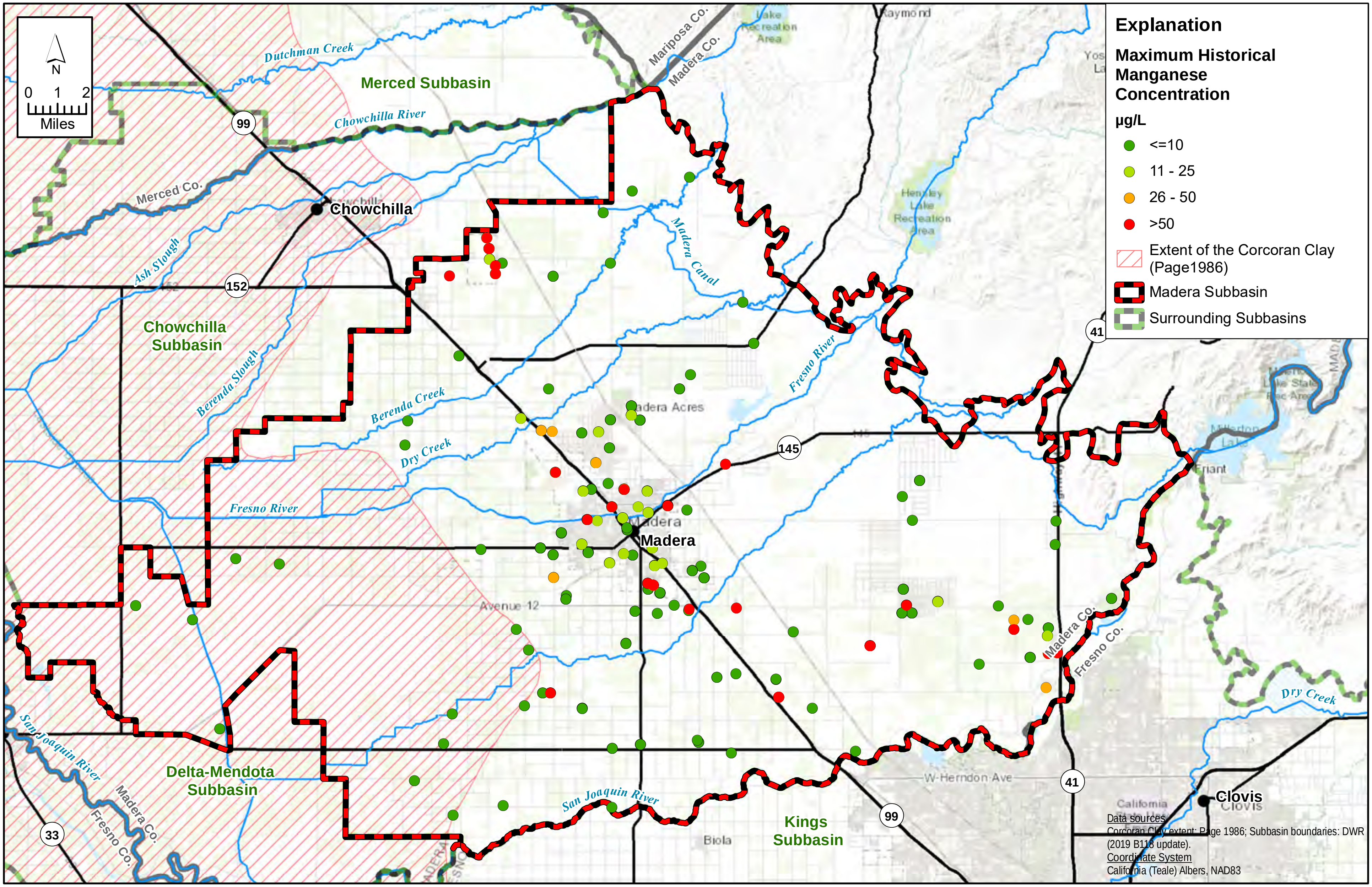
APPENDIX 2.E
Groundwater Quality Map: Boron Concentrations in All Wells



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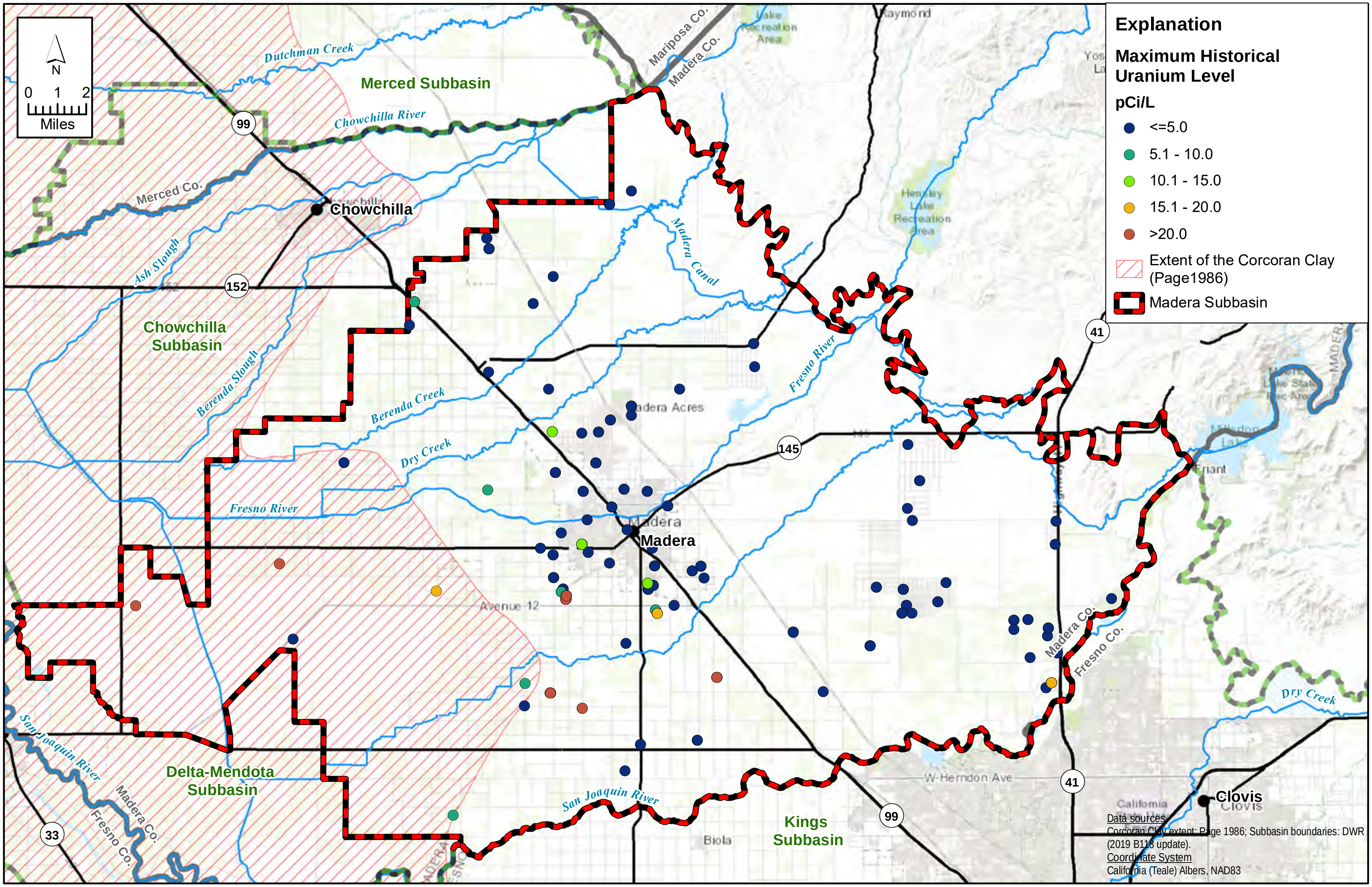
APPENDIX 2.E
Groundwater Quality Map: Manganese Concentrations in All Wells



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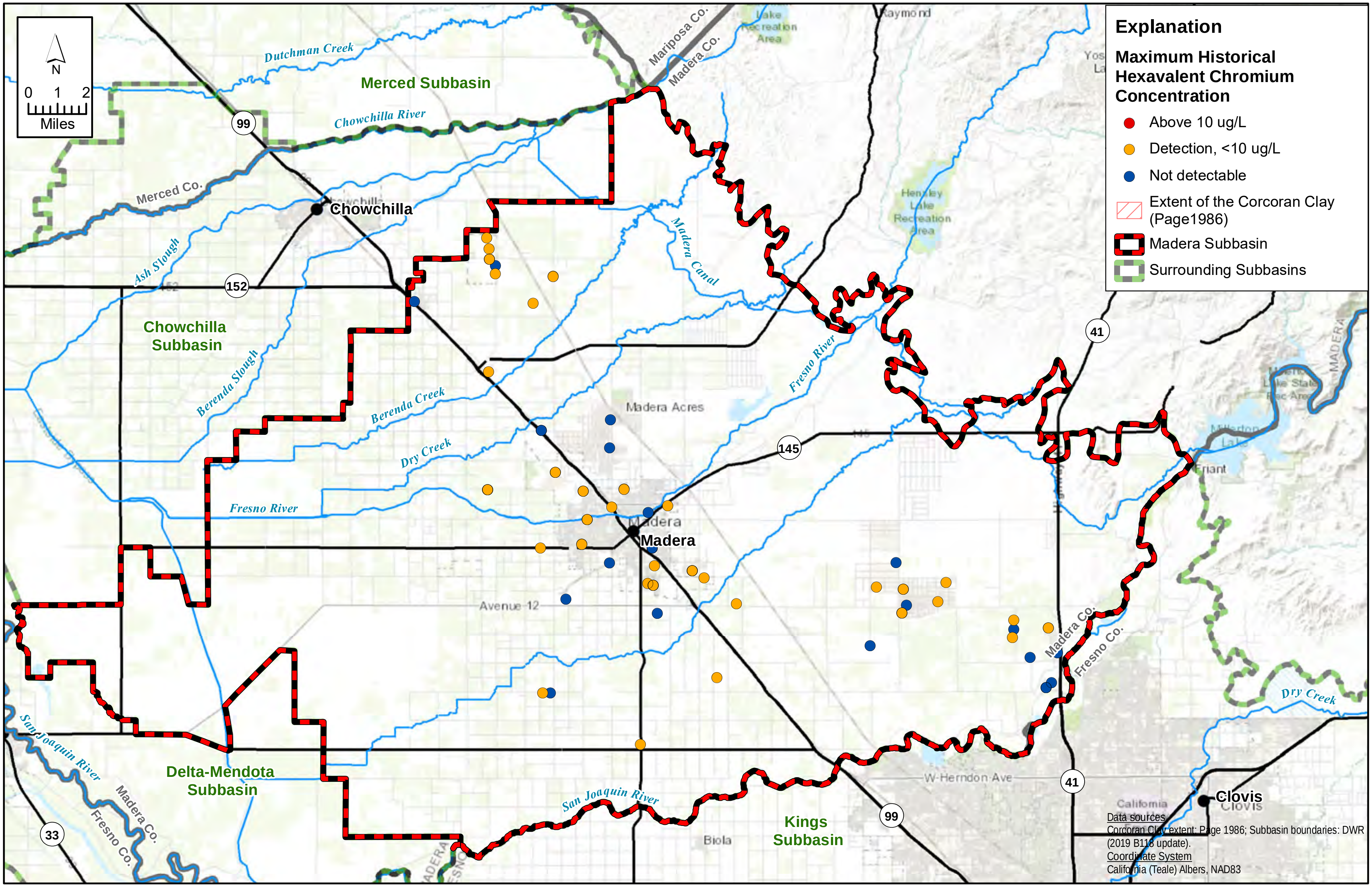
APPENDIX 2.E
Groundwater Quality Map: Uranium Levels in All Wells



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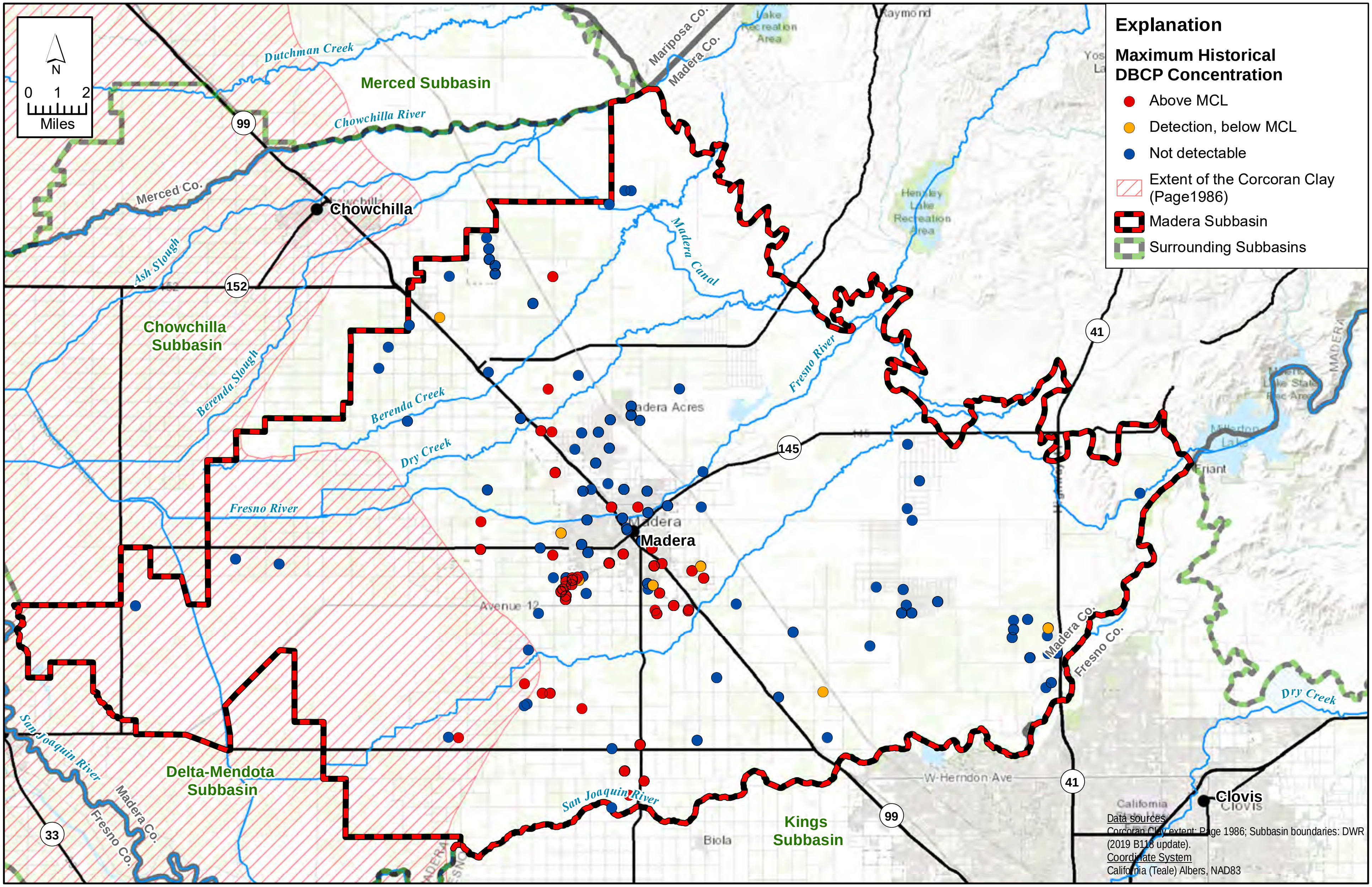
APPENDIX 2.E
Groundwater Quality Map: Chromium-6 (Hexavalent Chromium) Concentrations in All Wells



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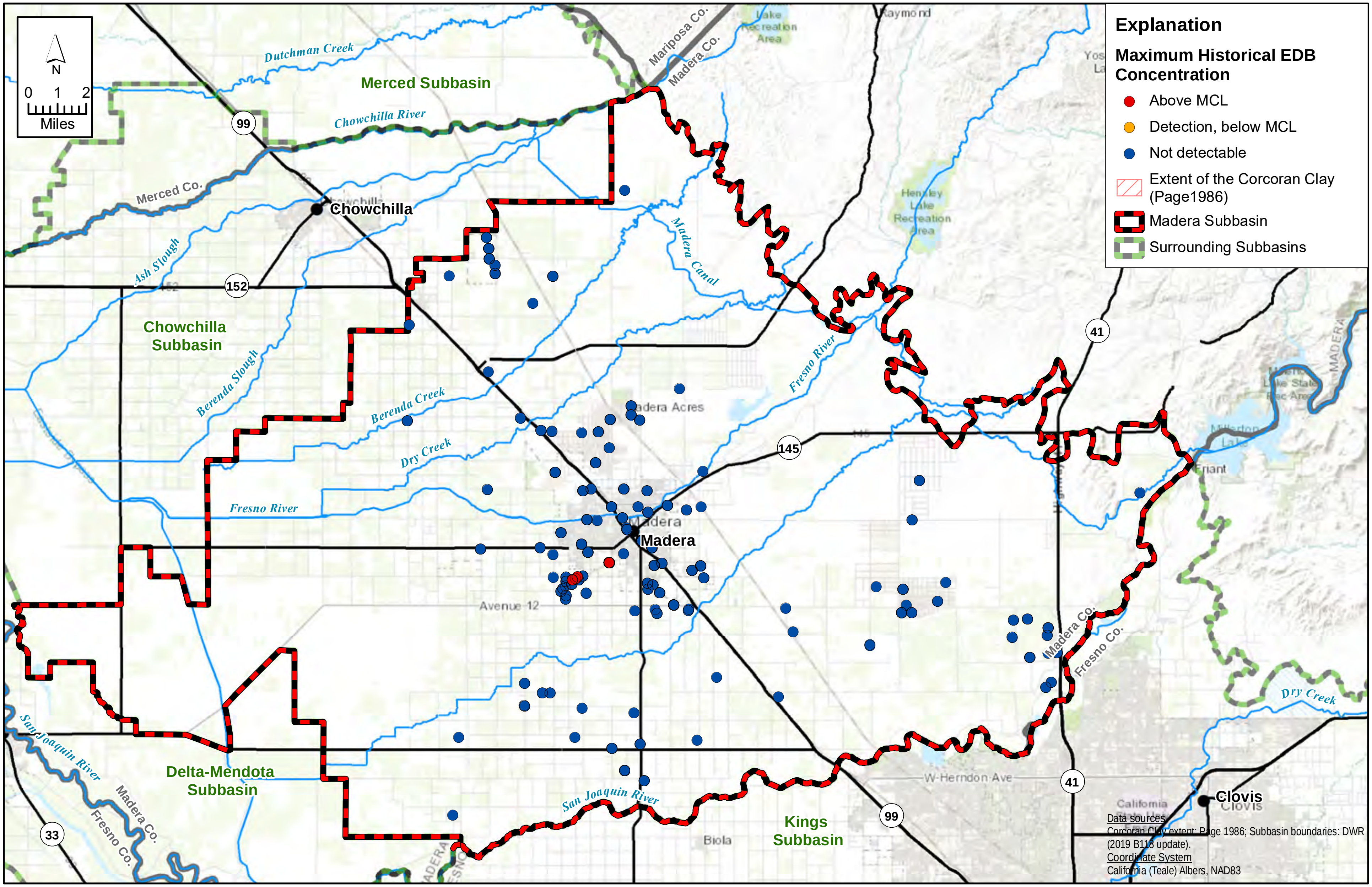
APPENDIX 2.E
Groundwater Quality Map: DBCP Concentrations in All Wells



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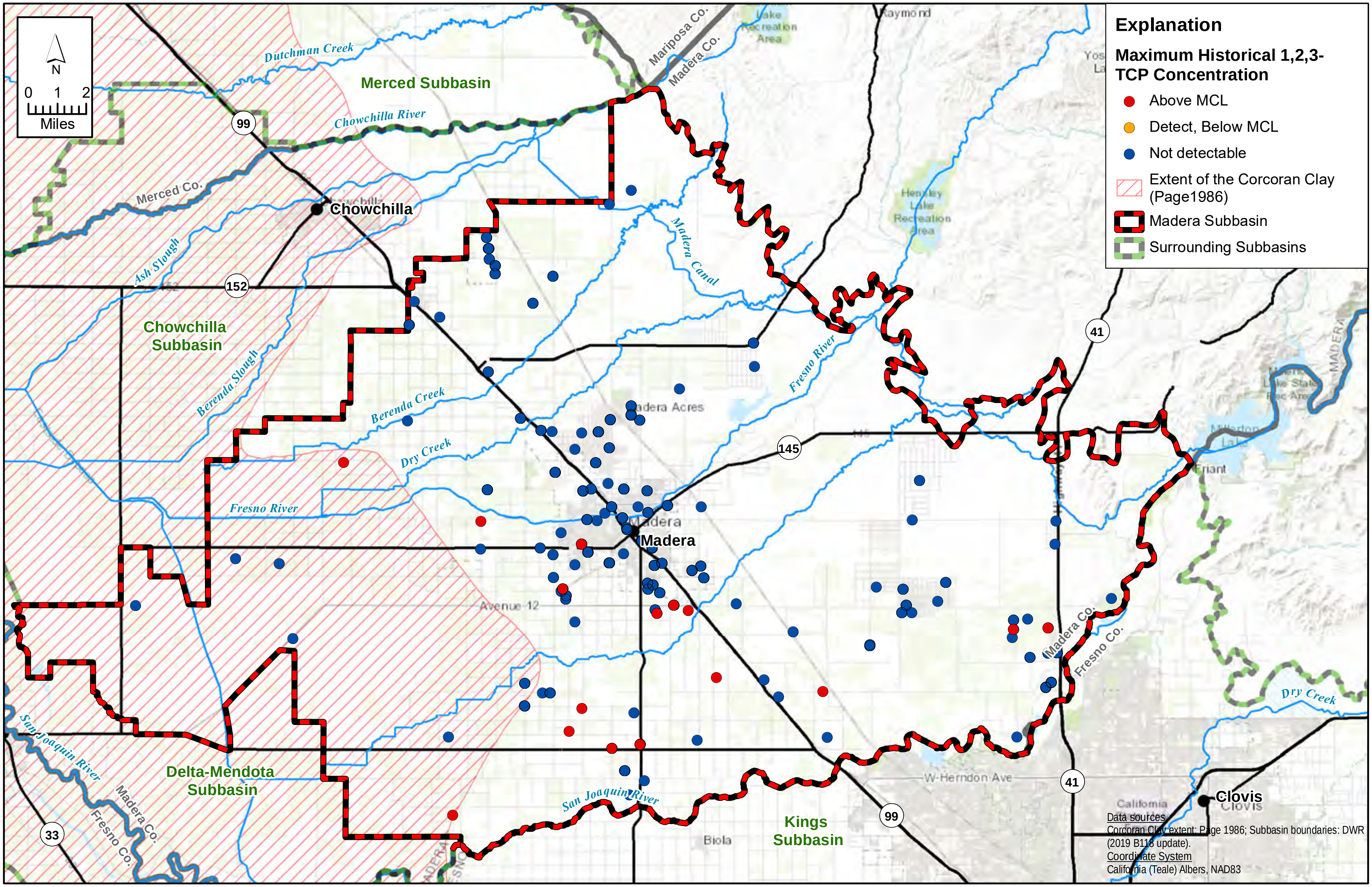
APPENDIX 2.E
Groundwater Quality Map: EDB Concentrations in All Wells



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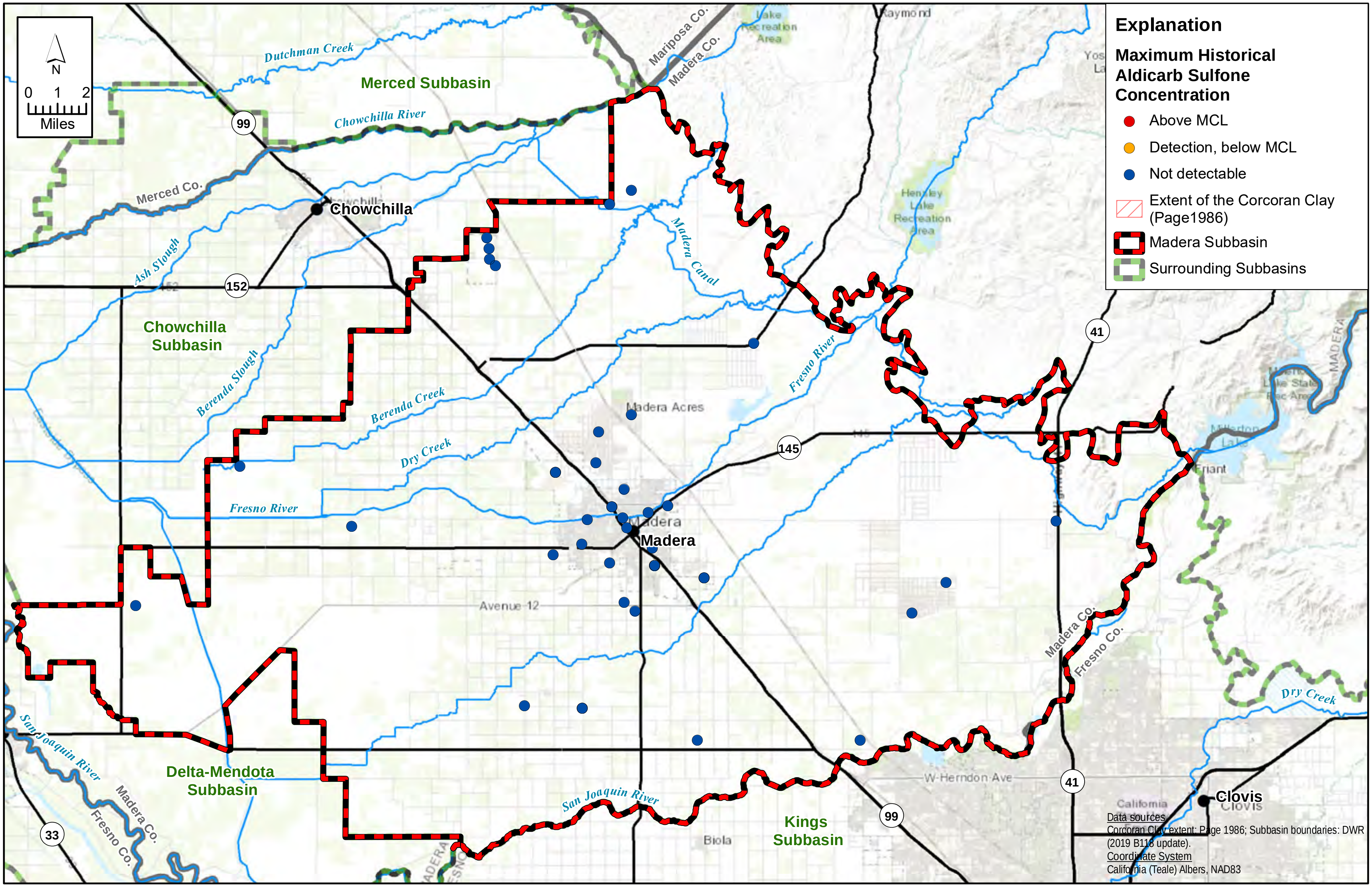
APPENDIX 2.E
Groundwater Quality Map: 1,2,3-Trichloropropane (TCP) Concentrations in All Wells



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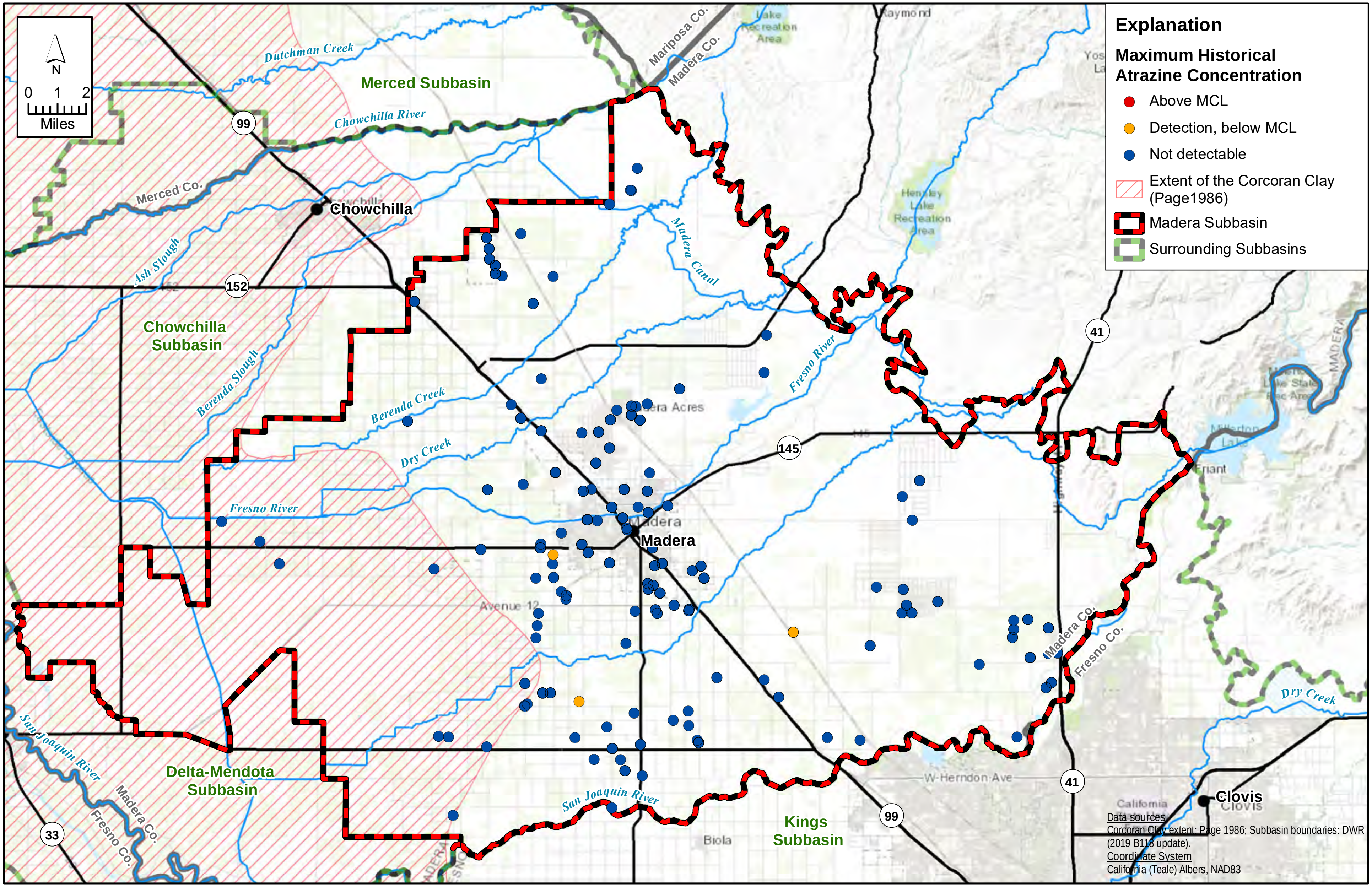
APPENDIX 2.E
Groundwater Quality Map: Aldicarb Sulfone Concentrations in All Wells



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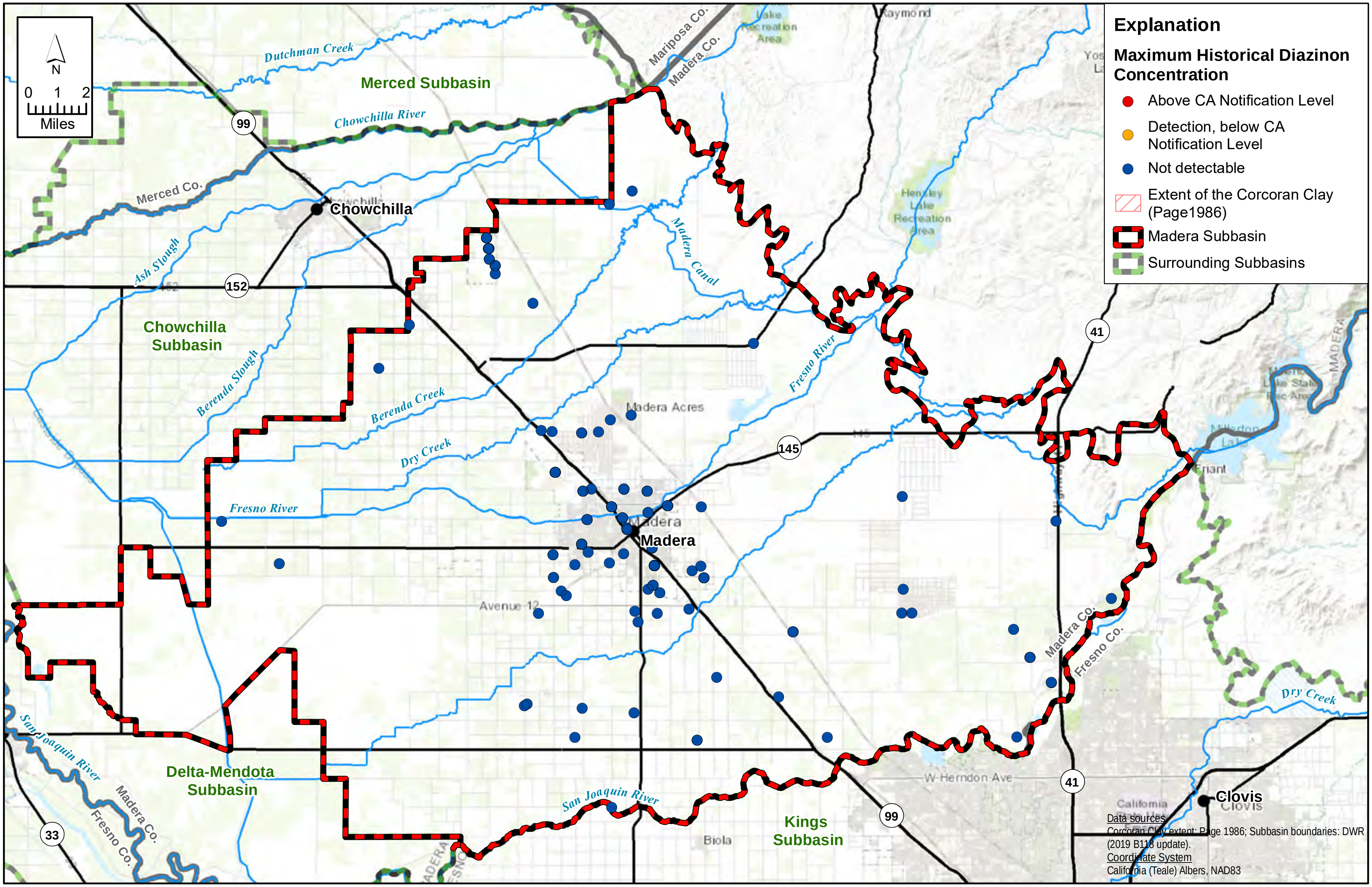
APPENDIX 2.E
Groundwater Quality Map: Atrazine Concentrations in All Wells



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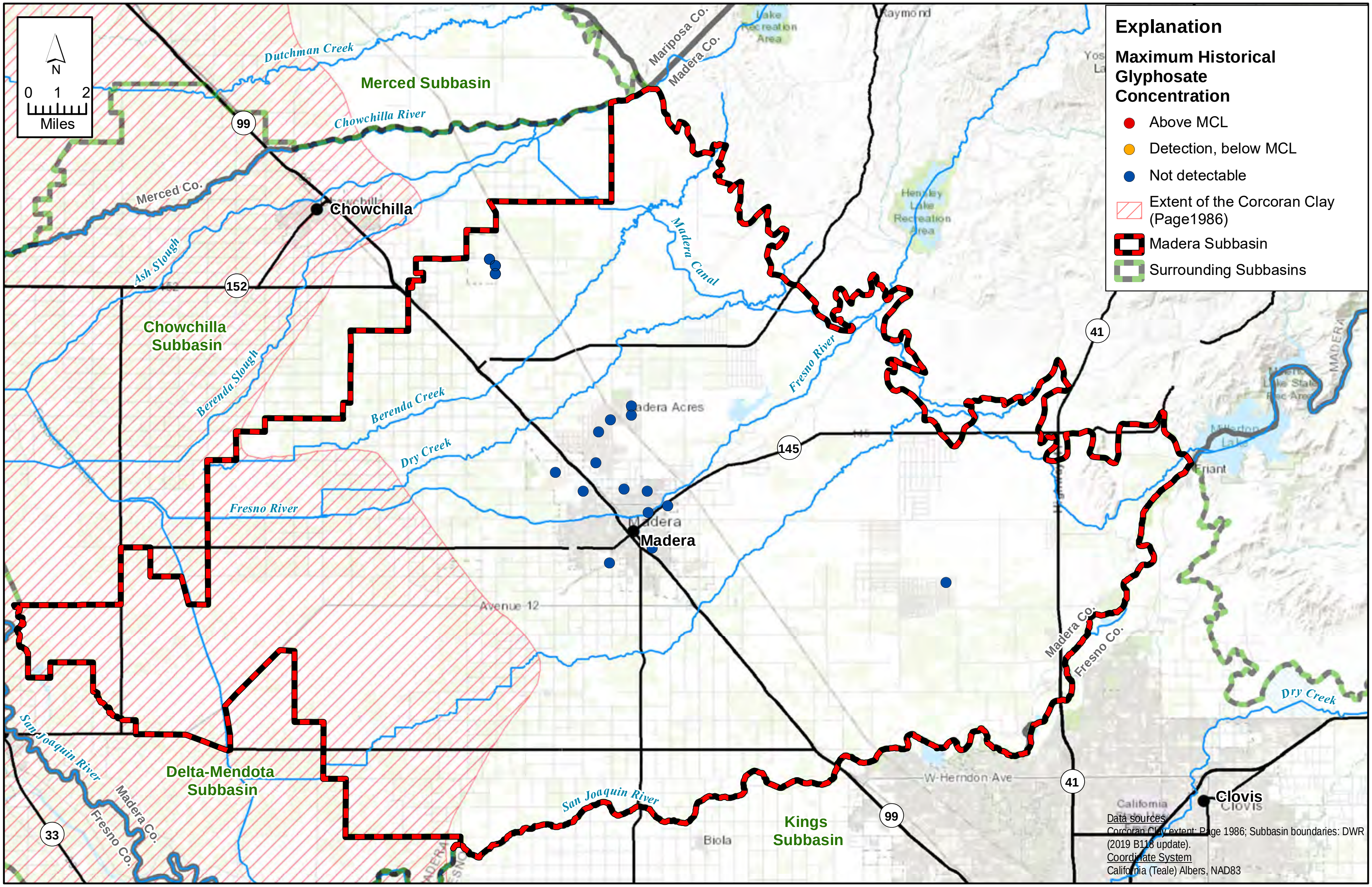
APPENDIX 2.E
Groundwater Quality Map: Diazinon Concentrations in All Wells



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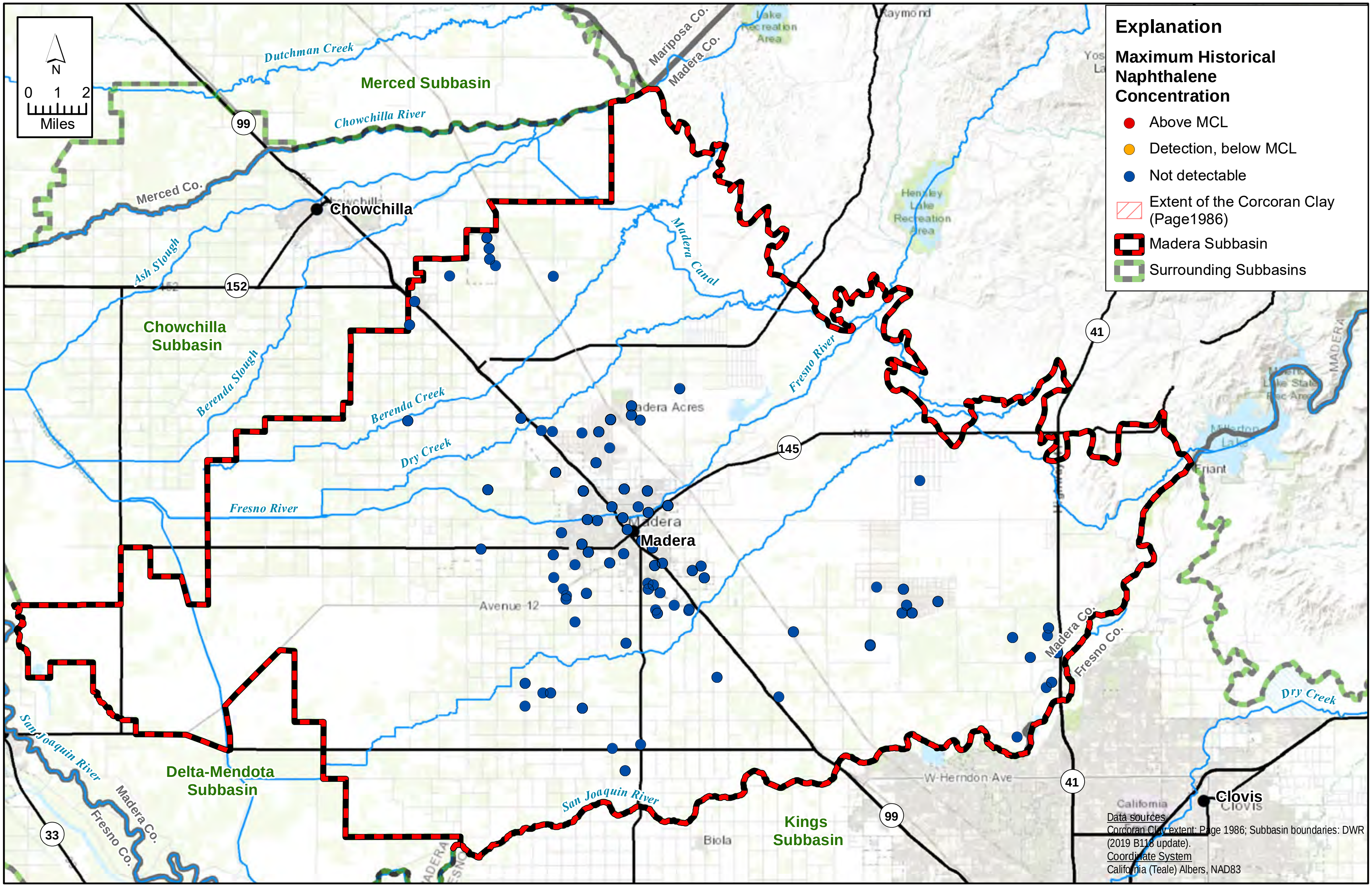
APPENDIX 2.E
Groundwater Quality Map: Glyphosate Concentrations in All Wells



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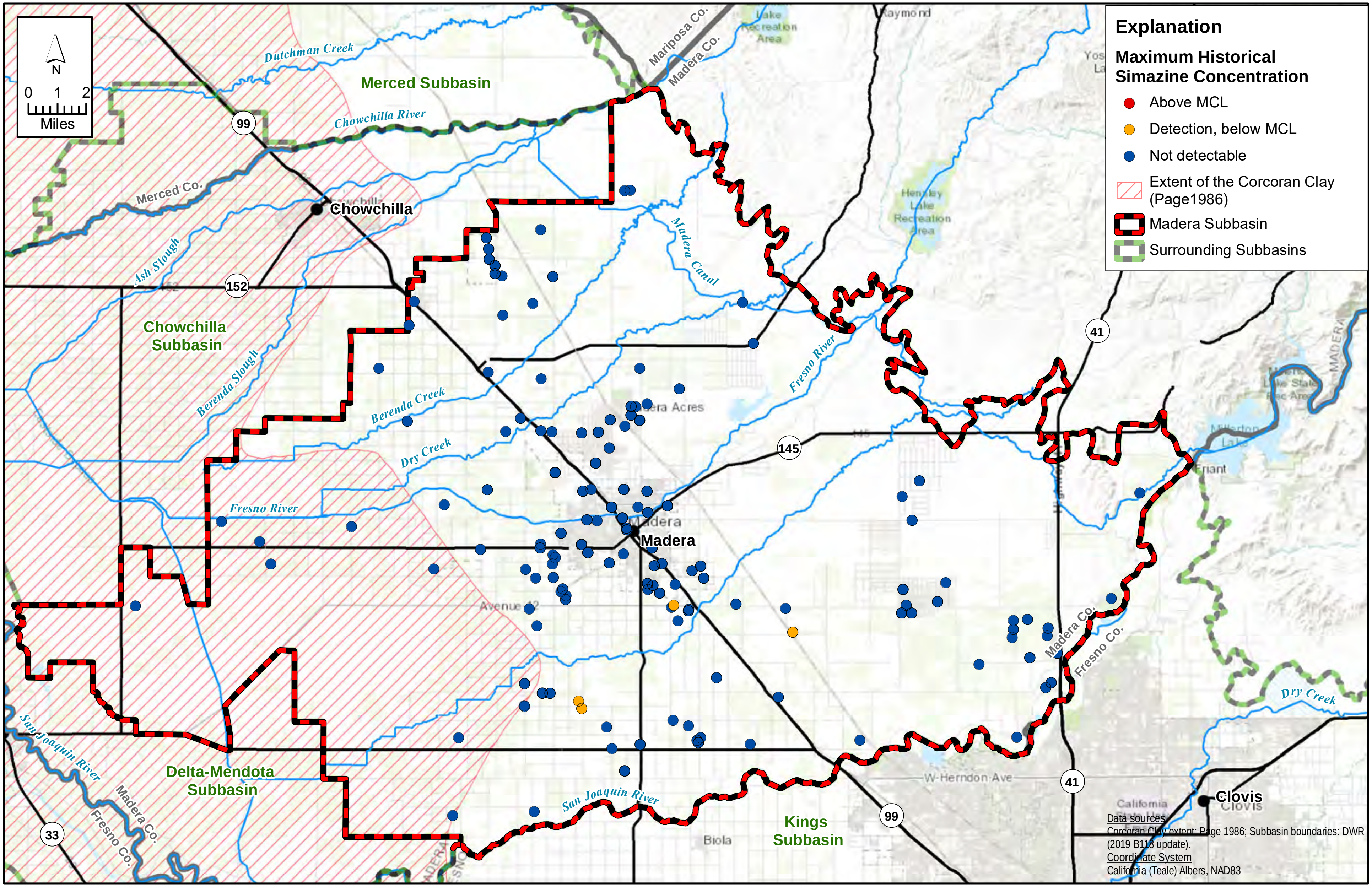
APPENDIX 2.E
Groundwater Quality Map: Naphthalene Concentrations in All Wells



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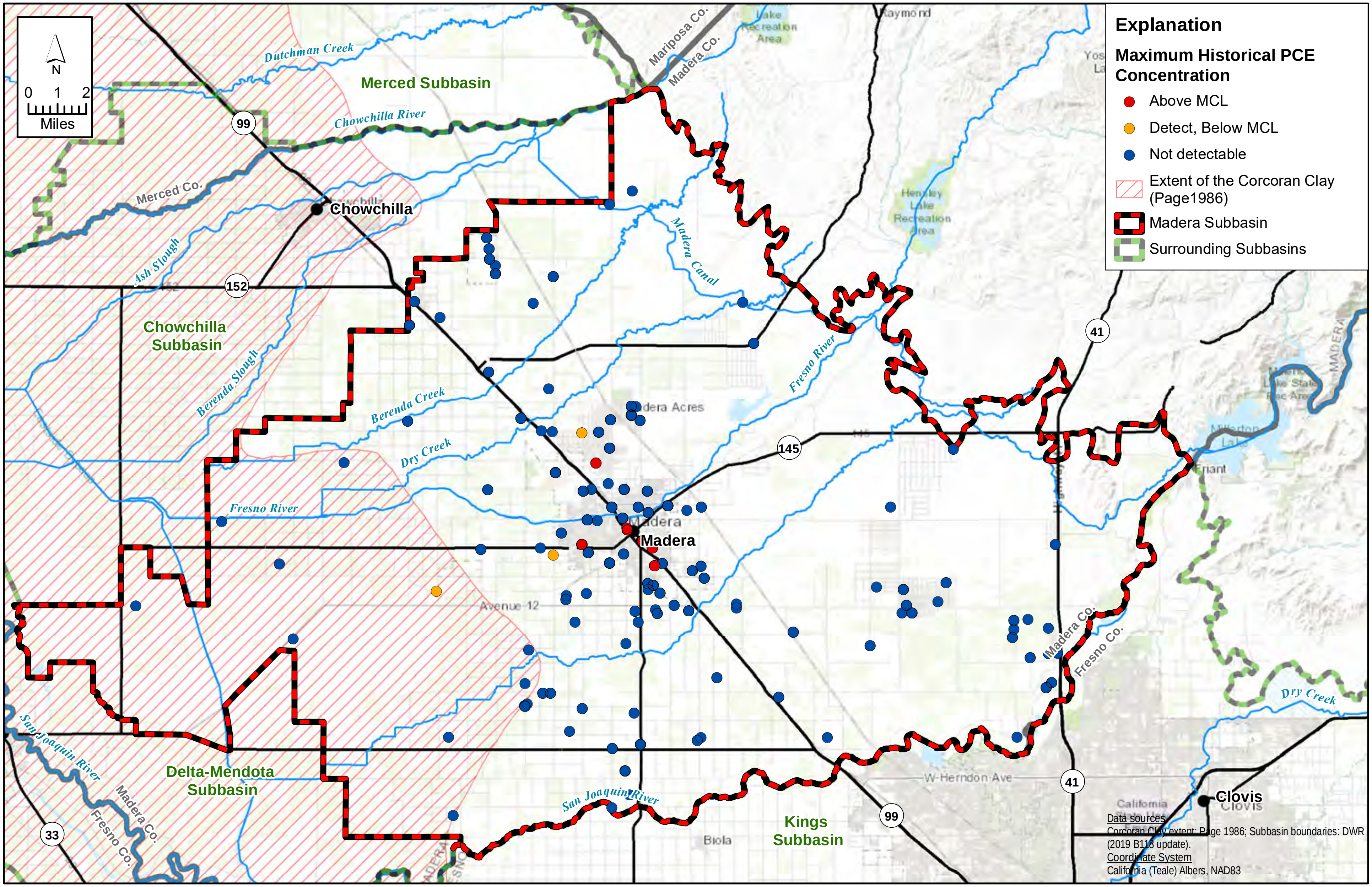
APPENDIX 2.E
Groundwater Quality Map: Simazine Concentrations in All Wells



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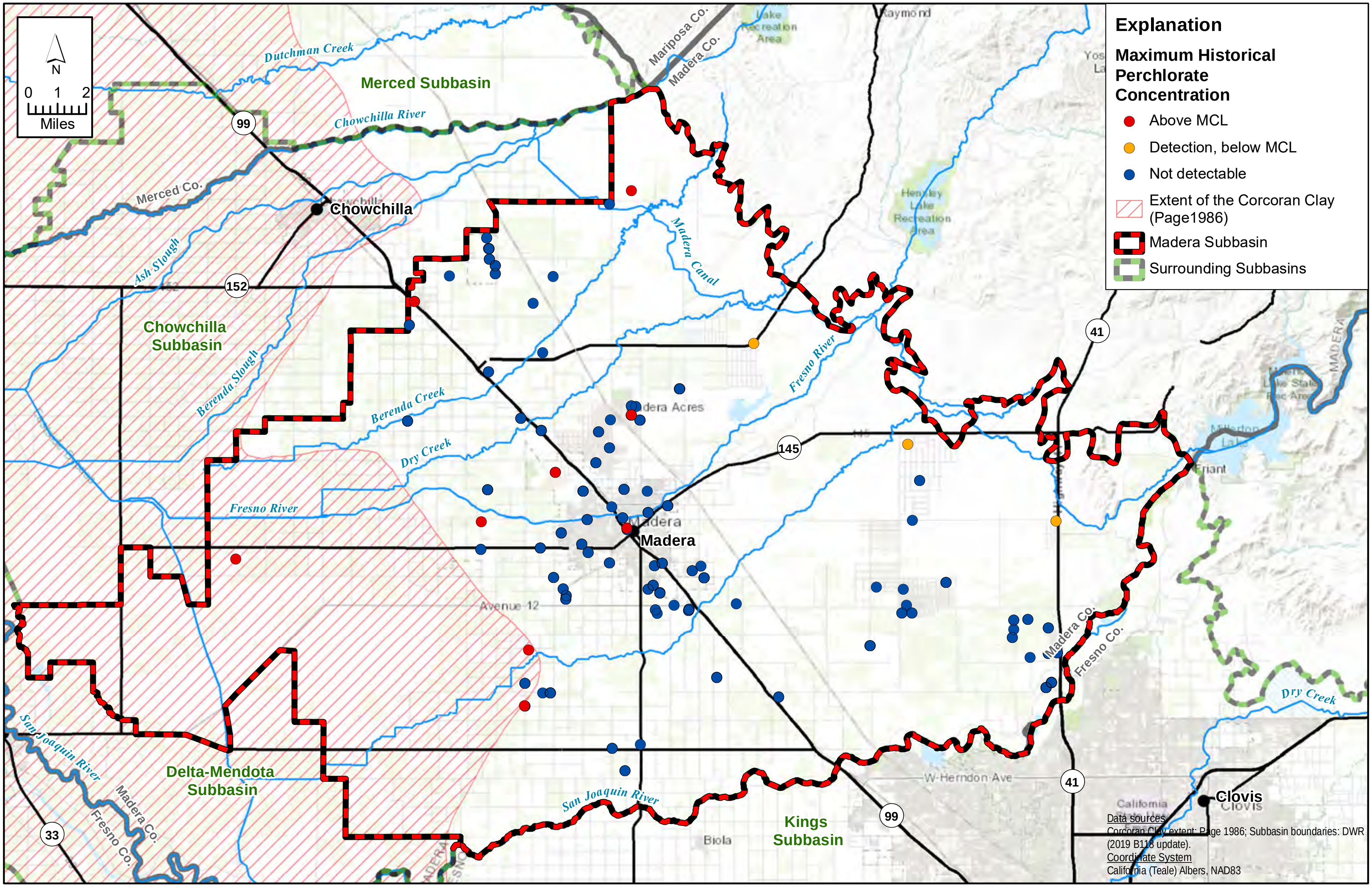
APPENDIX 2.E
Groundwater Quality Map: Tetrachloroethylene (PCE) Concentrations in All Wells



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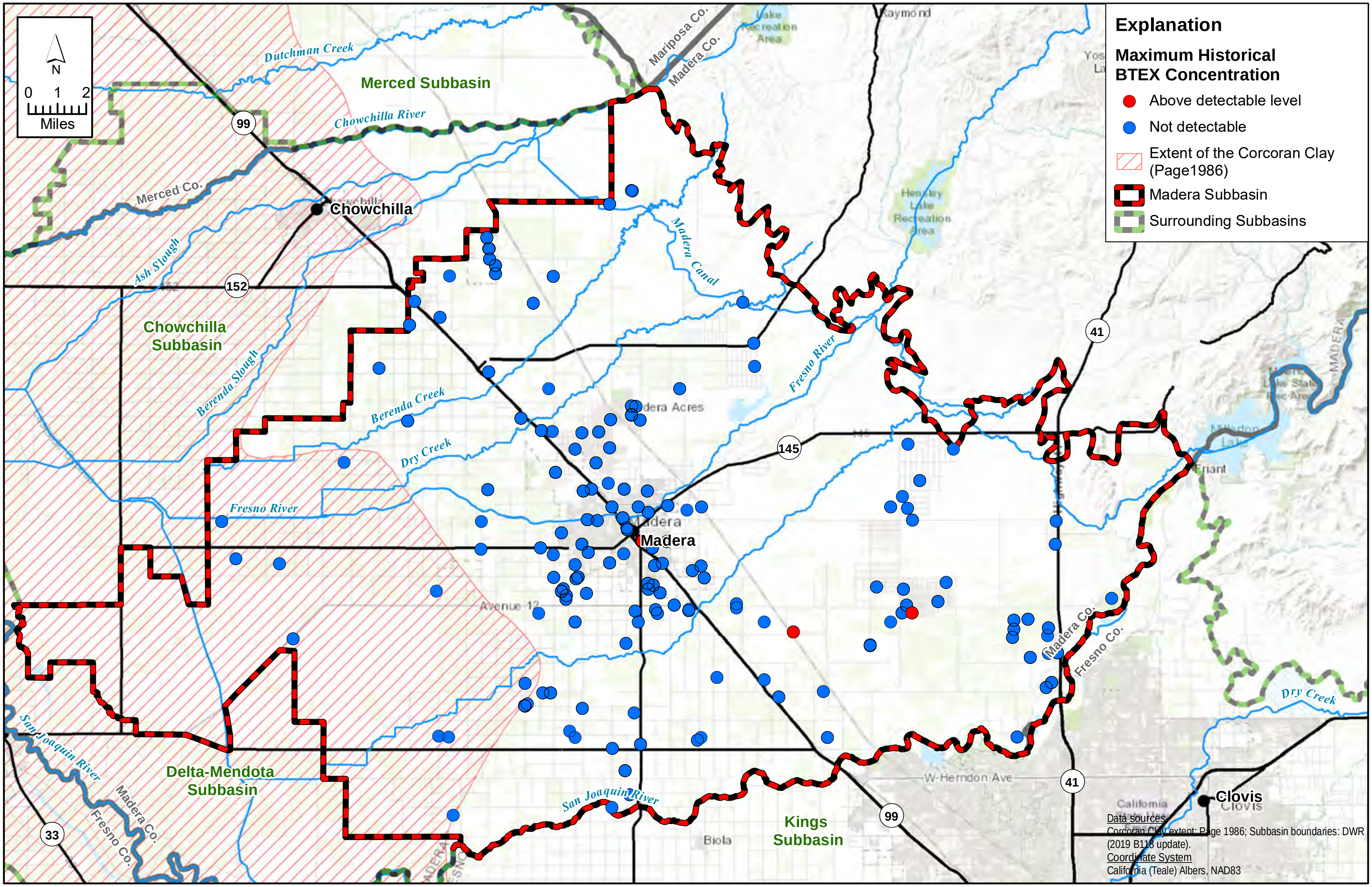
APPENDIX 2.E
Groundwater Quality Map: Perchlorate Concentrations in All Wells



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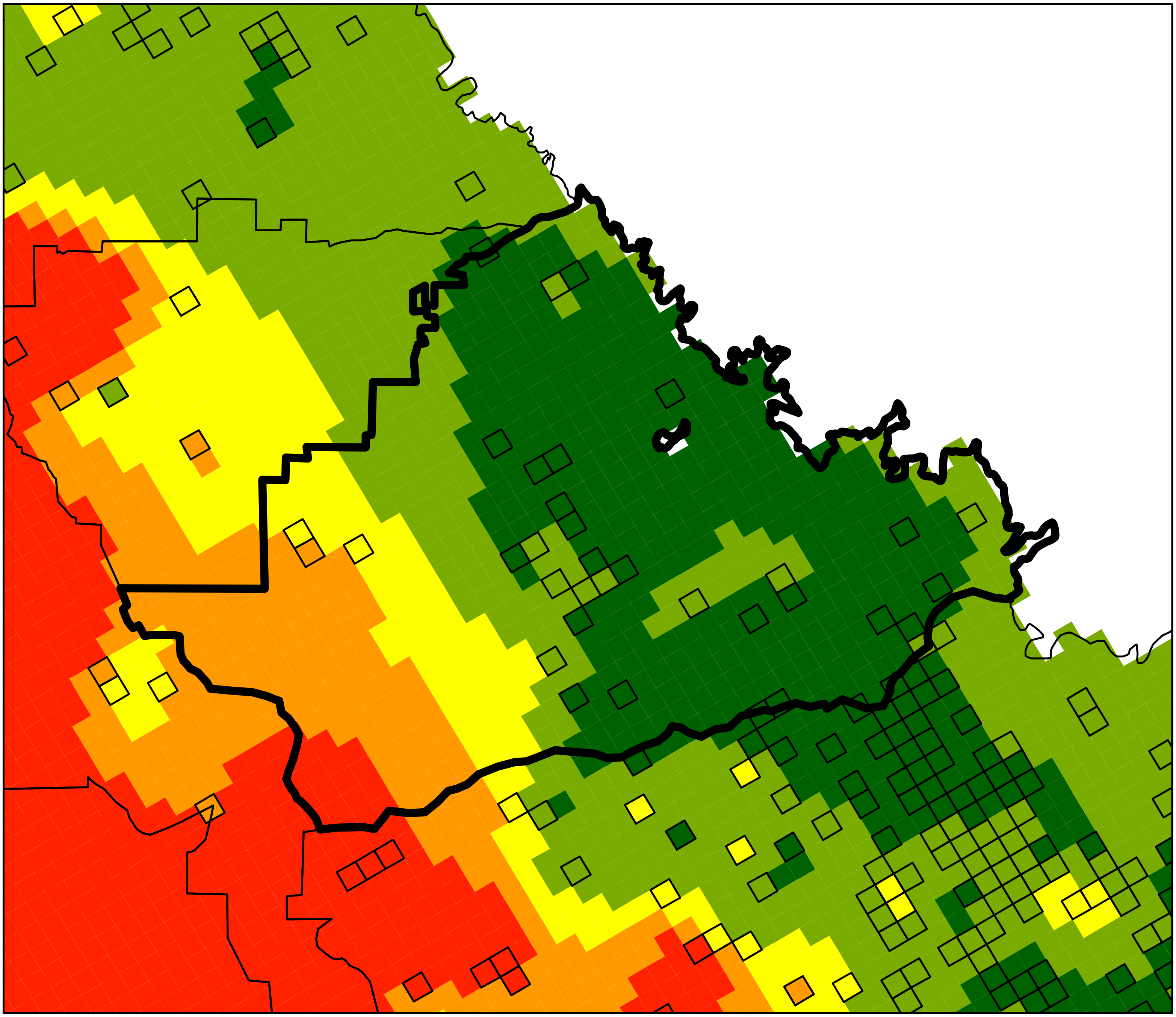
APPENDIX 2.E
Map of Groundwater Quality: BTEX (Benzene, Toluene, Ethylbenze, Xylene) in All Wells



Ambient Conditions (Data: 2000-2016)

Cells With Data (1 sq mi)

Upper Zone

TDS (mg/L)

- 1 - 250
- 251 - 500
- 501 - 750
- 751 - 1,000
- >1,000
- Region 5
- DWR B118 Basins

N

0 5 10 Miles

DWR B118 Code:5-22.06

Groundwater Basin:
SAN JOAQUIN VALLEY

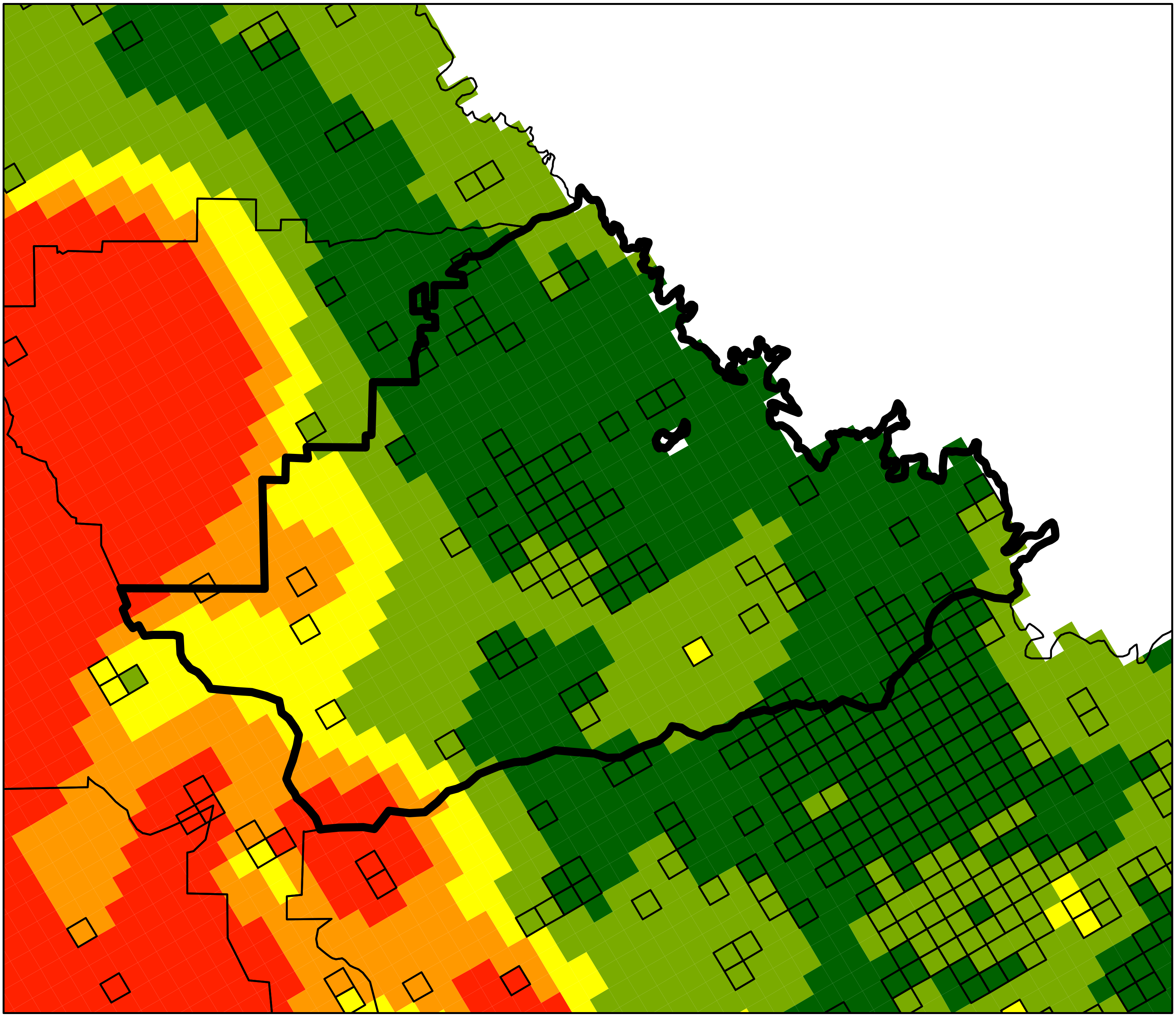
Groundwater Subbasin:
MADERA

LUHDORFF & SCALMANINI CONSULTING ENGINEERS

LARRY WALKER ASSOCIATES

Figure 157

A2.E.c-18



Ambient Conditions (Data: 2000-2016)

Cells With Data (1 sq mi)

Lower Zone

TDS (mg/L)

- 1 - 250
- 251 - 500
- 501 - 750
- 751 - 1,000
- >1,000
- Region 5
- DWR B118 Basins

N

0 5 10 Miles

DWR B118 Code:5-22.06

Groundwater Basin:
SAN JOAQUIN VALLEY

Groundwater Subbasin:
MADERA

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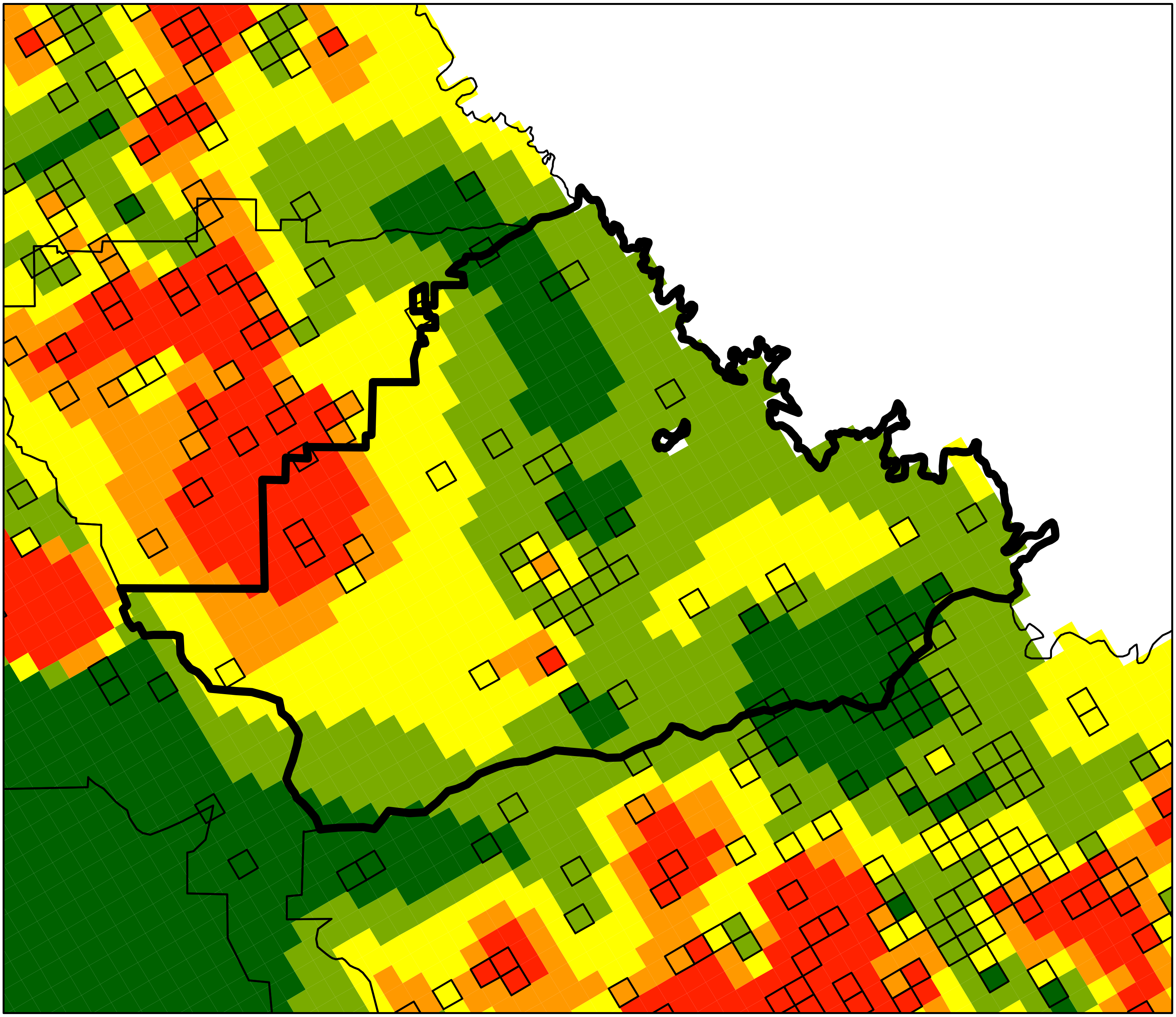
Figure 198

A2.E.c-19



Ambient Conditions
(Data: 2000-2016)

Cells With Data (1 sq mi)

Upper Zone

Nitrate (mg/L as N)

- 0.1 - 2.5
- 2.6 - 5.0
- 5.1 - 7.5
- 7.6 - 10.0
- >10
- Region 5
- DWR B118 Basins

N

0 5 10 Miles

DWR B118 Code:5-22.06

Groundwater Basin:
SAN JOAQUIN VALLEY

Groundwater Subbasin:
MADERA

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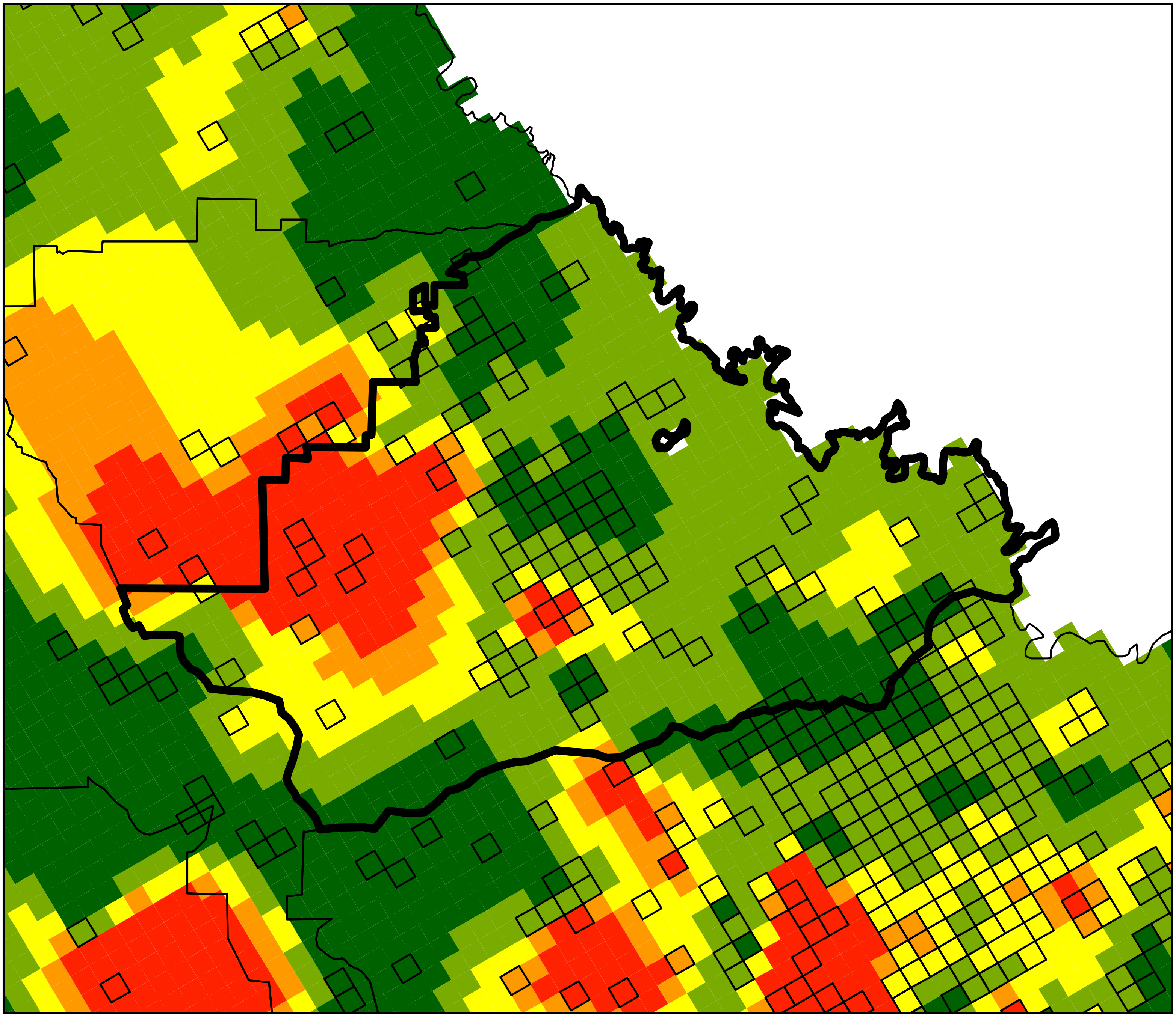
LARRY WALKER ASSOCIATES

Figure 34



Ambient Conditions (Data: 2000-2016)

Cells With Data (1 sq mi)

Lower Zone

Nitrate (mg/L as N)

- 0.1 - 2.5
- 2.6 - 5.0
- 5.1 - 7.5
- 7.6 - 10.0
- >10
- Region 5
- DWR B118 Basins

N

0 5 10 Miles

DWR B118 Code:5-22.06

Groundwater Basin:
SAN JOAQUIN VALLEY

Groundwater Subbasin:
MADERA

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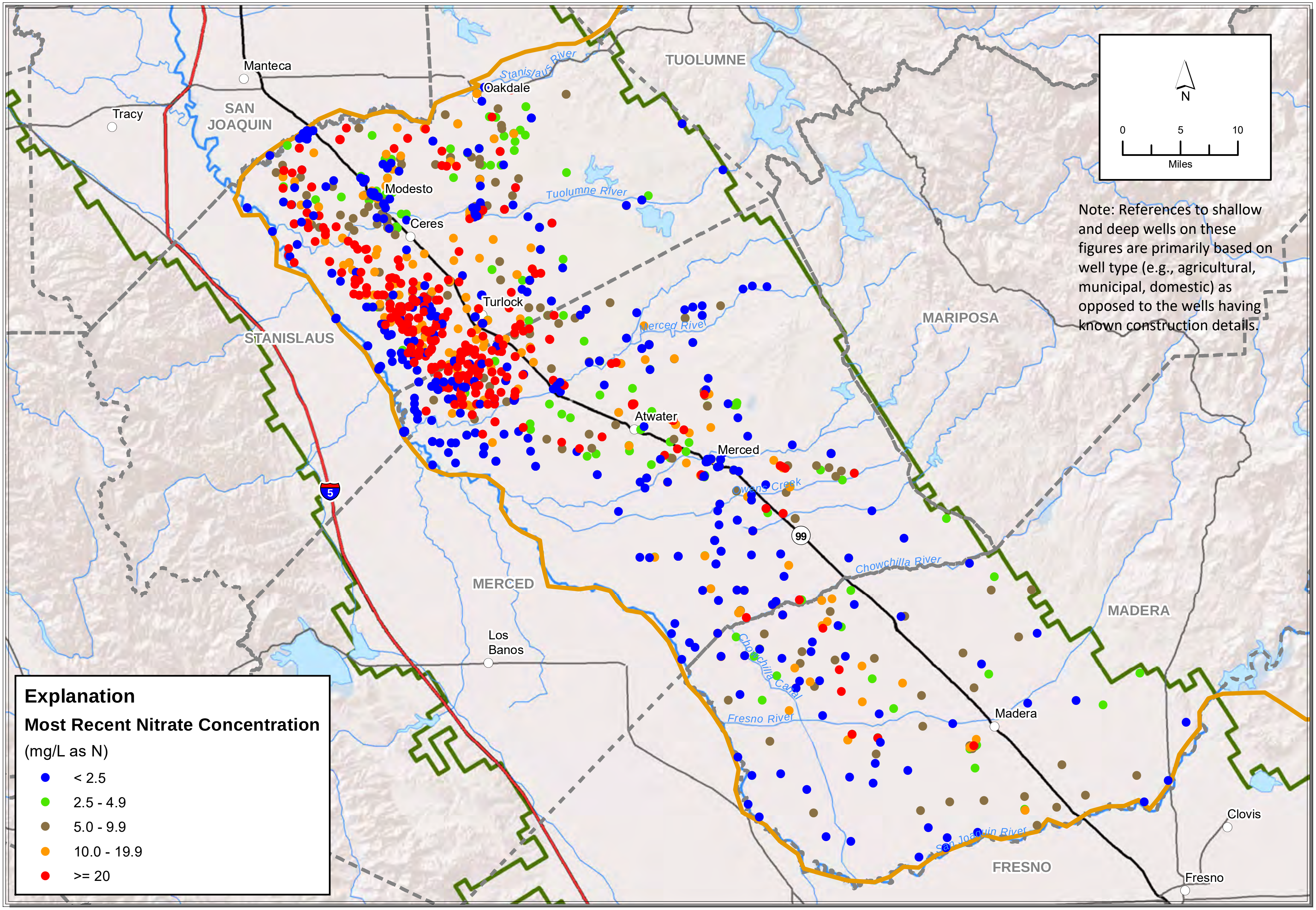
Figure 75



Path: X:\2012 Job Files\12-118\Report\Figures\Final GIS Map Files\Figure 5-4 Nitrate Concentrations in Central Valley Floor Shallow Wells.mxd

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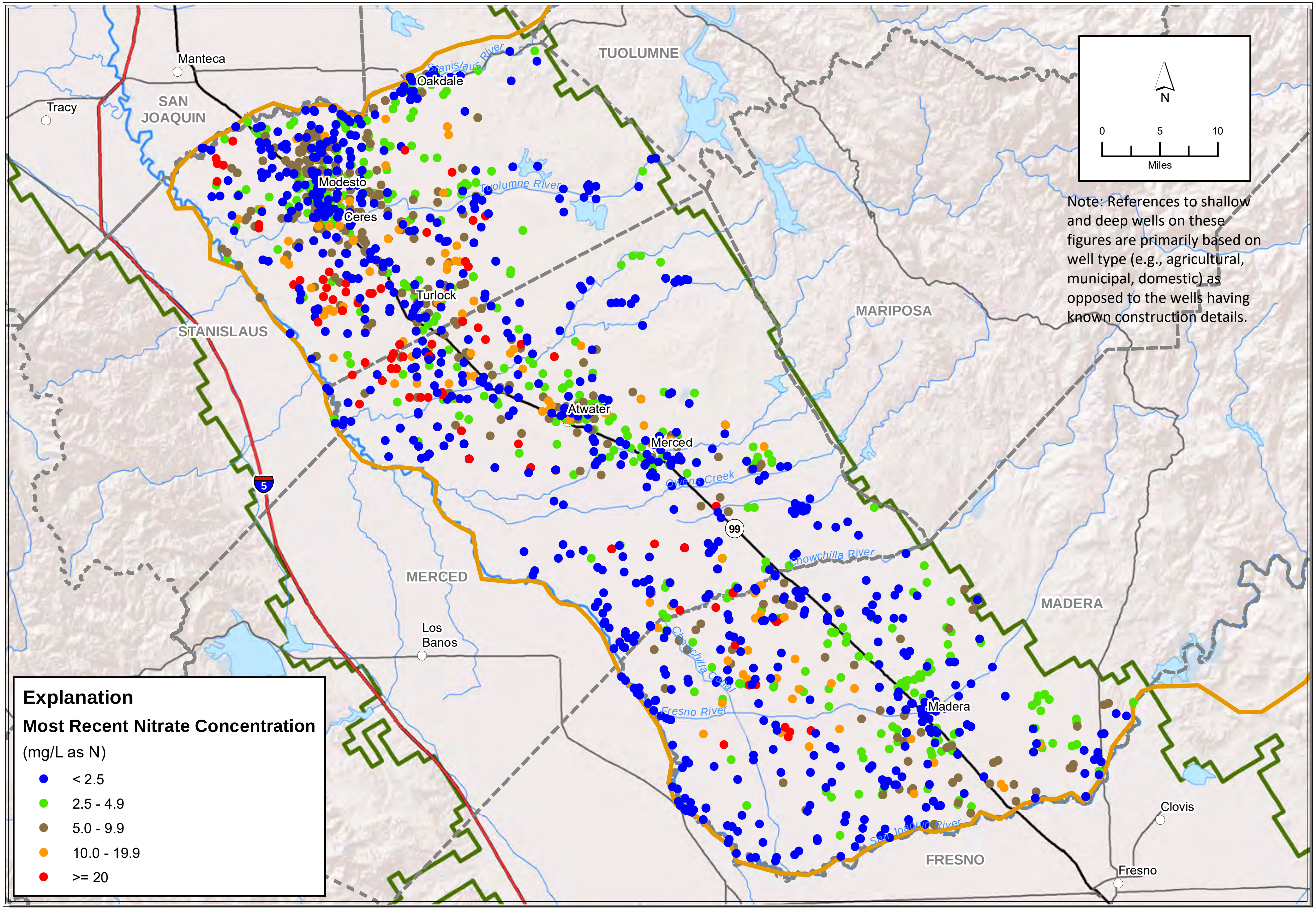
Figure 5-4
Nitrate Concentrations in the Central Valley Floor: Shallow Wells



Path: X:\2012 Job Files\12-118\Report\Figures\Final GIS Map Files\Figure 5-5 Nitrate Concentrations in Central Valley Floor Deep Wells.mxd

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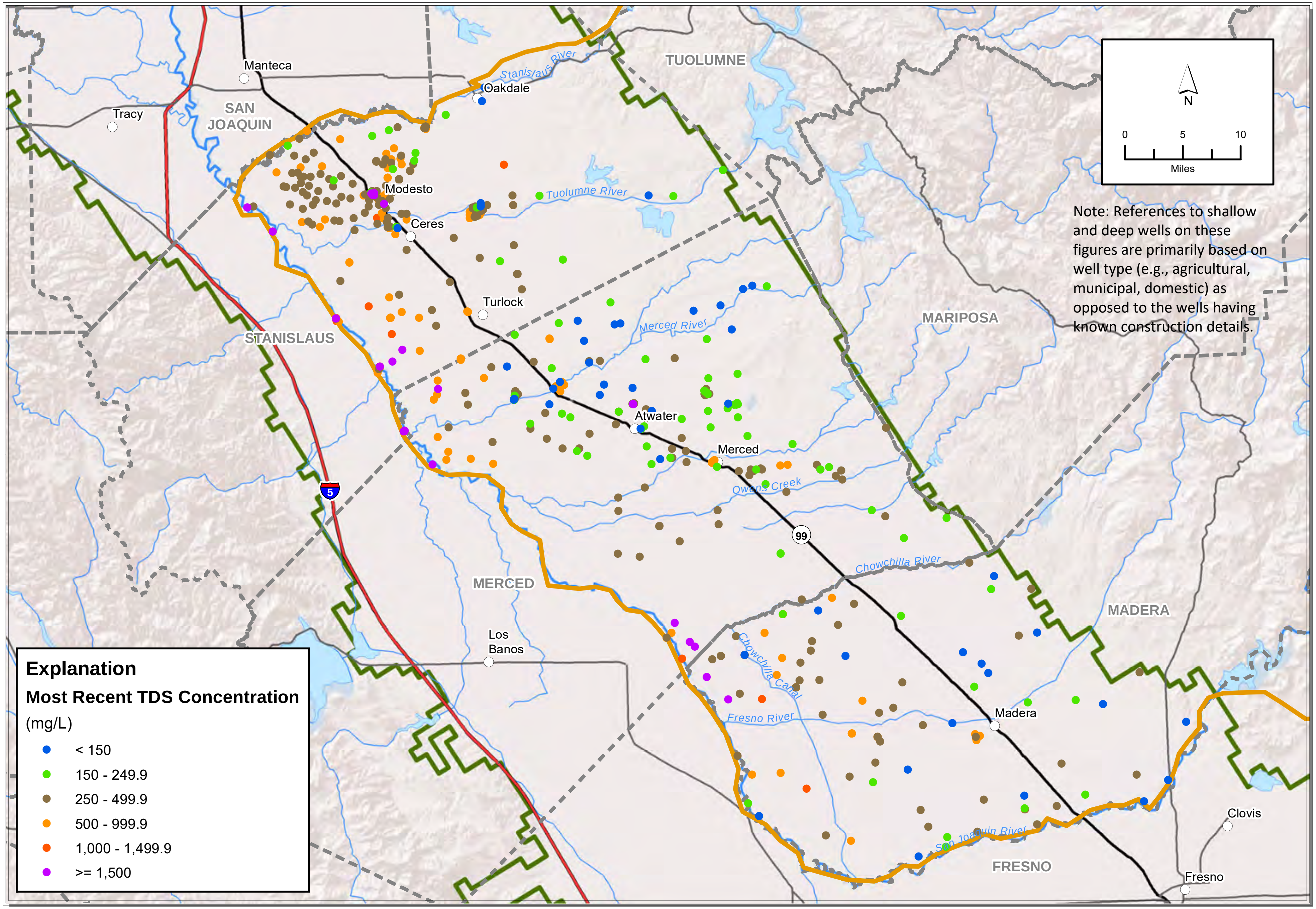
Figure 5-5
Nitrate Concentrations in the Central Valley Floor: Deep Wells



Path: X:\2012 Job Files\12-118\Report\Figures\Final GIS Map Files\Figure 5-7 TDS Concentrations in Central Valley Floor Shallow Wells.mxd

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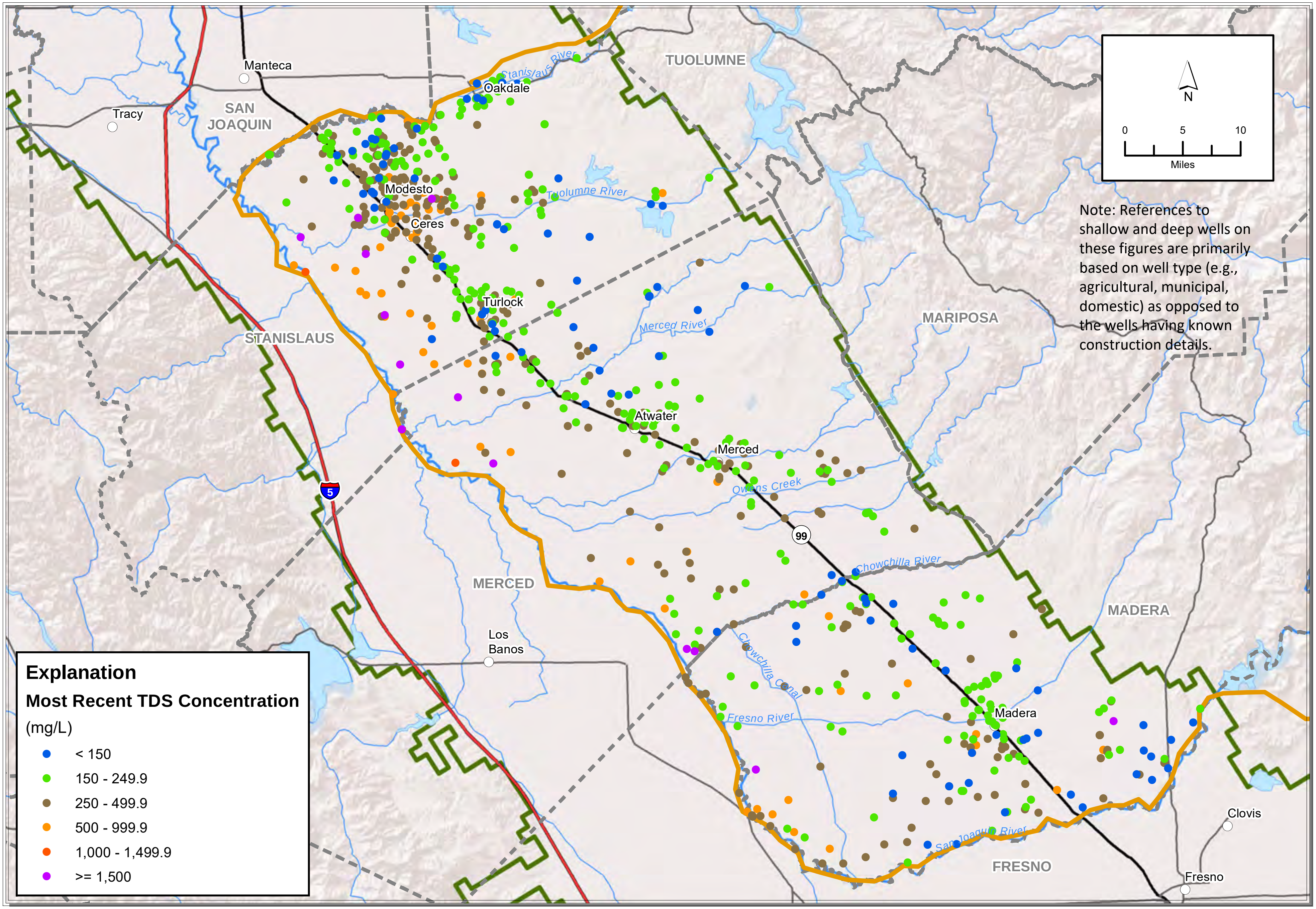
Figure 5-7

TDS Concentrations in the Central Valley Floor: Shallow Wells



Path: X:\2012 Job Files\12-118\Report\Figures\Final GIS Map Files\Figure 5-8 TDS Concentrations in Central Valley Floor Deep Wells.mxd

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Figure 5-8
TDS Concentrations in the Central Valley Floor: Deep Wells

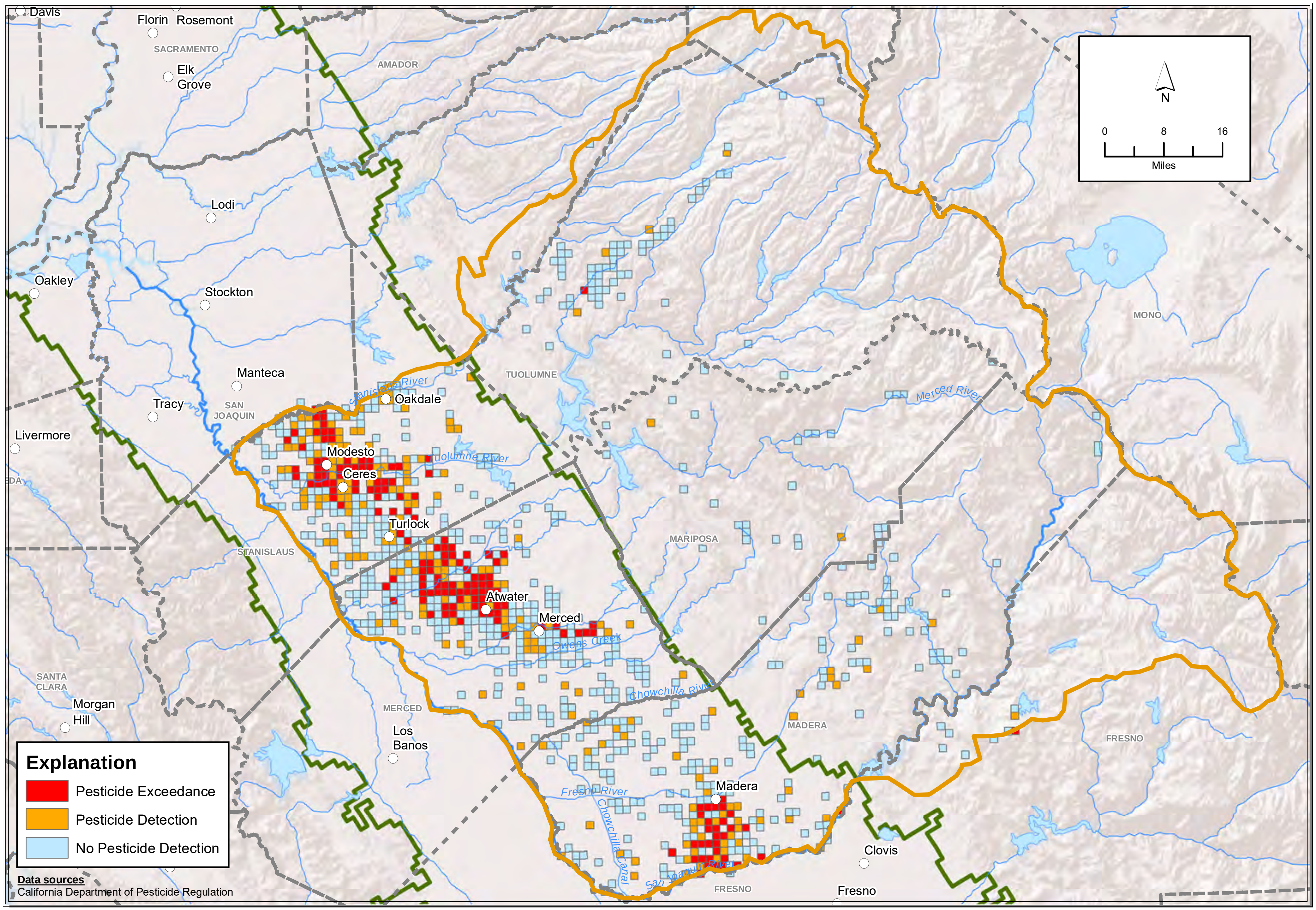

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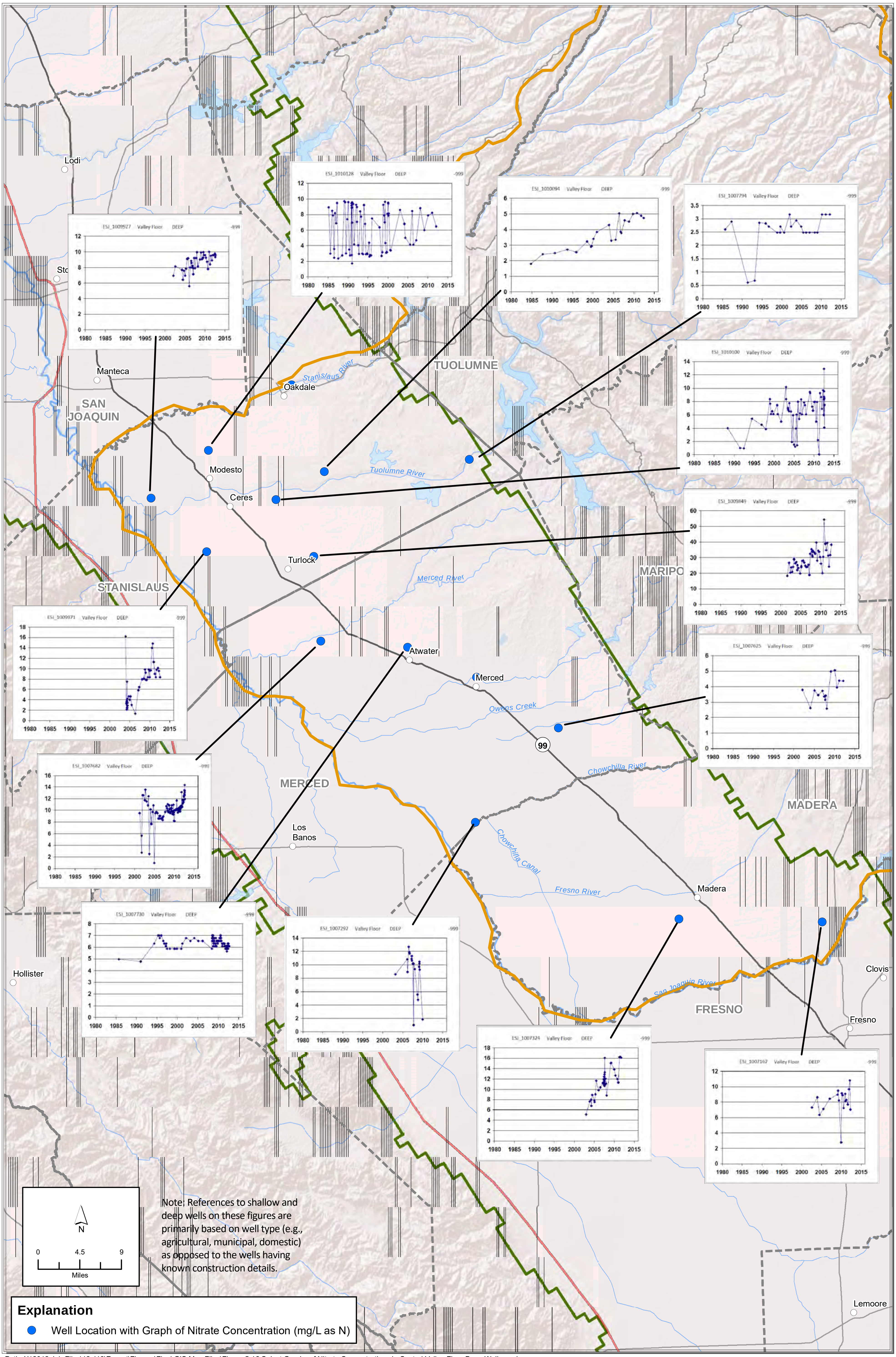
Figure 5-10c
Pesticide Detection Or Exceedance By Section

AC-E5-26



Path: X:\2012 Job Files\12-118\Report\Figures\Final GIS Map Files\Figure 5-12 Select Graphs of Nitrate Concentrations in Central Valley Floor Deep Wells.mxd

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Figure 5-12
Select Graphs of Nitrate Concentrations in the Central Valley Floor: Deep Wells

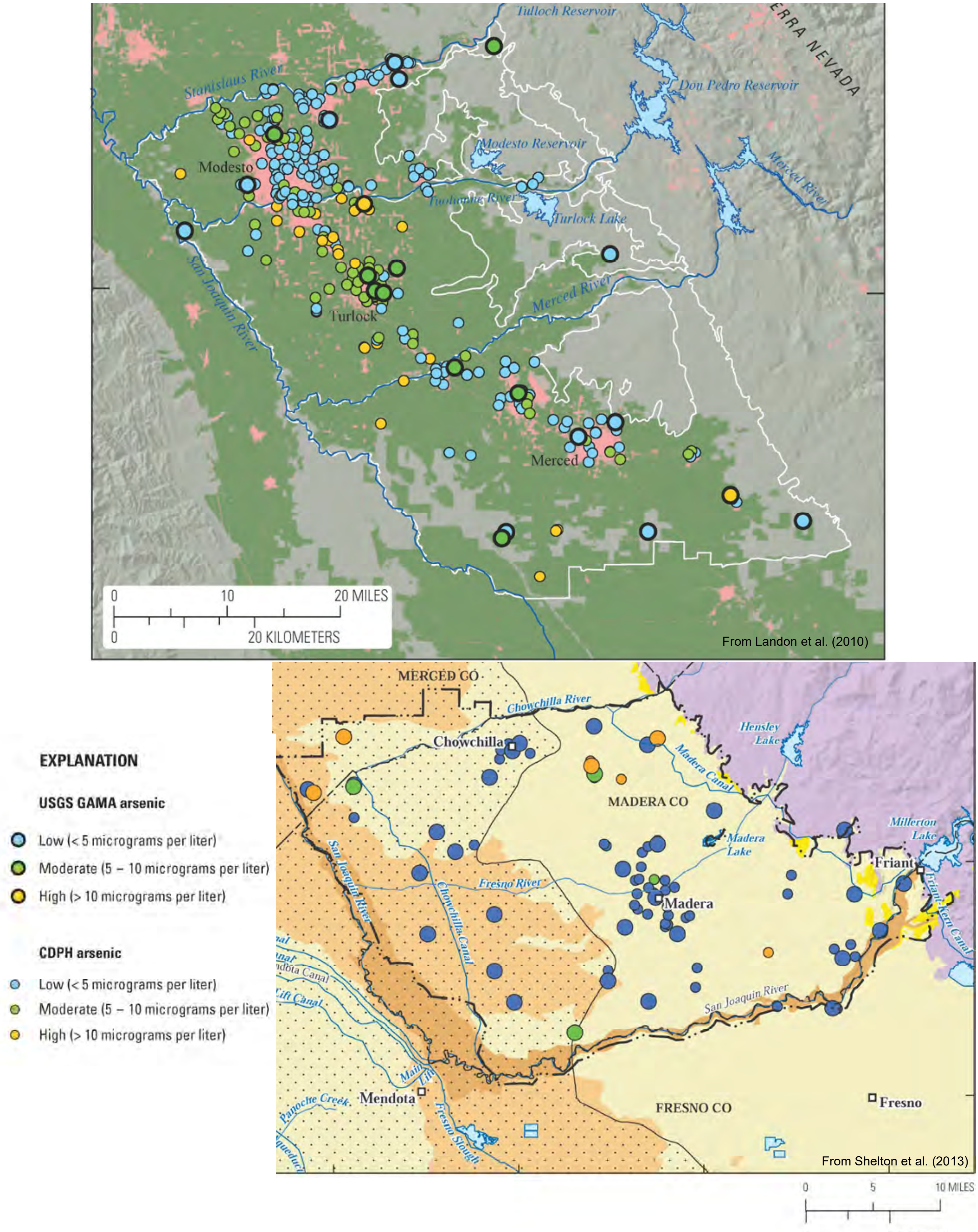

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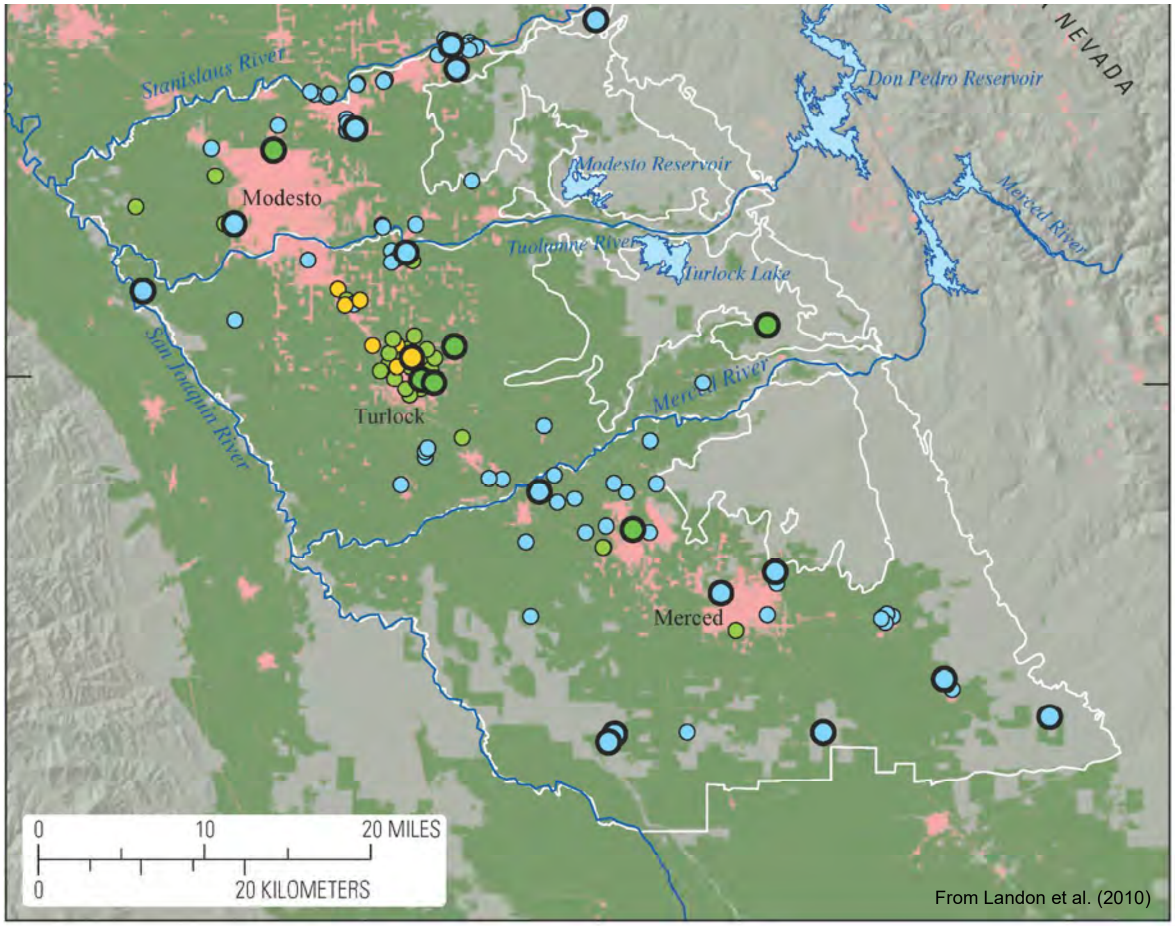
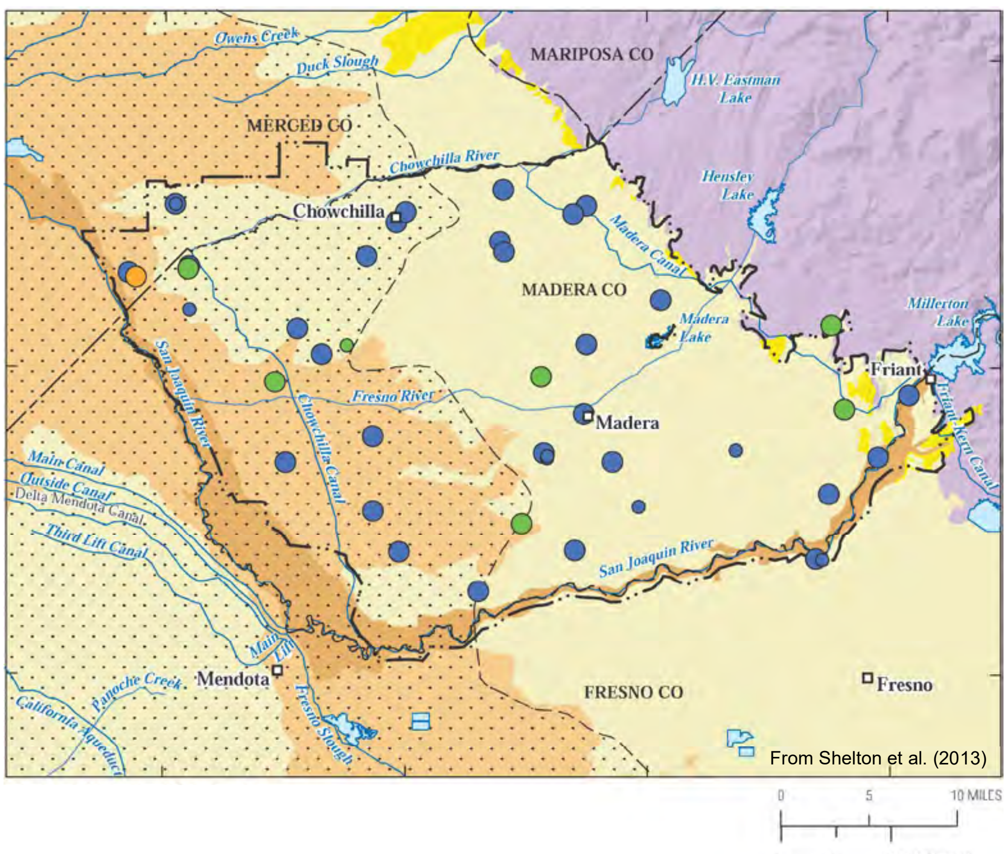
Figure 5-23a
Other Groundwater Quality Data: Arsenic



From Landon et al. (2010)



From Shelton et al. (2013)

EXPLANATION

USGS GAMA vanadium

- Low (< 25 micrograms per liter)
- Moderate (25 – 50 micrograms per liter)
- High (> 50 micrograms per liter)

CDPH vanadium

- Low (< 25 micrograms per liter)
- Moderate (25 – 50 micrograms per liter)
- High (> 50 micrograms per liter)

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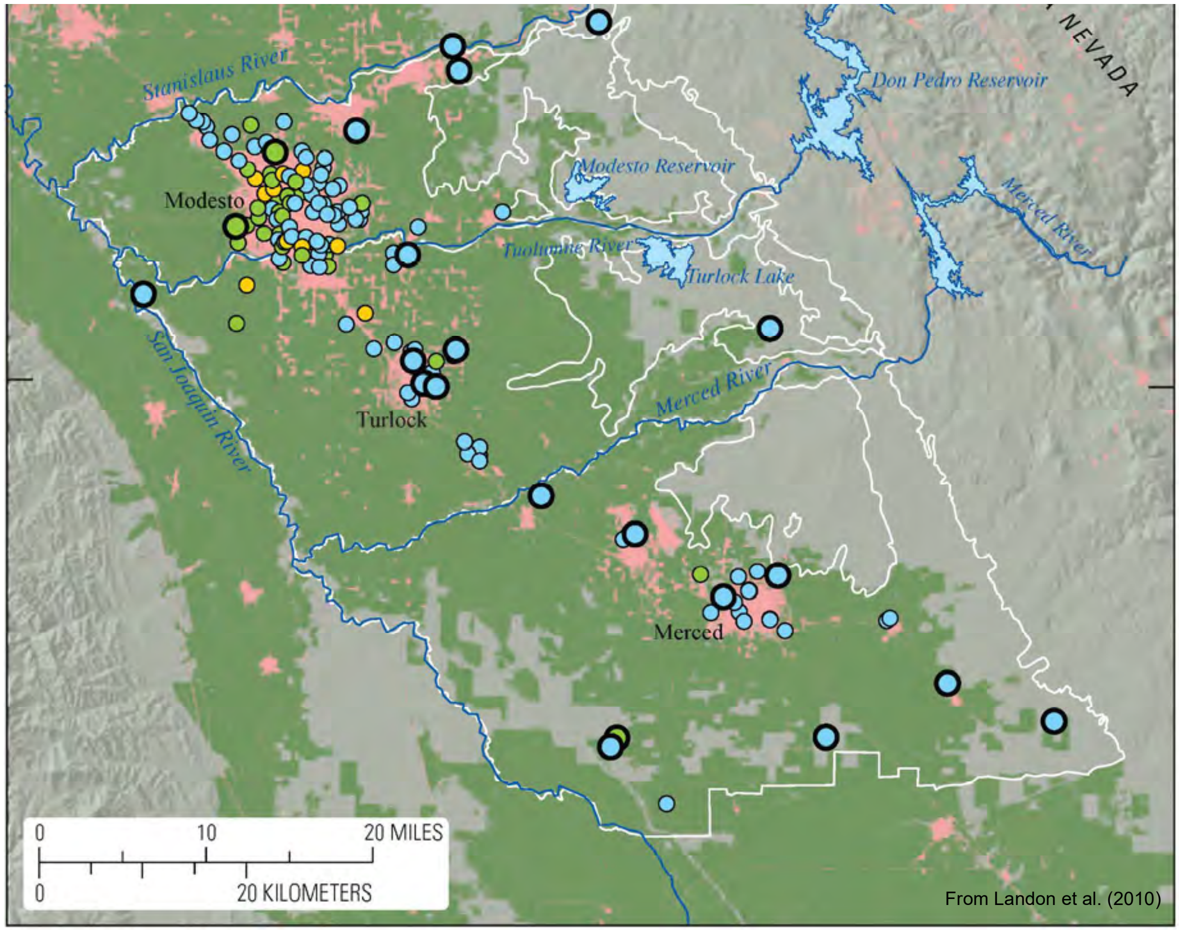
Figure 5-23b
Other Groundwater Quality Data: Vanadium



EXPLANATION

USGS GAMA uranium

- Low (< 15 micrograms per liter)
- Moderate (15 – 30 micrograms per liter)
- High (> 30 micrograms per liter)

CDPH uranium

- Low (< 15 micrograms per liter)
- Moderate (15 – 30 micrograms per liter)
- High (> 30 micrograms per liter)

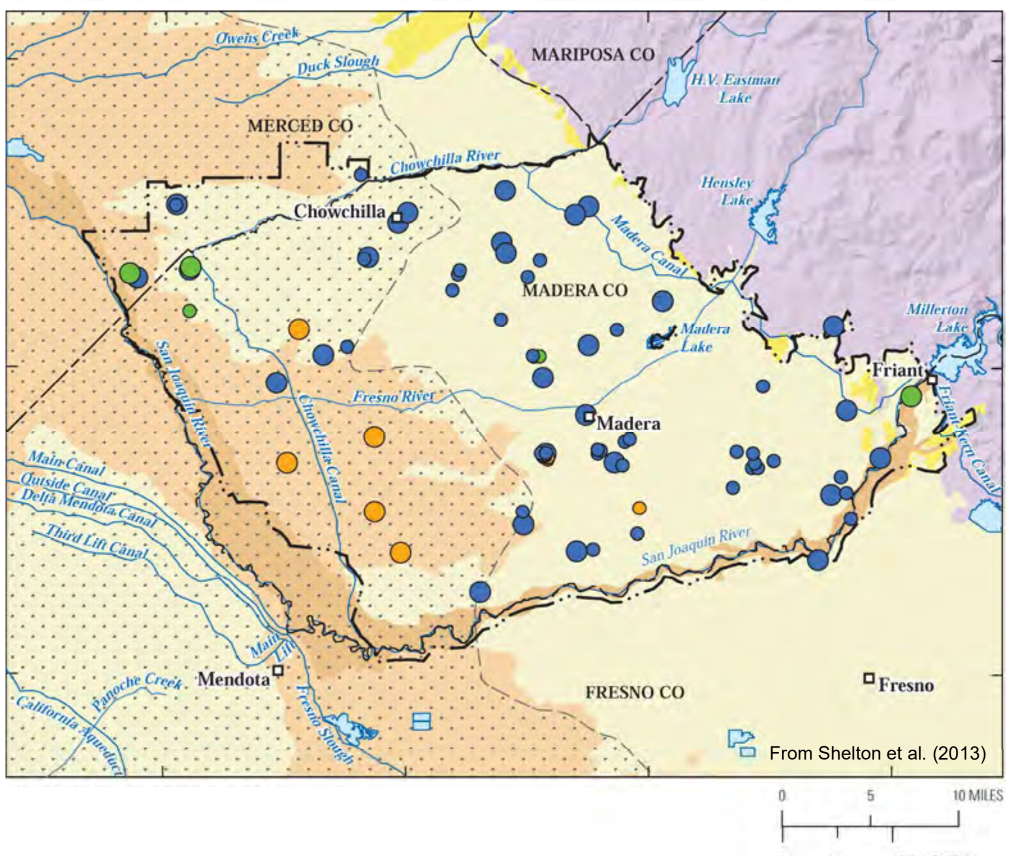
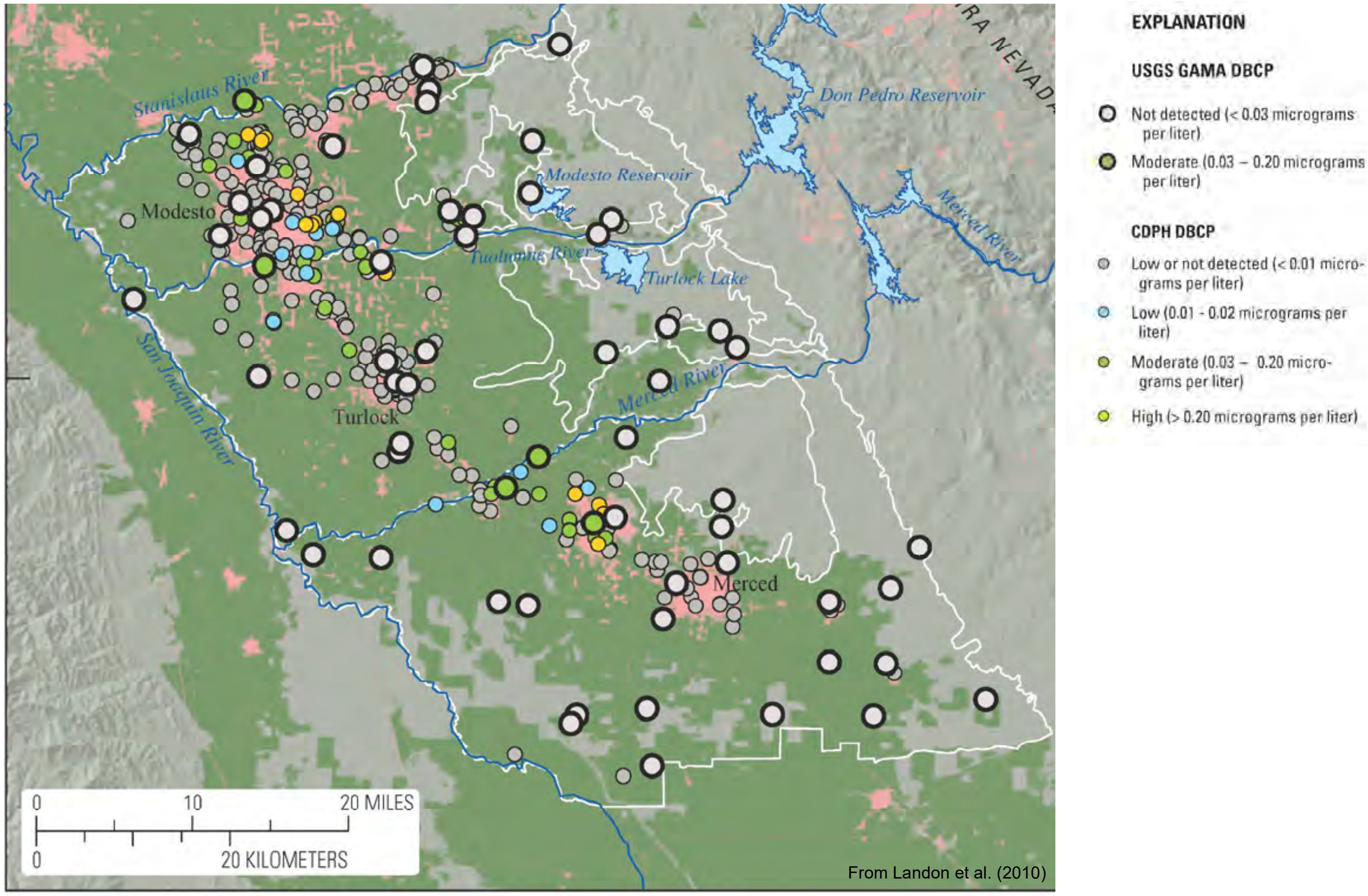


Figure 5-23c
Other Groundwater Quality Data: Uranium



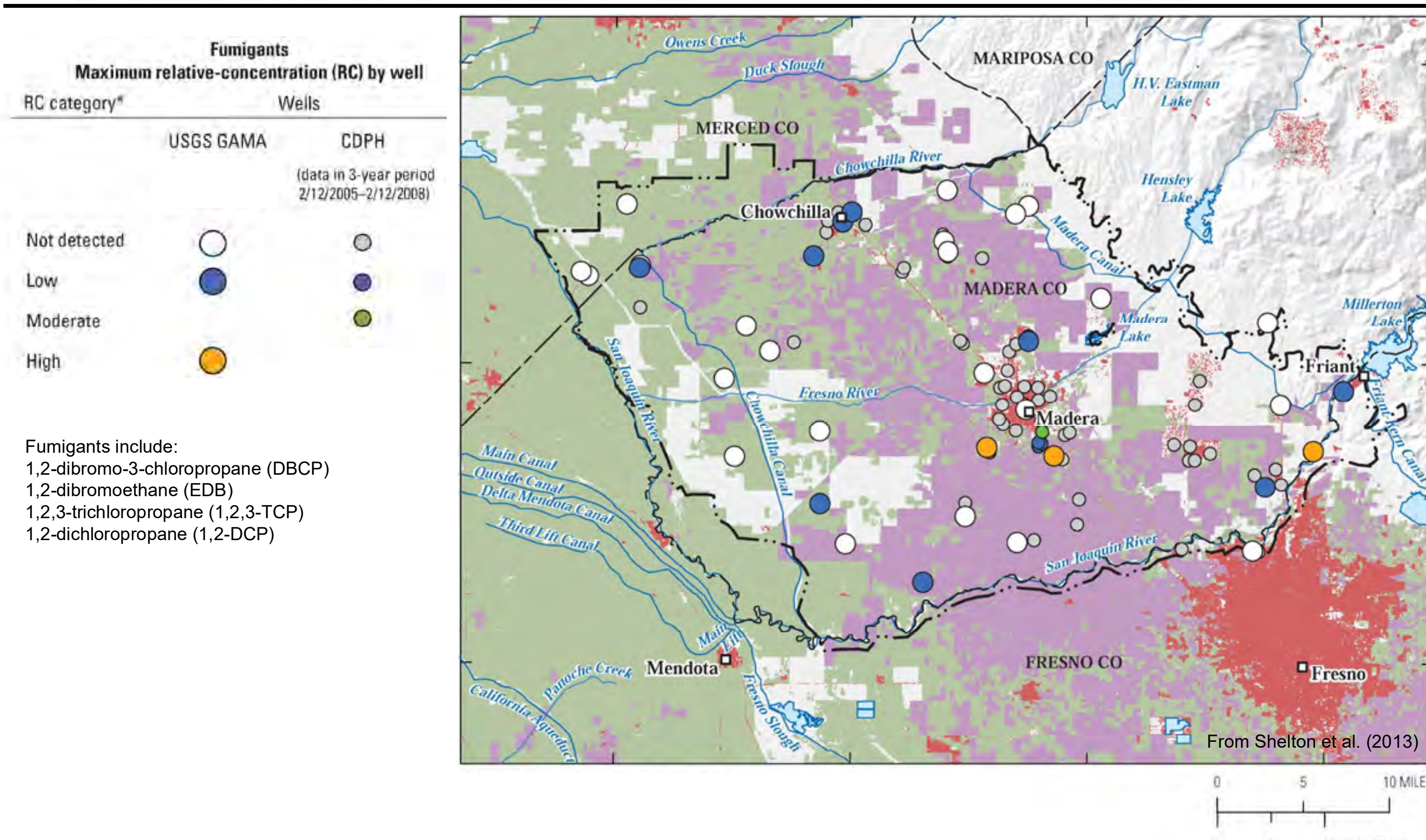


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Figure 5-23d

Other Groundwater Quality Data: DBCP/Fumigants

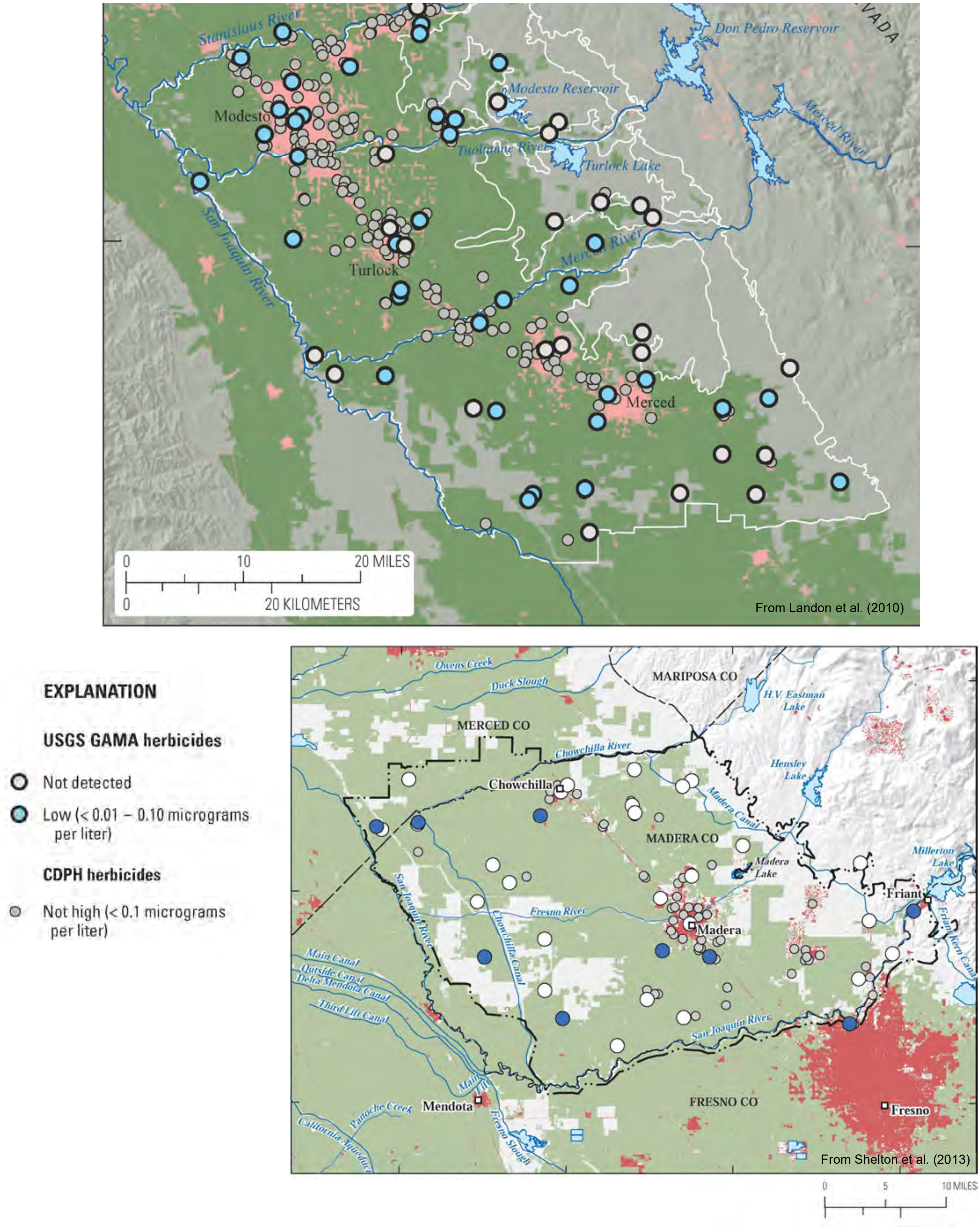

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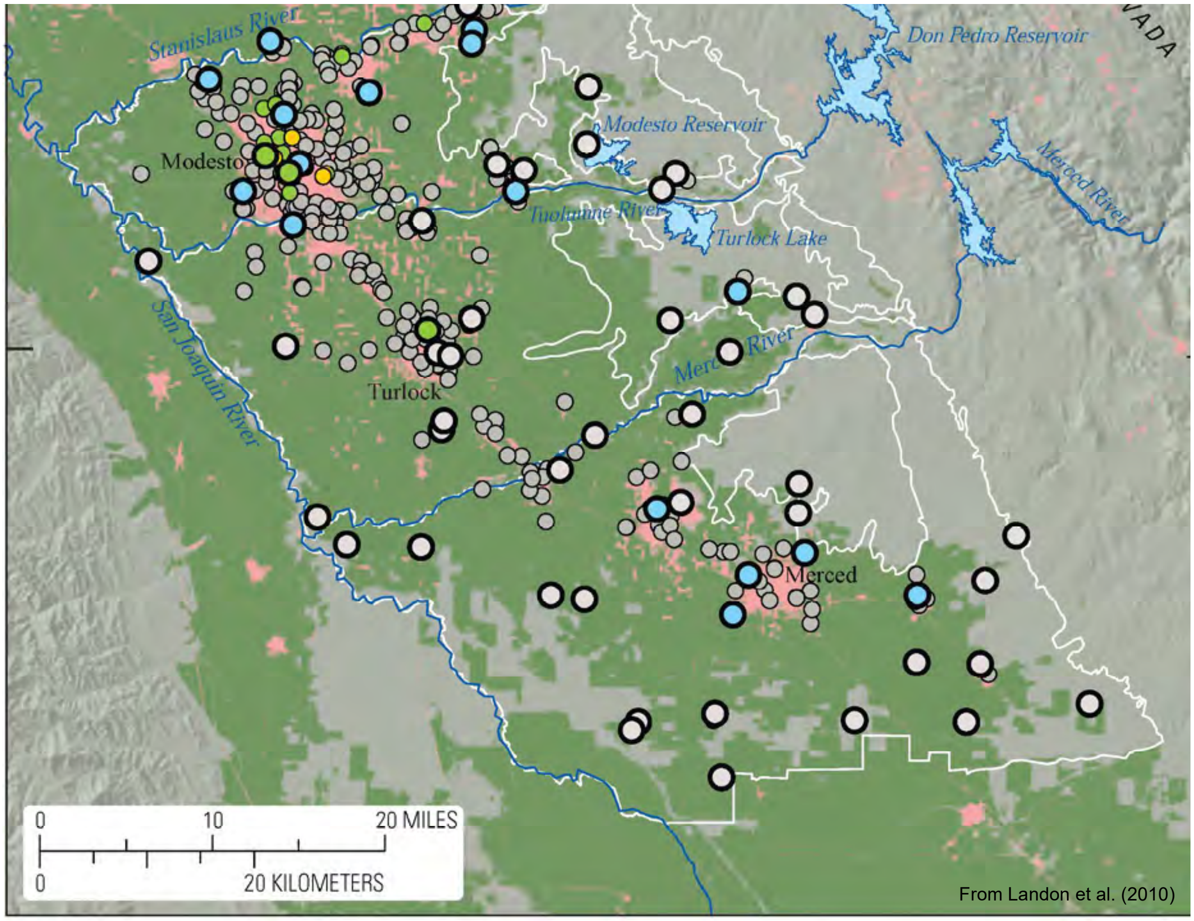
Figure 5-23e
Other Groundwater Quality Data: Herbicides



USGS GAMA solvents

- Not detected
- Low (< 0.1)
- Moderate (> 0.1 – 1.0)

CDPH solvents

- Low or not detected (< 0.1)
- Moderate (0.1 – 1.0)
- High (> 1.0)

Solvents include:
tetrachloroethylene (PCE)
carbon tetrachloride
trichloroethylene (TCE)
dichloromethane
dibromomethane
cis-1,2-dichloroethene
n-propylbenzene

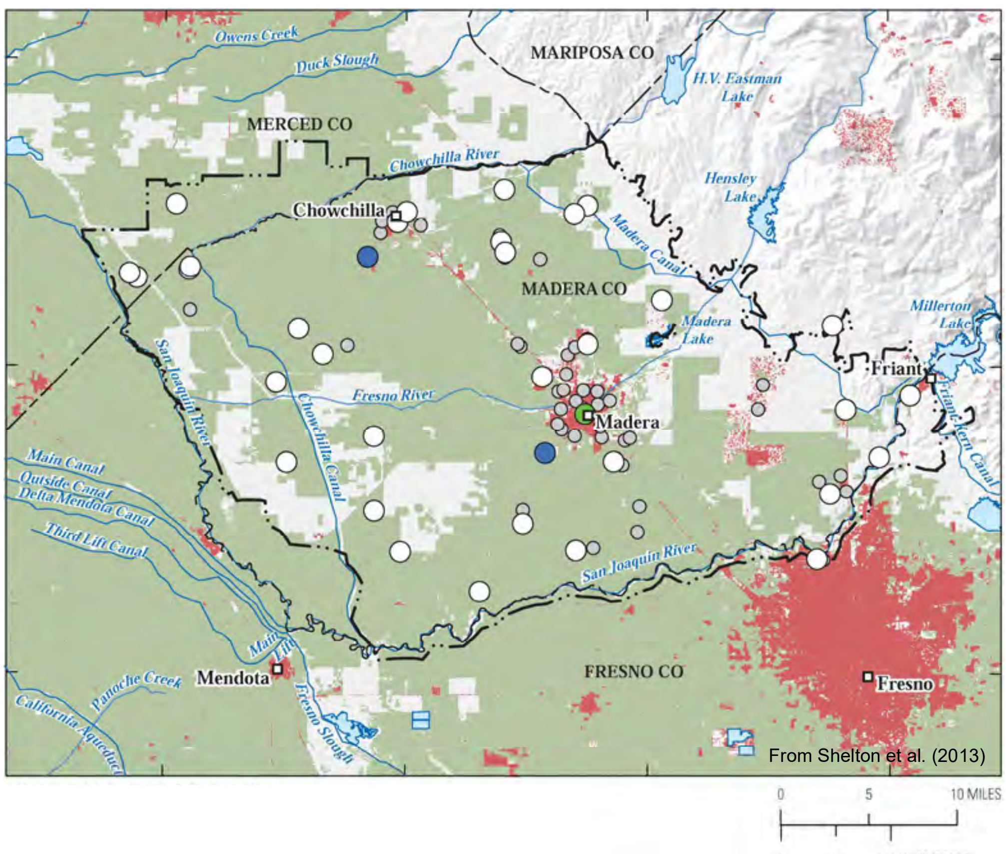


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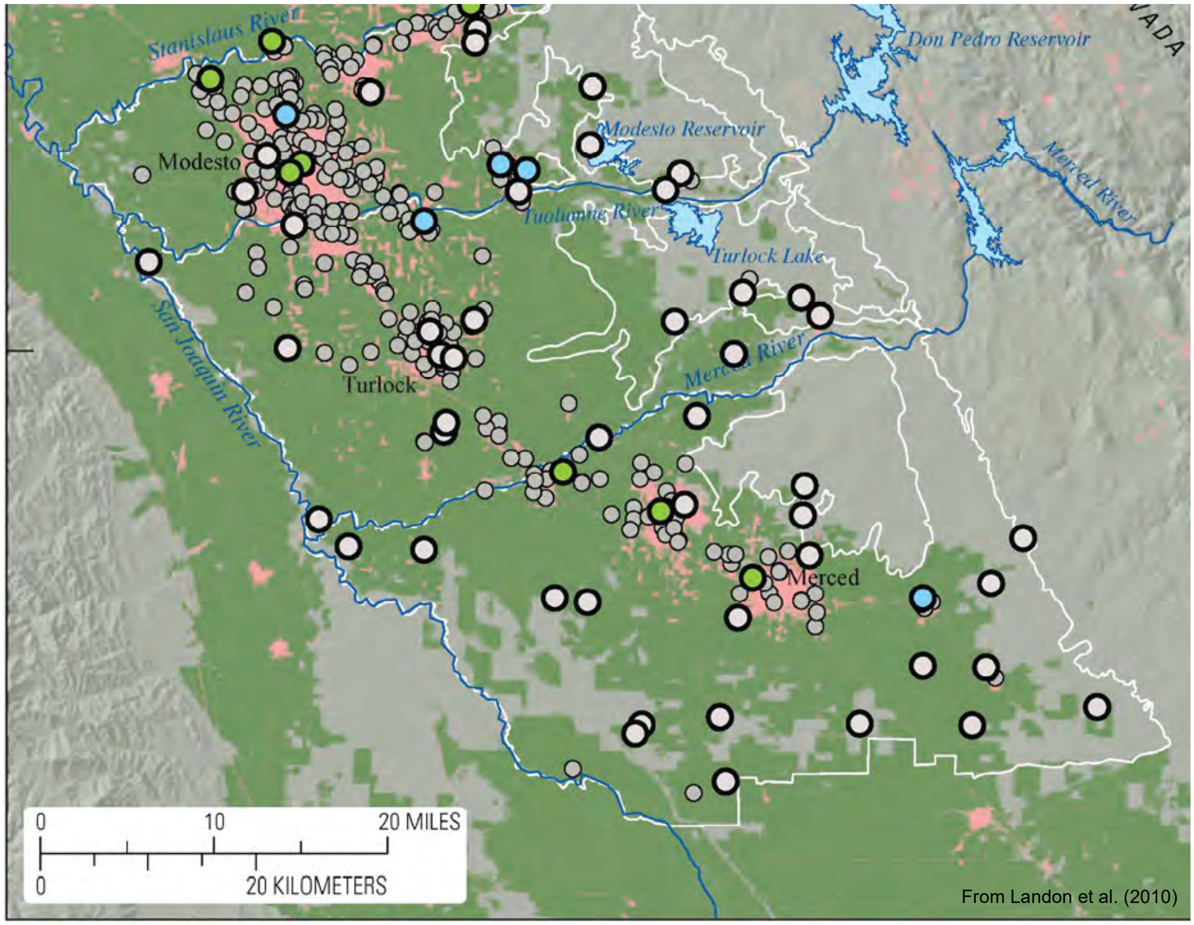
Figure 5-23f
Other Groundwater Quality Data: Solvents



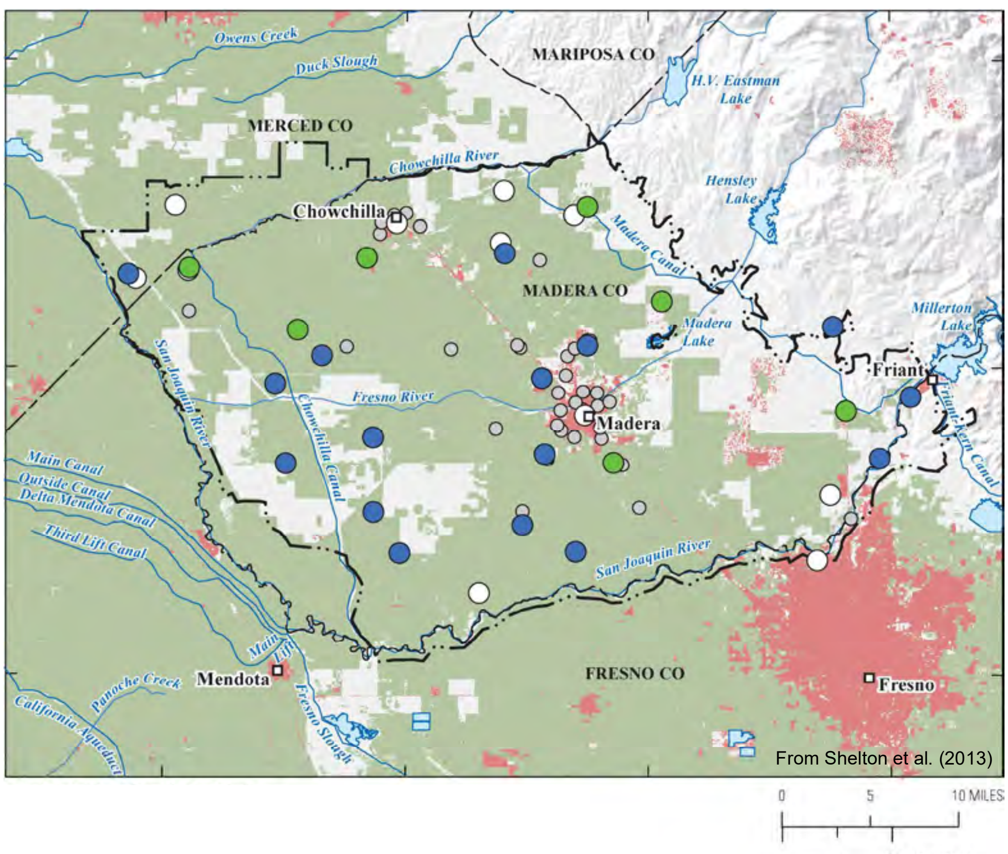


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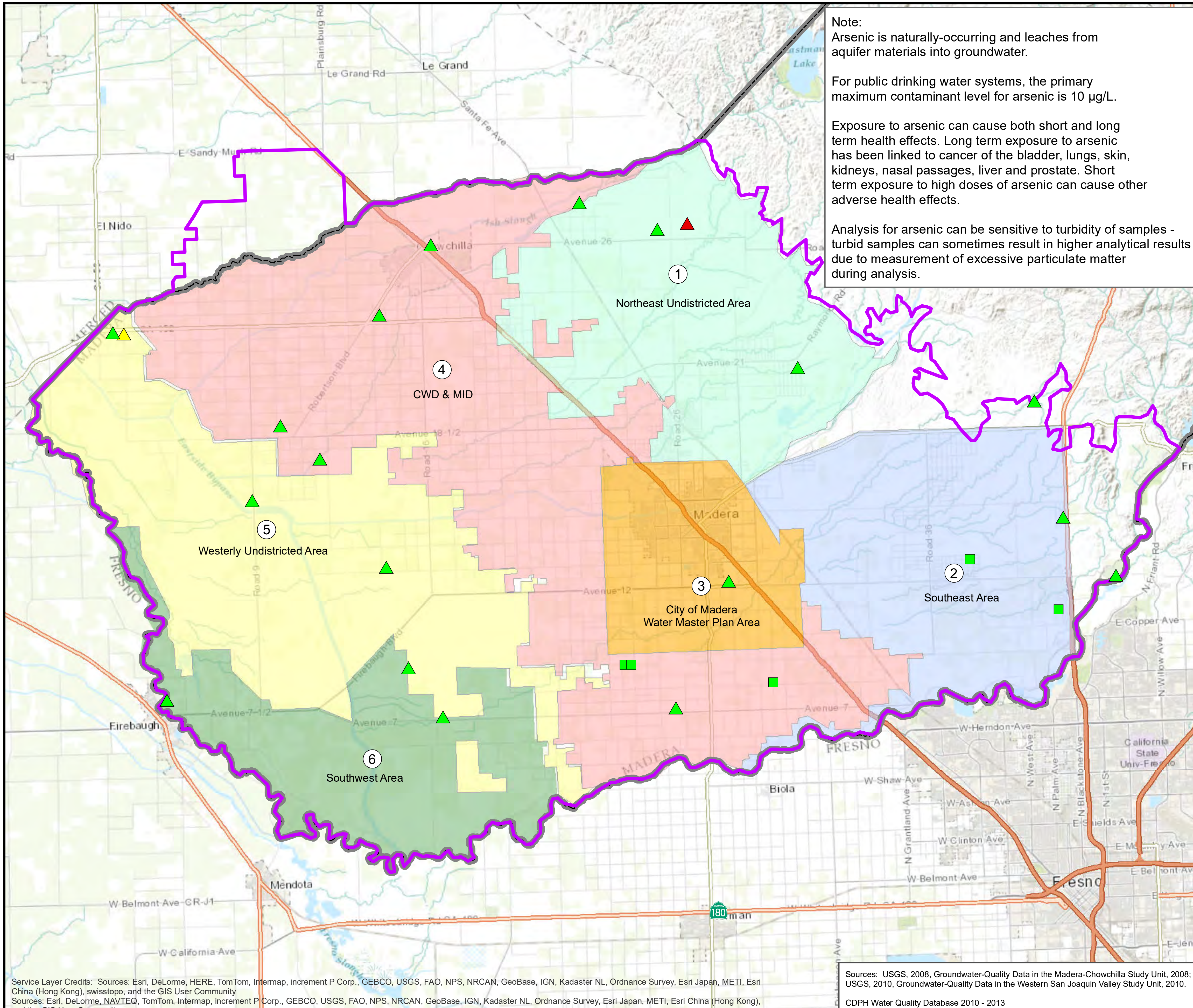
Figure 5-23g
Other Groundwater Quality Data: Perchlorate

MAP OF ARSENIC CONCENTRATION IN SHALLOW WELLS

MADERA REGIONAL
GROUNDWATER MANAGEMENT PLAN
APRIL 2014



Note:
Arsenic is naturally-occurring and leaches from aquifer materials into groundwater.

For public drinking water systems, the primary maximum contaminant level for arsenic is 10 µg/L.

Exposure to arsenic can cause both short and long term health effects. Long term exposure to arsenic has been linked to cancer of the bladder, lungs, skin, kidneys, nasal passages, liver and prostate. Short term exposure to high doses of arsenic can cause other adverse health effects.

Analysis for arsenic can be sensitive to turbidity of samples - turbid samples can sometimes result in higher analytical results due to measurement of excessive particulate matter during analysis.

NORTH

0 2 4
MILES

Arsenic (µg/L) in City Wells < 400 feet
- < 5
- 5 - 10
- > 10

Arsenic (µg/L) in County Wells < 400 feet
- < 5
- 5 - 10
- > 10

Arsenic (µg/L) in USGS GAMA Wells < 400 feet
- < 5
- 5 - 10
- > 10

Groundwater Management Plan Boundary
Madera County Boundary

Note: All wells are classified by total well depth. The represented wells may have different sanitary seal depths and perforation intervals and therefore may represent unique water quality or composite water quality of the shallow aquifers.

Sources: USGS, 2008, Groundwater-Quality Data in the Madera-Chowchilla Study Unit, 2008; USGS, 2010, Groundwater-Quality Data in the Western San Joaquin Valley Study Unit, 2010.
CDPH Water Quality Database 2010 - 2013

Service Layer Credits: Sources: Esri, DeLorme, HERE, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

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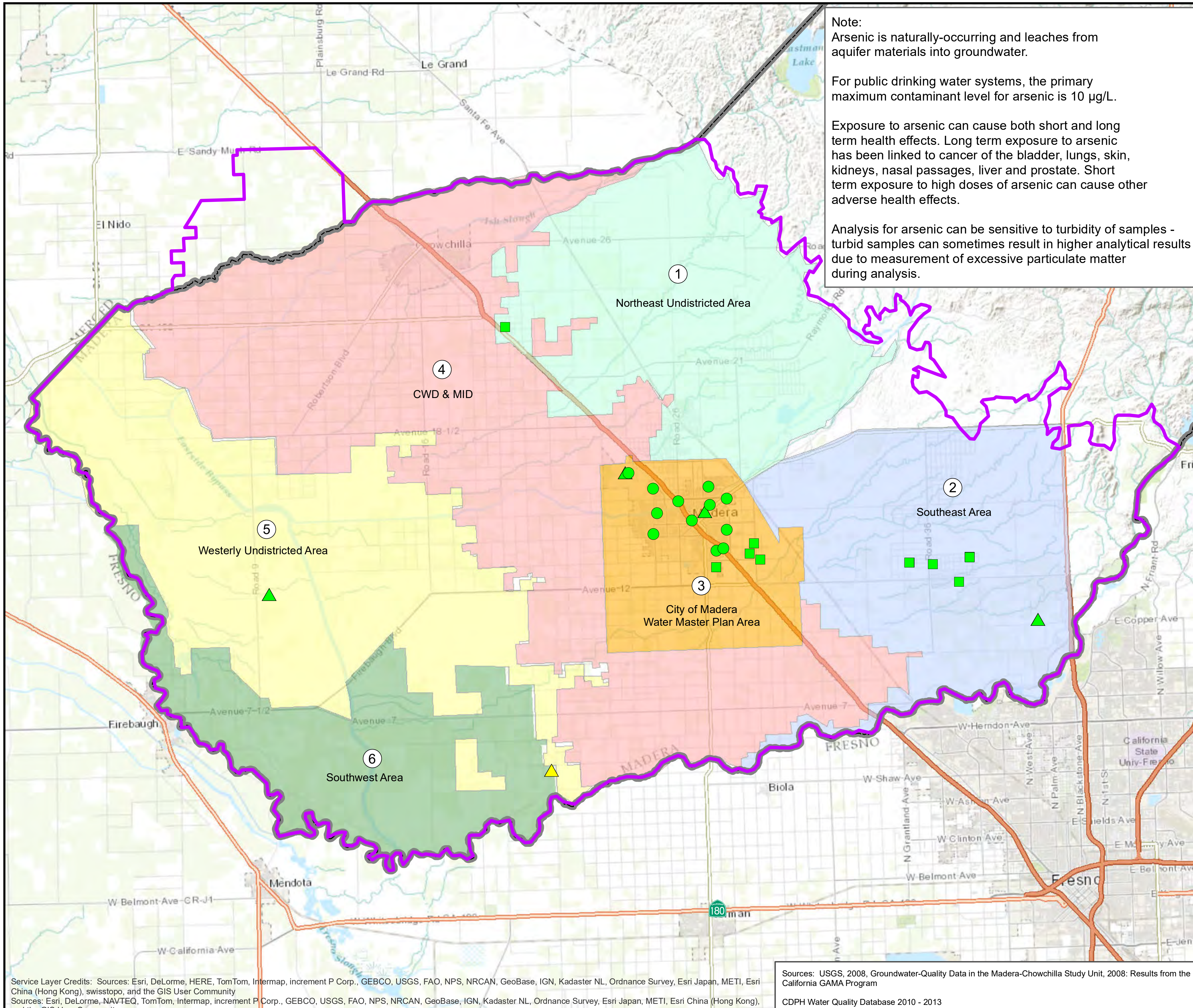
Document Path: J:\Jobs\8489_Madera_County\8489.005_Madera_County_GMP\GIS\Tasks\Water_Quality_Maps\20140402_Updated_Figures\Madera_Arsenic_Map_1_Shallow_20140407.mxd

MAP OF ARSENIC CONCENTRATION IN INTERMEDIATE WELLS

MADERA REGIONAL
GROUNDWATER MANAGEMENT PLAN
APRIL 2014



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Analysis for arsenic can be sensitive to turbidity of samples - turbid samples can sometimes result in higher analytical results due to measurement of excessive particulate matter during analysis.

Arsenic (μg/L) in City Wells 400 - 600 feet

- < 5
- 5 - 10
- > 10

Arsenic (μg/L) in County Wells 400 - 600 feet

- < 5
- 5 - 10
- > 10

Arsenic (μg/L) in USGS GAMA Wells 400 - 600 feet

- < 5
- 5 - 10
- > 10

Groundwater Management Plan Boundary

Madera County Boundary

Note: All wells are classified by total well depth. Some wells may have screen perforations that begin shallower than the depth classification and therefore may represent composite water quality across two or more aquifers.

Service Layer Credits: Sources: Esri, DeLorme, HERE, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community
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Sources: USGS, 2008, Groundwater-Quality Data in the Madera-Chowchilla Study Unit, 2008: Results from the California GAMA Program

CDPH Water Quality Database 2010 - 2013

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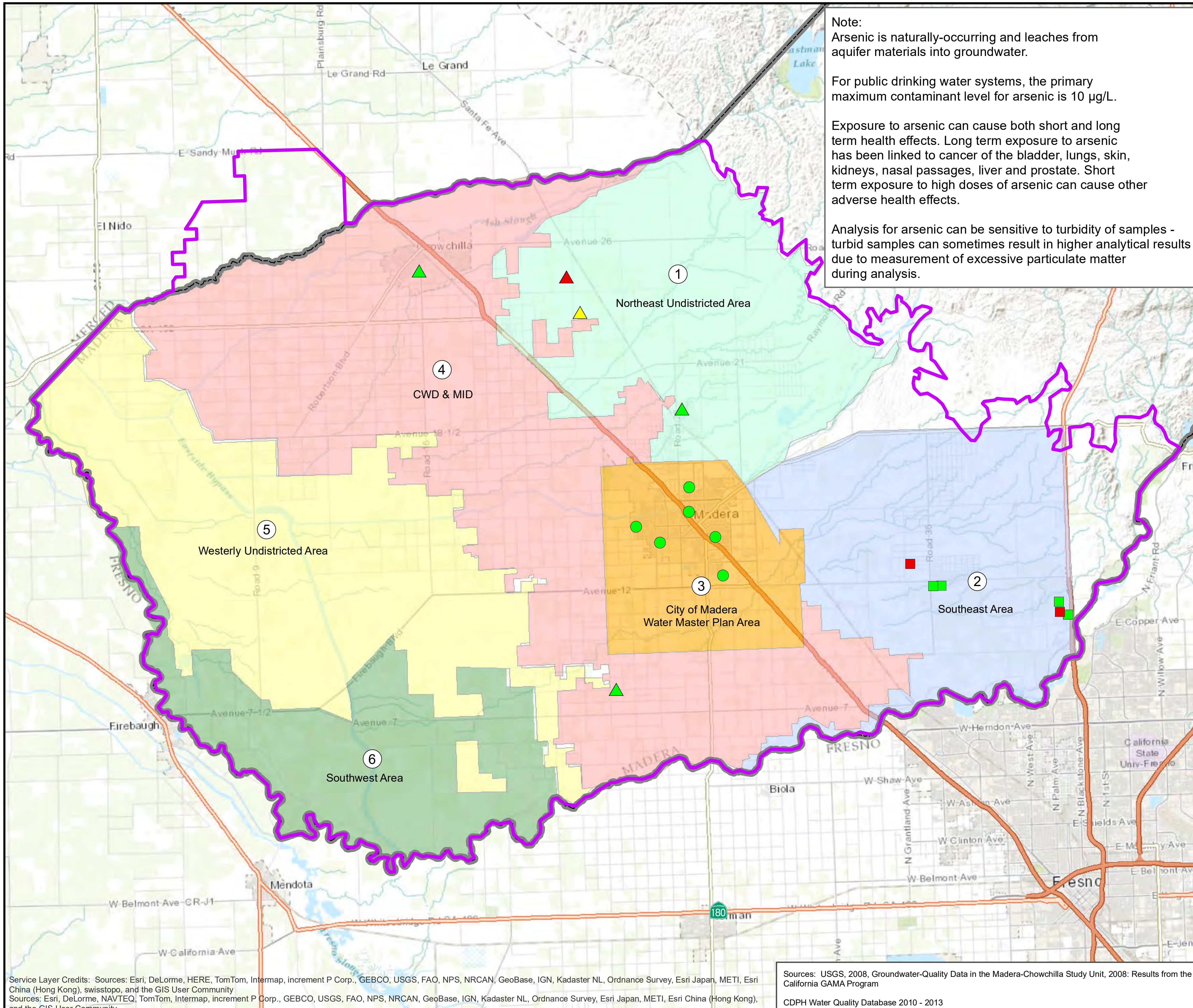

Note:
Arsenic is naturally-occurring and leaches from aquifer materials into groundwater.

For public drinking water systems, the primary maximum contaminant level for arsenic is 10 µg/L.

Exposure to arsenic can cause both short and long term health effects. Long term exposure to arsenic has been linked to cancer of the bladder, lungs, skin, kidneys, nasal passages, liver and prostate. Short term exposure to high doses of arsenic can cause other adverse health effects.

Analysis for arsenic can be sensitive to turbidity of samples - turbid samples can sometimes result in higher analytical results due to measurement of excessive particulate matter during analysis.

MAP OF ARSENIC CONCENTRATION IN DEEP WELLS

MADERA REGIONAL
GROUNDWATER MANAGEMENT PLAN
APRIL 2014

NORTH

0 2 4
MILES

Arsenic (µg/L) in City Wells > 600 feet
- < 5
- 5 - 10
- > 10

Arsenic (µg/L) in County Wells > 600 feet
- < 5
- 5 - 10
- > 10

Arsenic (µg/L) in USGS GAMA Wells > 600 feet
- < 5
- 5 - 10
- > 10

Groundwater Management Plan Boundary

Madera County Boundary

Note: All wells are classified by total well depth. Some wells may have screen perforations that begin shallower than the depth classification and therefore may represent composite water quality across two or more aquifers.

Service Layer Credits: Sources: Esri, DeLorme, HERE, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

Sources: USGS, 2008, Groundwater-Quality Data in the Madera-Chowchilla Study Unit, 2008: Results from the California GAMA Program

CDPH Water Quality Database 2010 - 2013

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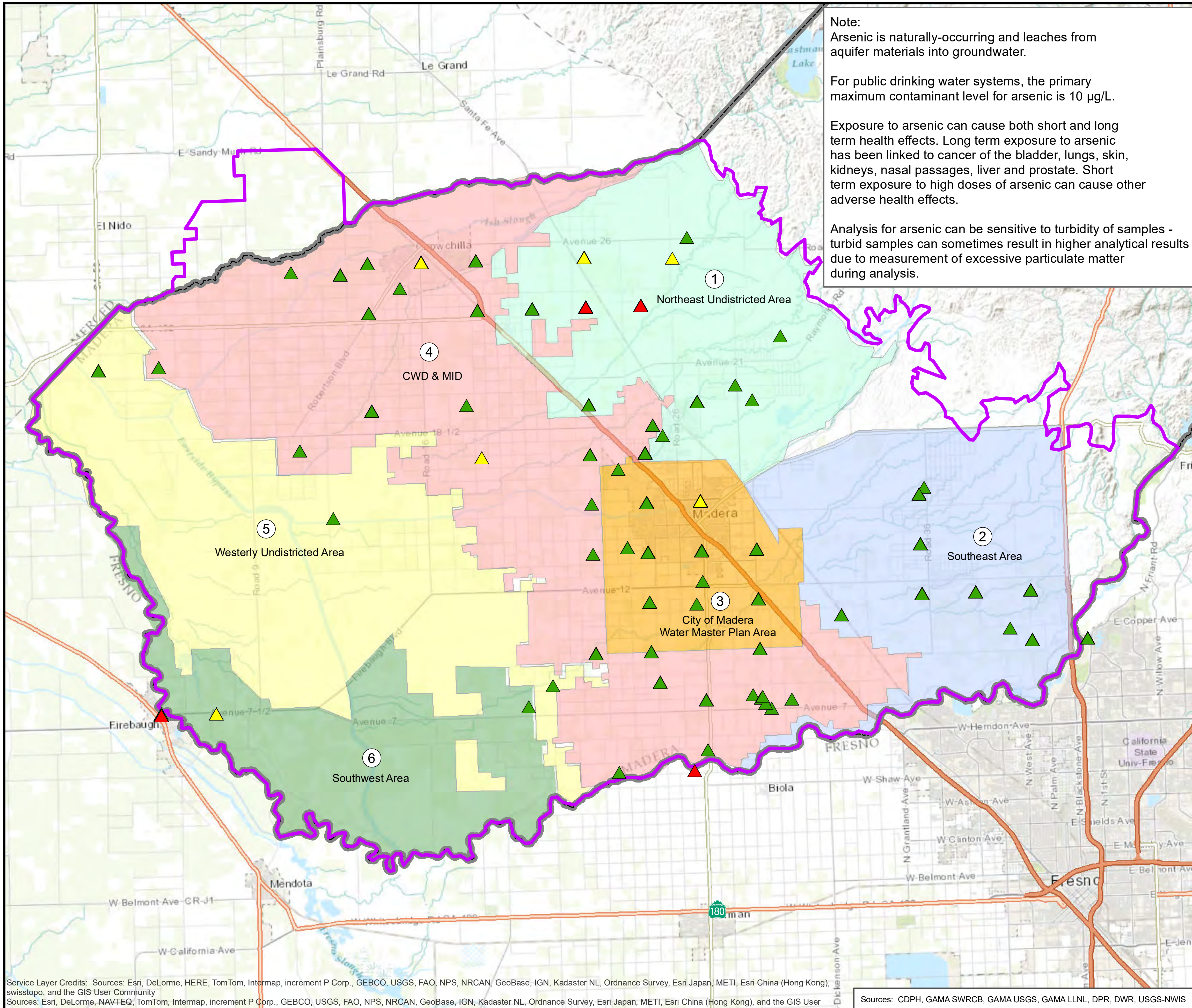
MAP OF ARSENIC CONCENTRATION IN WELLS OF UNKNOWN DEPTH

MADERA REGIONAL
GROUNDWATER MANAGEMENT PLAN
APRIL 2014



Note:
Arsenic is naturally-occurring and leaches from aquifer materials into groundwater.

For public drinking water systems, the primary maximum contaminant level for arsenic is 10 µg/L.

Exposure to arsenic can cause both short and long term health effects. Long term exposure to arsenic has been linked to cancer of the bladder, lungs, skin, kidneys, nasal passages, liver and prostate. Short term exposure to high doses of arsenic can cause other adverse health effects.

Analysis for arsenic can be sensitive to turbidity of samples - turbid samples can sometimes result in higher analytical results due to measurement of excessive particulate matter during analysis.

Arsenic (µg/L) in Other USGS GAMA Wells

- < 5
- 5 - 10
- > 10
- Groundwater Management Plan Boundary
- Madera County Boundary

Note: Well construction records were not available for these wells. Some wells may have screen perforations that connect two or more aquifers and may therefore represent composite water quality.

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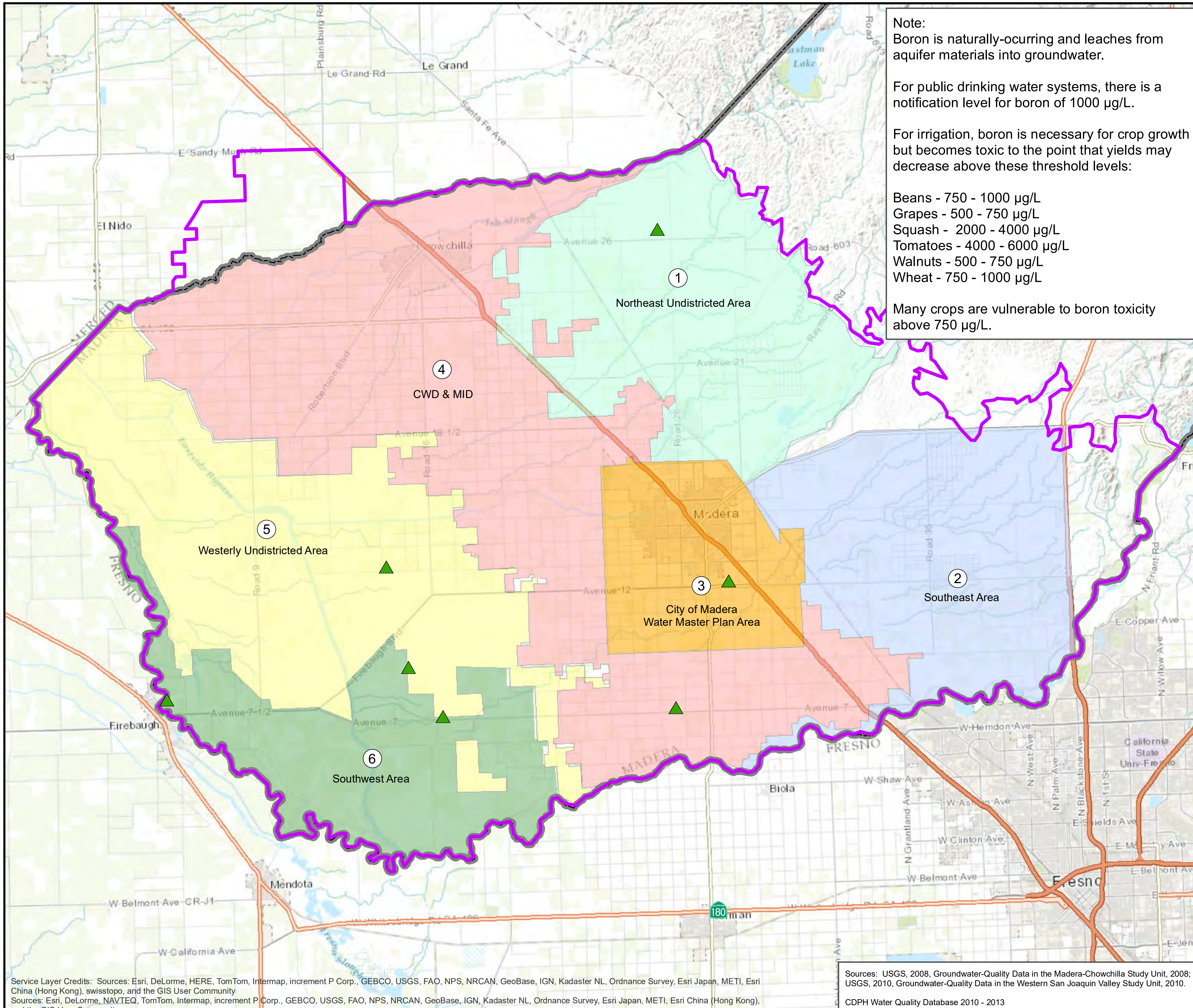
MAP OF BORON CONCENTRATION IN SHALLOW WELLS

MADERA REGIONAL
GROUNDWATER MANAGEMENT PLAN
APRIL 2014



Note:
Boron is naturally-ocurring and leaches from aquifer materials into groundwater.

For public drinking water systems, there is a notification level for boron of 1000 µg/L.

For irrigation, boron is necessary for crop growth but becomes toxic to the point that yields may decrease above these threshold levels:

Beans - 750 - 1000 µg/L
Grapes - 500 - 750 µg/L
Squash - 2000 - 4000 µg/L
Tomatoes - 4000 - 6000 µg/L
Walnuts - 500 - 750 µg/L
Wheat - 750 - 1000 µg/L

Many crops are vulnerable to boron toxicity above 750 µg/L.

Boron (µg/L) in City Wells < 400 feet
- < 500
- 500 - 750
- 750 - 1000
- 1000 - 2000
- > 2000

Boron (µg/L) in County Wells < 400 feet
- < 500
- 500 - 750
- 750 - 1000
- 1000 - 2000
- > 2000

Boron (µg/L) in USGS GAMA Wells < 400 feet
- < 500
- 500 - 750
- 750 - 1000
- 1000 - 2000
- > 2000

Groundwater Management Plan Boundary
Madera County Boundary

Service Layer Credits: Sources: Esri, DeLorme, HERE, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

Sources: USGS, 2008, Groundwater-Quality Data in the Madera-Chowchilla Study Unit, 2008; USGS, 2010, Groundwater-Quality Data in the Western San Joaquin Valley Study Unit, 2010.

CDPH Water Quality Database 2010 - 2013

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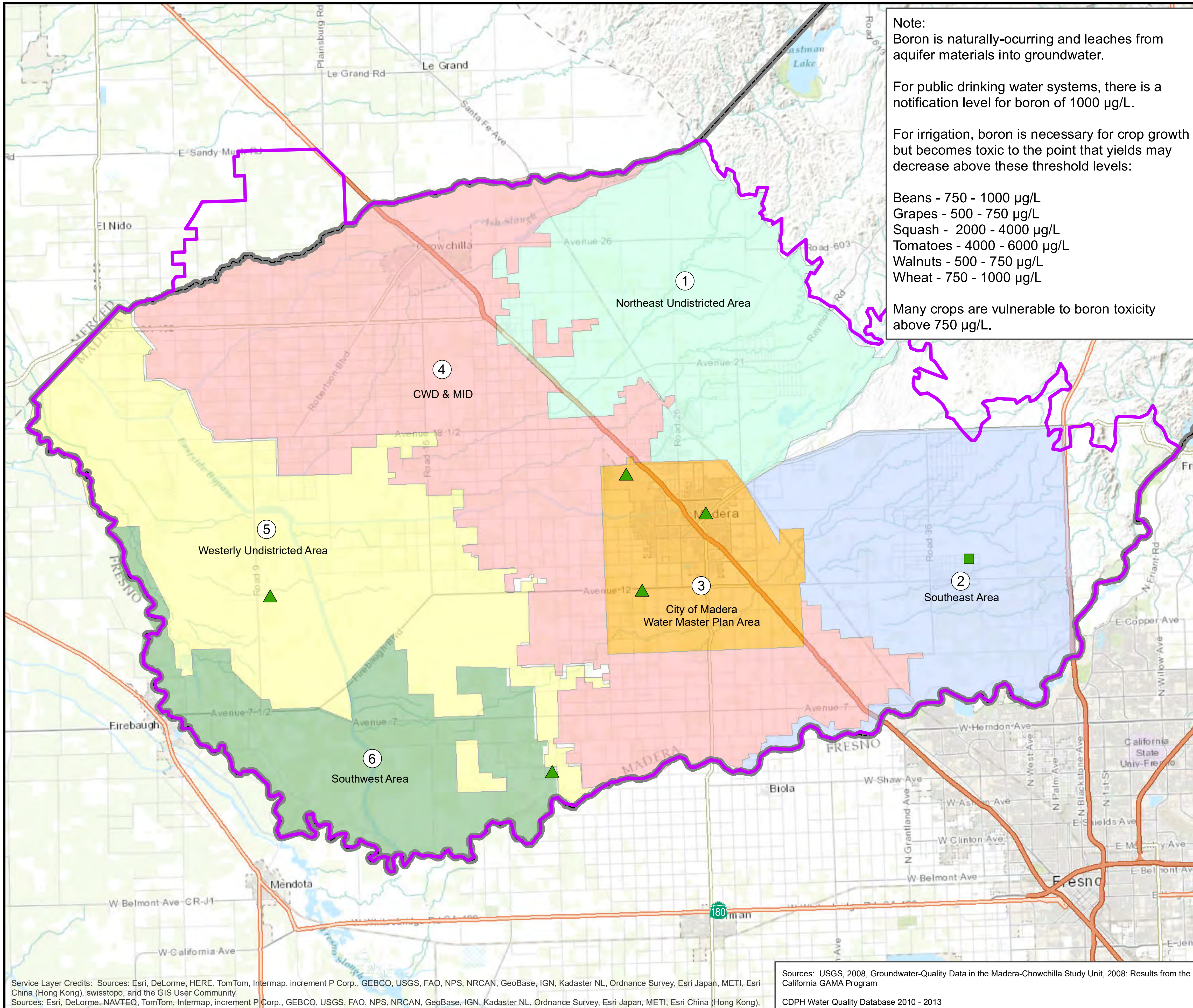

MAP OF BORON CONCENTRATION IN INTERMEDIATE WELLS

MADERA REGIONAL GROUNDWATER MANAGEMENT PLAN
APRIL 2014

NORTH

0 2 4
MILES

Boron (µg/L) in County Wells 400 - 600 feet

- < 500
- 500 - 750
- 750 - 1000
- 1000 - 2000
- > 2000

Boron (µg/L) in City Wells 400 - 600 feet

- < 500
- 500 - 750
- 750 - 1000
- 1000 - 2000
- > 2000

Boron (µg/L) in USGS GAMA Wells 400 - 600 feet

- < 500
- 500 - 750
- 750 - 1000
- 1000 - 2000
- > 2000

Groundwater Management Plan Boundary

Madera County Boundary

Note: All wells are classified by total well depth. Some wells may have screen perforations that begin shallower than the depth classification and therefore may represent composite water quality across two or more aquifers.

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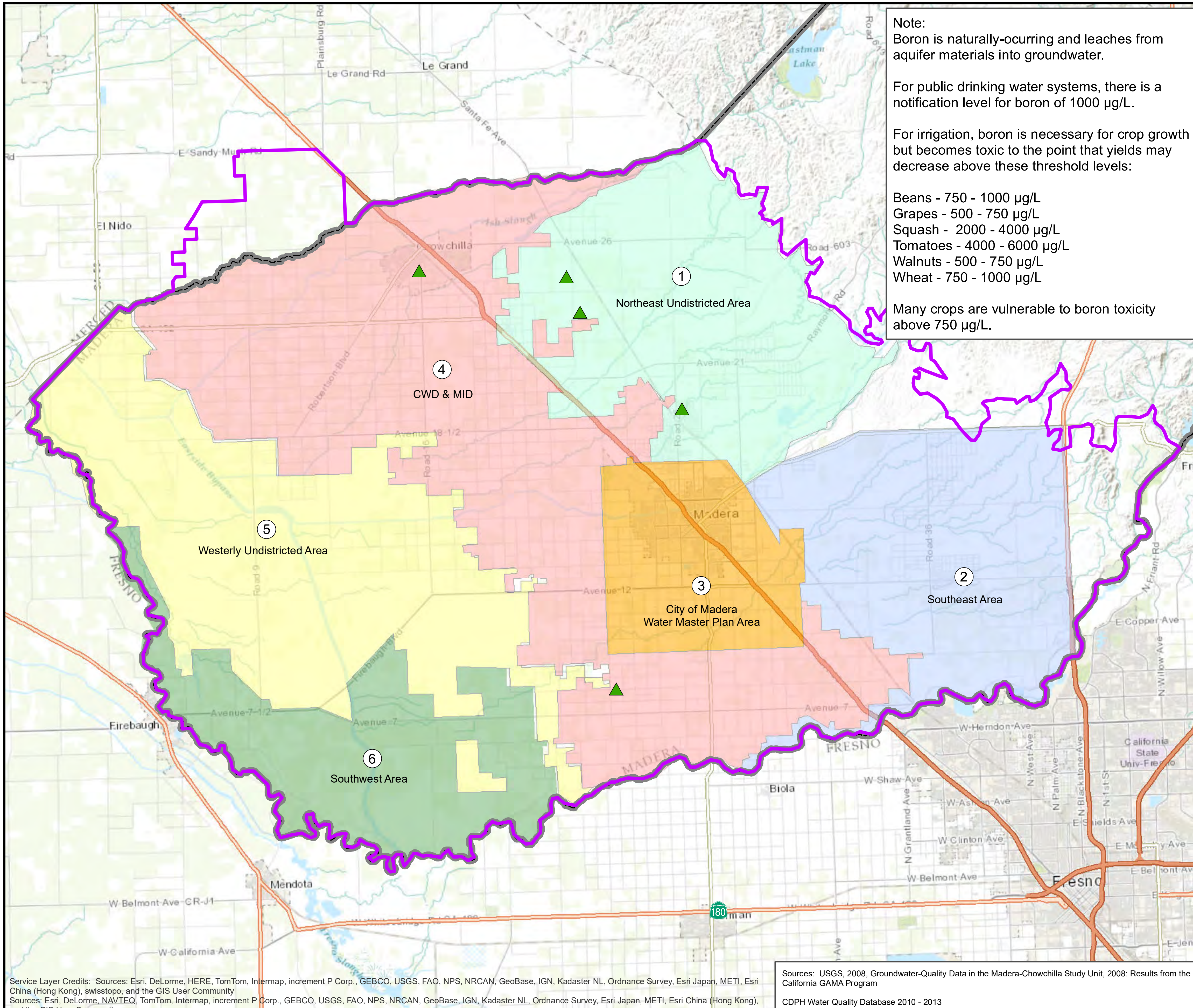
MAP OF BORON CONCENTRATION IN DEEP WELLS

MADERA REGIONAL
GROUNDWATER MANAGEMENT PLAN
APRIL 2014



Note:
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For public drinking water systems, there is a notification level for boron of 1000 µg/L.

For irrigation, boron is necessary for crop growth but becomes toxic to the point that yields may decrease above these threshold levels:

Beans - 750 - 1000 µg/L
Grapes - 500 - 750 µg/L
Squash - 2000 - 4000 µg/L
Tomatoes - 4000 - 6000 µg/L
Walnuts - 500 - 750 µg/L
Wheat - 750 - 1000 µg/L

Many crops are vulnerable to boron toxicity above 750 µg/L.

Boron (µg/L) in City Wells > 600 feet

- < 500
- 500 - 750
- 750 - 1000
- 1000 - 2000
- > 2000

Boron (µg/L) in County Wells > 600 feet

- < 500
- 500 - 750
- 750 - 1000
- 1000 - 2000
- > 2000

Boron (µg/L) in USGS GAMA Wells > 600 feet

- < 500
- 500 - 750
- 750 - 1000
- 1000 - 2000
- > 2000

Groundwater Management Plan Boundary
Madera County Boundary

Note: All wells are classified by total well depth. Some wells may have screen perforations that begin shallower than the depth classification and therefore may represent composite water quality across two or more aquifers.

Service Layer Credits: Sources: Esri, DeLorme, HERE, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community
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Sources: USGS, 2008, Groundwater-Quality Data in the Madera-Chowchilla Study Unit, 2008: Results from the California GAMA Program

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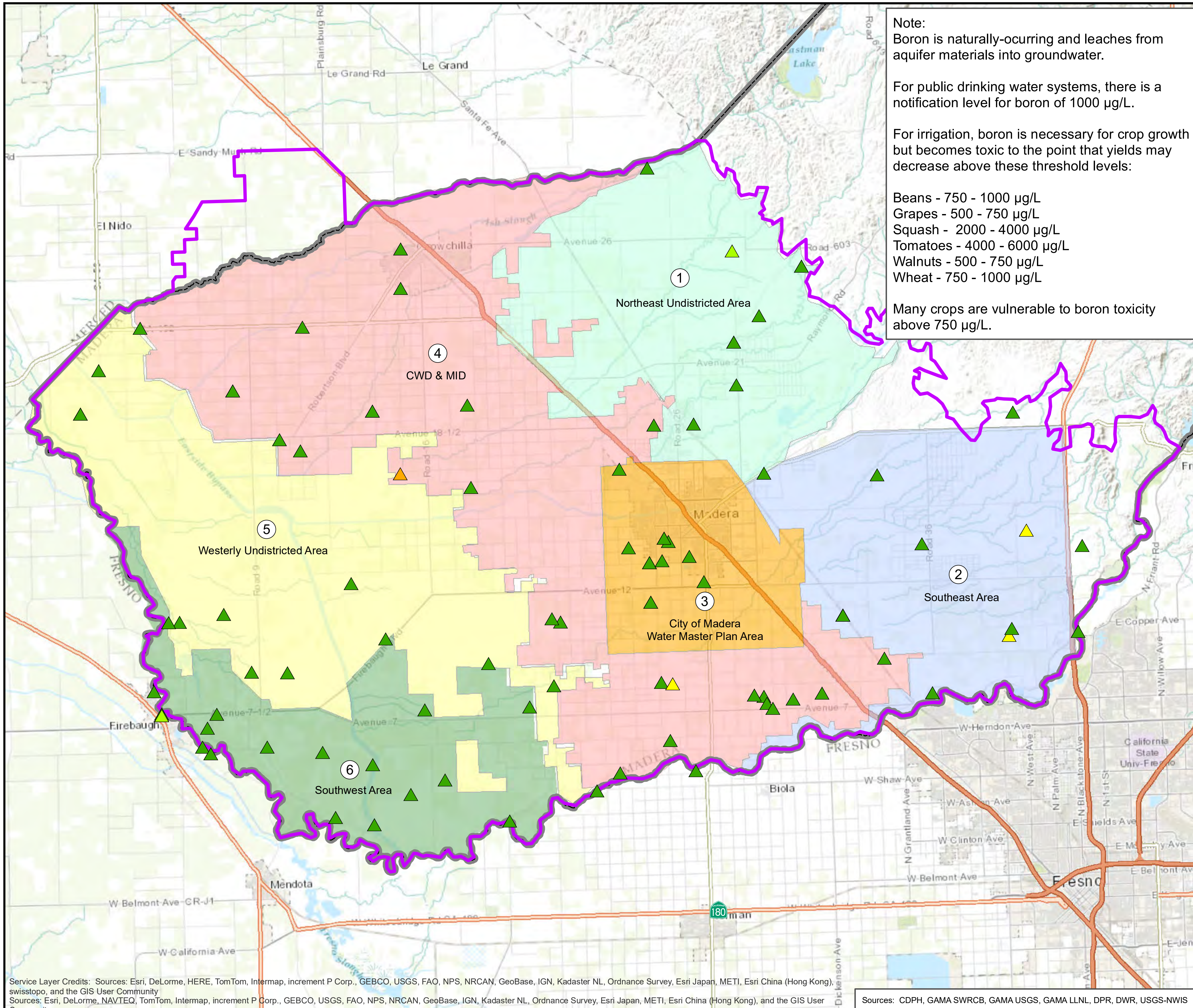
MAP OF BORON CONCENTRATION IN WELLS OF UNKNOWN DEPTH

MADERA REGIONAL GROUNDWATER MANAGEMENT PLAN
APRIL 2014



Note:
Boron is naturally-ocurring and leaches from aquifer materials into groundwater.

For public drinking water systems, there is a notification level for boron of 1000 µg/L.

For irrigation, boron is necessary for crop growth but becomes toxic to the point that yields may decrease above these threshold levels:

Beans - 750 - 1000 µg/L
Grapes - 500 - 750 µg/L
Squash - 2000 - 4000 µg/L
Tomatoes - 4000 - 6000 µg/L
Walnuts - 500 - 750 µg/L
Wheat - 750 - 1000 µg/L

Many crops are vulnerable to boron toxicity above 750 µg/L.

Boron (µg/L) in Other USGS GAMA Wells

- < 500
- 500 - 750
- 750 - 1000
- 1000 - 2000
- > 2000
- Groundwater Management Plan Boundary
- Madera County Boundary

Note: Well construction records were not available for these wells. Some wells may have screen perforations that connect two or more aquifers and may therefore represent composite water quality.

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Sources: CDPH, GAMA SWRCB, GAMA USGS, GAMA LLNL, DPR, DWR, USGS-NWIS

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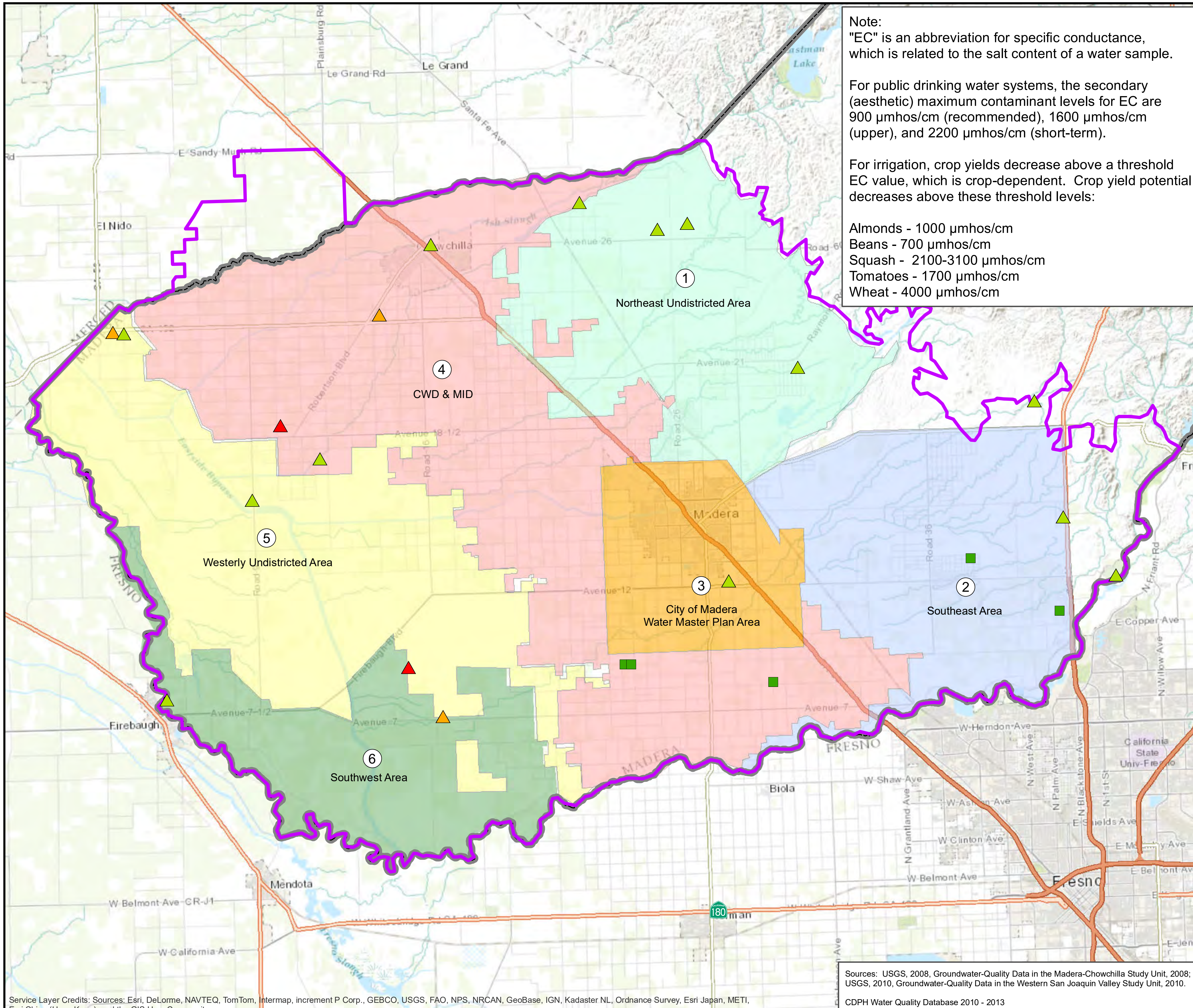

Note:
"EC" is an abbreviation for specific conductance, which is related to the salt content of a water sample.

For public drinking water systems, the secondary (aesthetic) maximum contaminant levels for EC are 900 µmhos/cm (recommended), 1600 µmhos/cm (upper), and 2200 µmhos/cm (short-term).

For irrigation, crop yields decrease above a threshold EC value, which is crop-dependent. Crop yield potential decreases above these threshold levels:

Almonds - 1000 µmhos/cm
Beans - 700 µmhos/cm
Squash - 2100-3100 µmhos/cm
Tomatoes - 1700 µmhos/cm
Wheat - 4000 µmhos/cm

Sources: USGS, 2008, Groundwater-Quality Data in the Madera-Chowchilla Study Unit, 2008; USGS, 2010, Groundwater-Quality Data in the Western San Joaquin Valley Study Unit, 2010.

CDPH Water Quality Database 2010 - 2013

MAP OF SPECIFIC CONDUCTANCE IN SHALLOW WELLS

MADERA REGIONAL
GROUNDWATER MANAGEMENT PLAN
APRIL 2014

NORTH

0 2 4
MILES

EC (µmhos/cm) in County Wells < 400 feet
- < 600
- 600 - 900
- 900 - 1600
- > 1600

EC (µmhos/cm) in City Wells < 400 feet
- < 600
- 600 - 900
- 900 - 1600
- > 1600

EC (µmhos/cm) in USGS GAMA Wells < 400 feet
- < 600
- 600 - 900
- 900 - 1600
- > 1600

Groundwater Management Plan Boundary
Madera County Boundary

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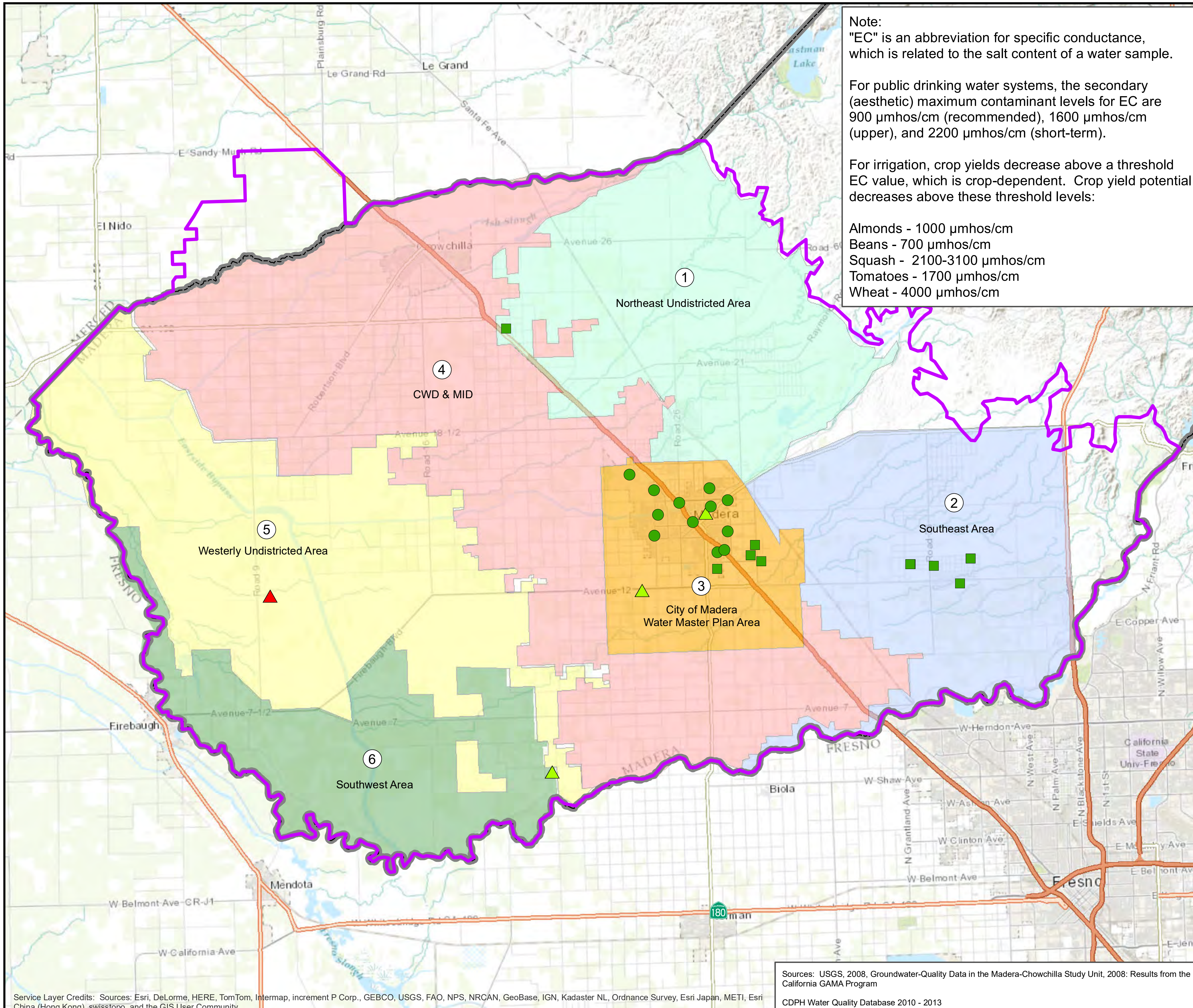
MAP OF SPECIFIC CONDUCTANCE IN INTERMEDIATE WELLS

MADERA REGIONAL
GROUNDWATER MANAGEMENT PLAN
APRIL 2014



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Beans - 700 µmhos/cm
Squash - 2100-3100 µmhos/cm
Tomatoes - 1700 µmhos/cm
Wheat - 4000 µmhos/cm

NORTH

0 2 4
MILES

EC (µmhos/cm) in City Wells 400 - 600 feet
- < 600
- 600 - 900
- 900 - 1600
- > 1600

EC (µmhos/cm) in County Wells 400 - 600 feet
- < 600
- 600 - 900
- 900 - 1600
- > 1600

EC (µmhos/cm) in USGS GAMA Wells 400 - 600 feet
- < 600
- 600 - 900
- 900 - 1600
- > 1600

Groundwater Management Plan Boundary
Madera County Boundary

Note: All wells are classified by total well depth. Some wells may have screen perforations that begin shallower than the depth classification and therefore represent composite water quality across two or more aquifers.

Service Layer Credits: Sources: Esri, DeLorme, HERE, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

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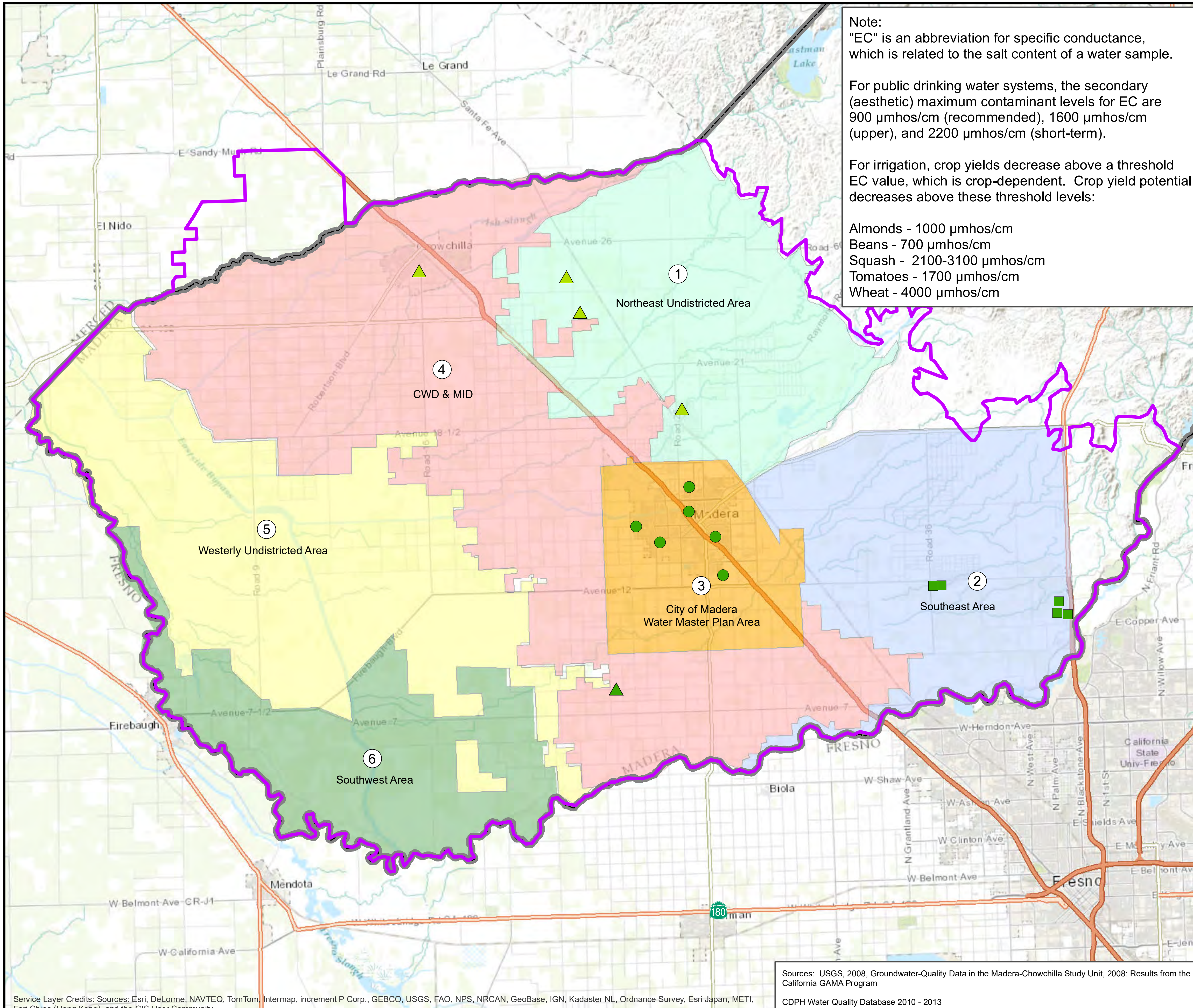

MAP OF SPECIFIC CONDUCTANCE IN DEEP WELLS

MADERA REGIONAL GROUNDWATER MANAGEMENT PLAN

APRIL 2014

NORTH

0 2 4

MILES

EC (µmhos/cm) in City Wells > 600 feet

- < 600
- 600 - 900
- 900 - 1600
- > 1600

EC (µmhos/cm) in County Wells > 600 feet

- < 600
- 600 - 900
- 900 - 1600
- > 1600

EC (µmhos/cm) in USGS GAMA Wells > 600 feet

- < 600
- 600 - 900
- 900 - 1600
- > 1600

Groundwater Management Plan Boundary

Madera County Boundary

Note: All wells are classified by total well depth. Some wells may have screen perforations that begin shallower than the depth classification and therefore may represent composite water quality across two or more aquifers.

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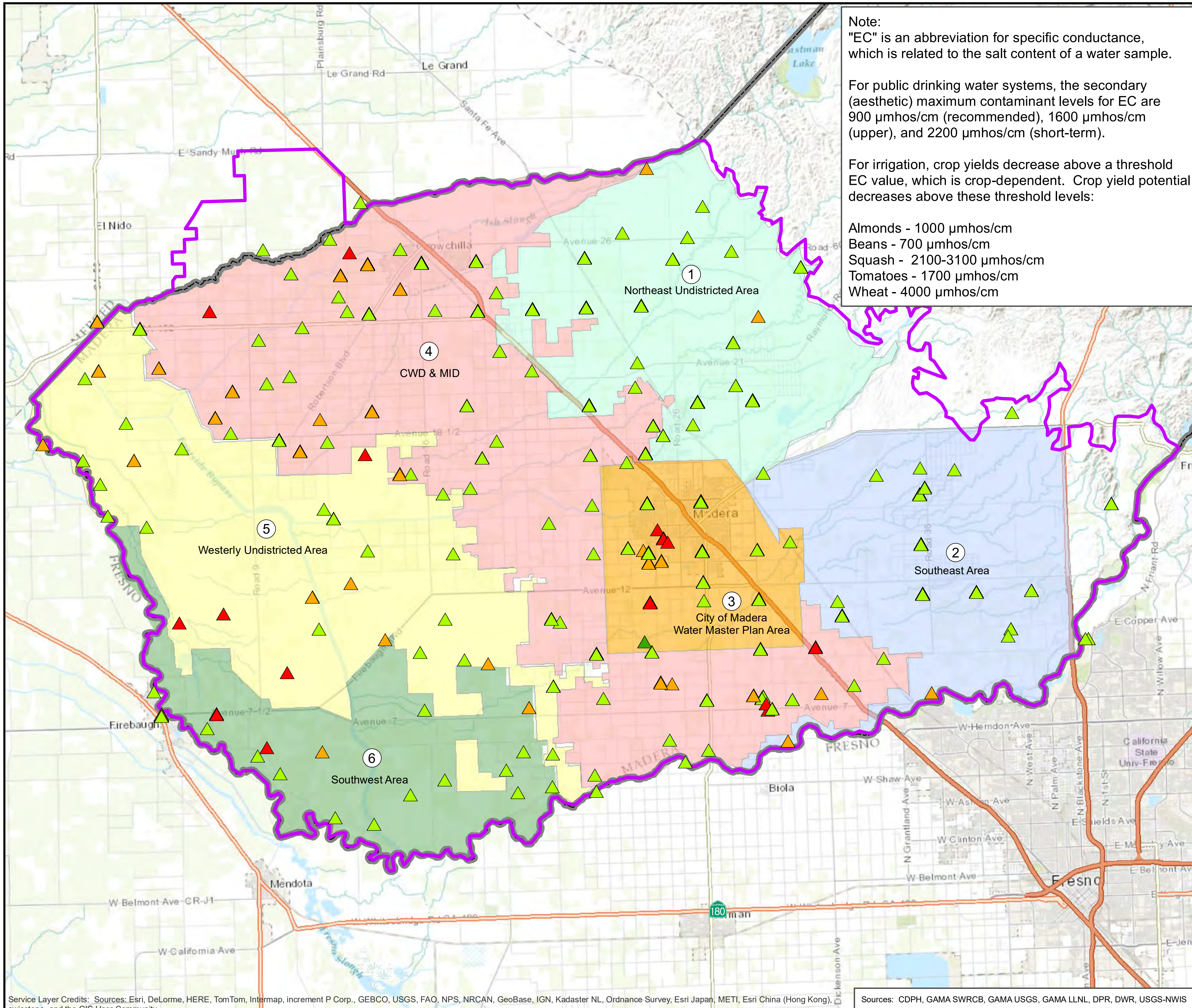

MAP OF SPECIFIC CONDUCTANCE IN WELLS OF UNKNOWN DEPTH

MADERA REGIONAL
GROUNDWATER MANAGEMENT PLAN
APRIL 2014

NORTH

0 2 4
MILES

EC (µmhos/cm) in Other USGS GAMA Wells

- < 600
- 600 - 900
- 900 - 1600
- > 1600
- Groundwater Management Plan Boundary
- Madera County Boundary

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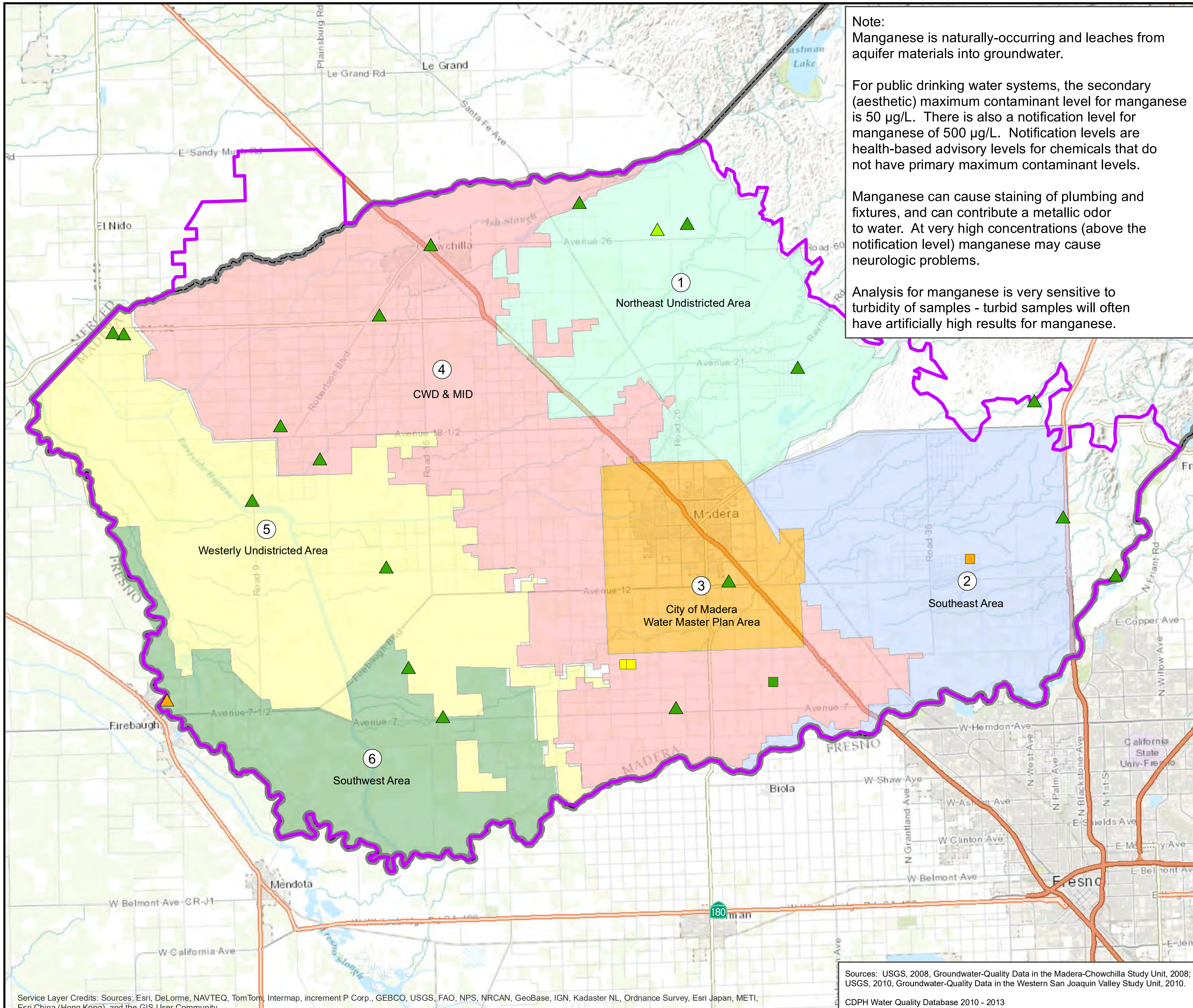
MAP OF MANGANESE CONCENTRATION IN SHALLOW WELLS

MADERA REGIONAL
GROUNDWATER MANAGEMENT PLAN
APRIL 2014



Note:
Manganese is naturally-occurring and leaches from aquifer materials into groundwater.

For public drinking water systems, the secondary (aesthetic) maximum contaminant level for manganese is 50 µg/L. There is also a notification level for manganese of 500 µg/L. Notification levels are health-based advisory levels for chemicals that do not have primary maximum contaminant levels.

Manganese can cause staining of plumbing and fixtures, and can contribute a metallic odor to water. At very high concentrations (above the notification level) manganese may cause neurologic problems.

Analysis for manganese is very sensitive to turbidity of samples - turbid samples will often have artificially high results for manganese.

NORTH

0 2 4
MILES

Manganese (µg/L) in City Wells < 400 feet
- < 25
- 25 - 50
- 50 - 150
- 150 - 500
- > 500

Manganese (µg/L) in County Wells < 400 feet
- < 25
- 25 - 50
- 50 - 150
- 150 - 500
- > 500

Manganese (µg/L) in USGS GAMA Wells < 400 feet
- < 25
- 25 - 50
- 50 - 150
- 150 - 500
- > 500

Groundwater Management Plan Boundary
Madera County Boundary

Sources: USGS, 2008, Groundwater-Quality Data in the Madera-Chowchilla Study Unit, 2008; USGS, 2010, Groundwater-Quality Data in the Western San Joaquin Valley Study Unit, 2010.
CDPH Water Quality Database 2010 - 2013

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MAP OF MANGANESE CONCENTRATION IN INTERMEDIATE WELLS

MADERA REGIONAL
GROUNDWATER MANAGEMENT PLAN
APRIL 2014

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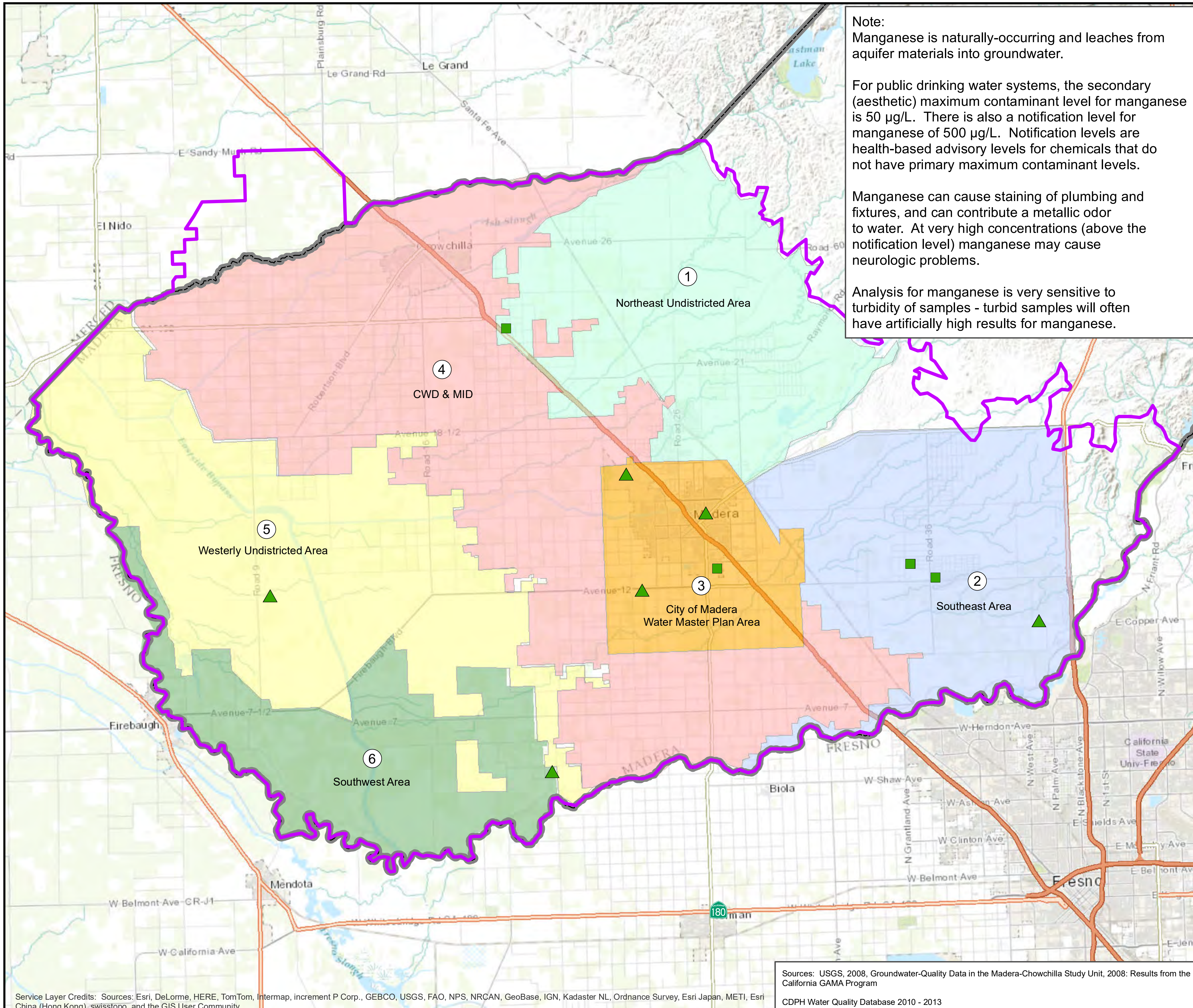

Manganese (µg/L) in City Wells 400 - 600 feet

- < 25
- 25 - 50
- 50 - 150
- 150 - 500
- > 500

Manganese (µg/L) in County Wells 400 - 600 feet

- < 25
- 25 - 50
- 50 - 150
- 150 - 500
- > 500

Manganese (µg/L) in USGS GAMA Wells 400 - 600 feet

- < 25
- 25 - 50
- 50 - 150
- 150 - 500
- > 500

Groundwater Management Plan Boundary

Madera County Boundary

Note: All wells are classified by total well depth. Some wells may have screen perforations that begin shallower than the depth classification and therefore represent composite water quality across two or more aquifers.

Sources: USGS, 2008, Groundwater-Quality Data in the Madera-Chowchilla Study Unit, 2008: Results from the California GAMA Program

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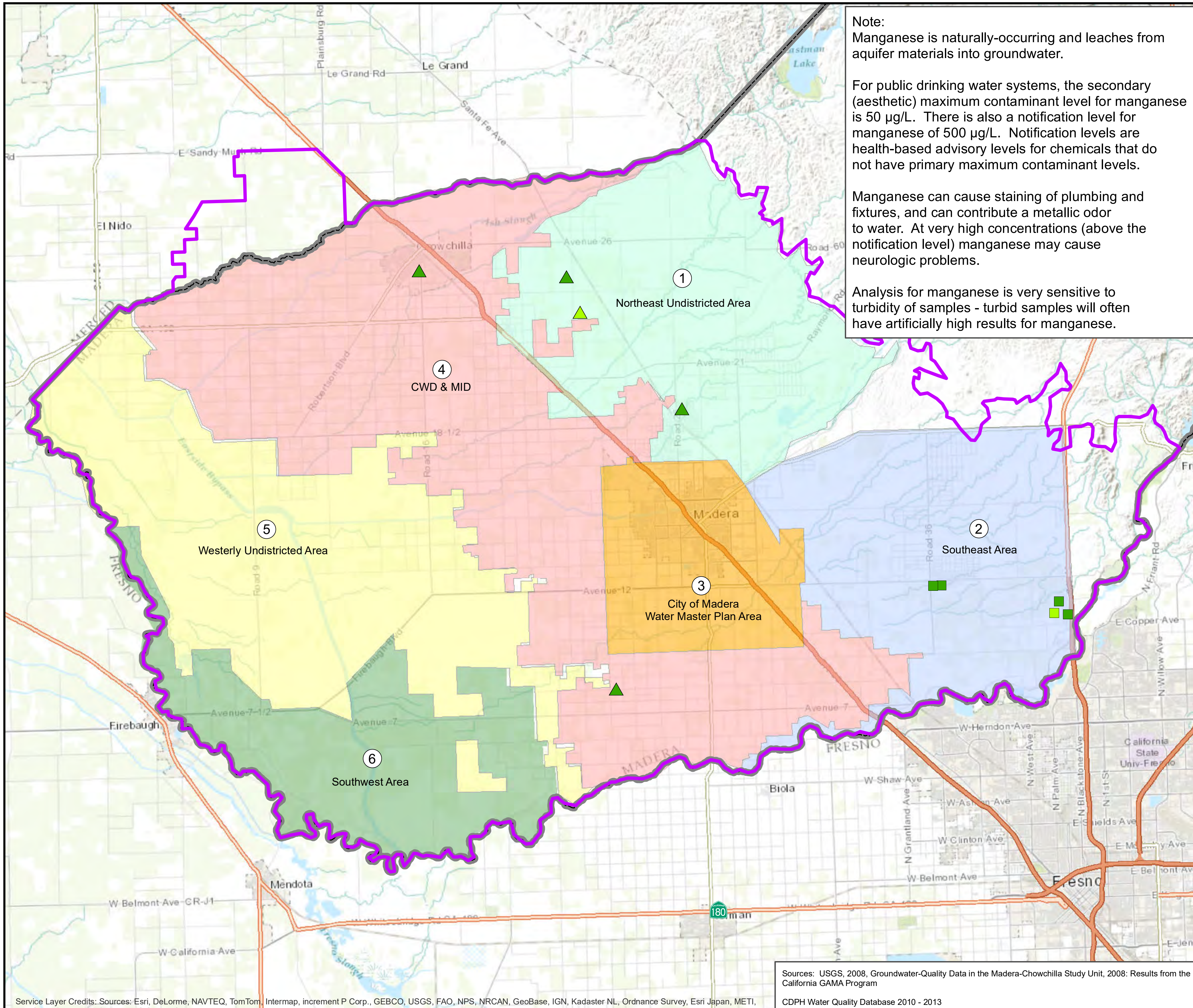
MAP OF MANGANESE CONCENTRATION IN DEEP WELLS

MADERA REGIONAL GROUNDWATER MANAGEMENT PLAN
APRIL 2014



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Sources: USGS, 2008, Groundwater-Quality Data in the Madera-Chowchilla Study Unit, 2008: Results from the California GAMA Program

CDPH Water Quality Database 2010 - 2013

NORTH

0 2 4 MILES

Manganese (µg/L) in City Wells > 600 feet

- < 25
- 25 - 50
- 50 - 150
- 150 - 500
- > 500

Manganese (µg/L) in County Wells > 600 feet

- < 25
- 25 - 50
- 50 - 150
- 150 - 500
- > 500

Manganese (µg/L) in USGS GAMA Wells > 600 feet

- < 25
- 25 - 50
- 50 - 150
- 150 - 500
- > 500

Groundwater Management Plan Boundary

Madera County Boundary

Note: All wells are classified by total well depth. Some wells may have screen perforations that begin shallower than the depth classification and therefore represent composite water quality across two or more aquifers.

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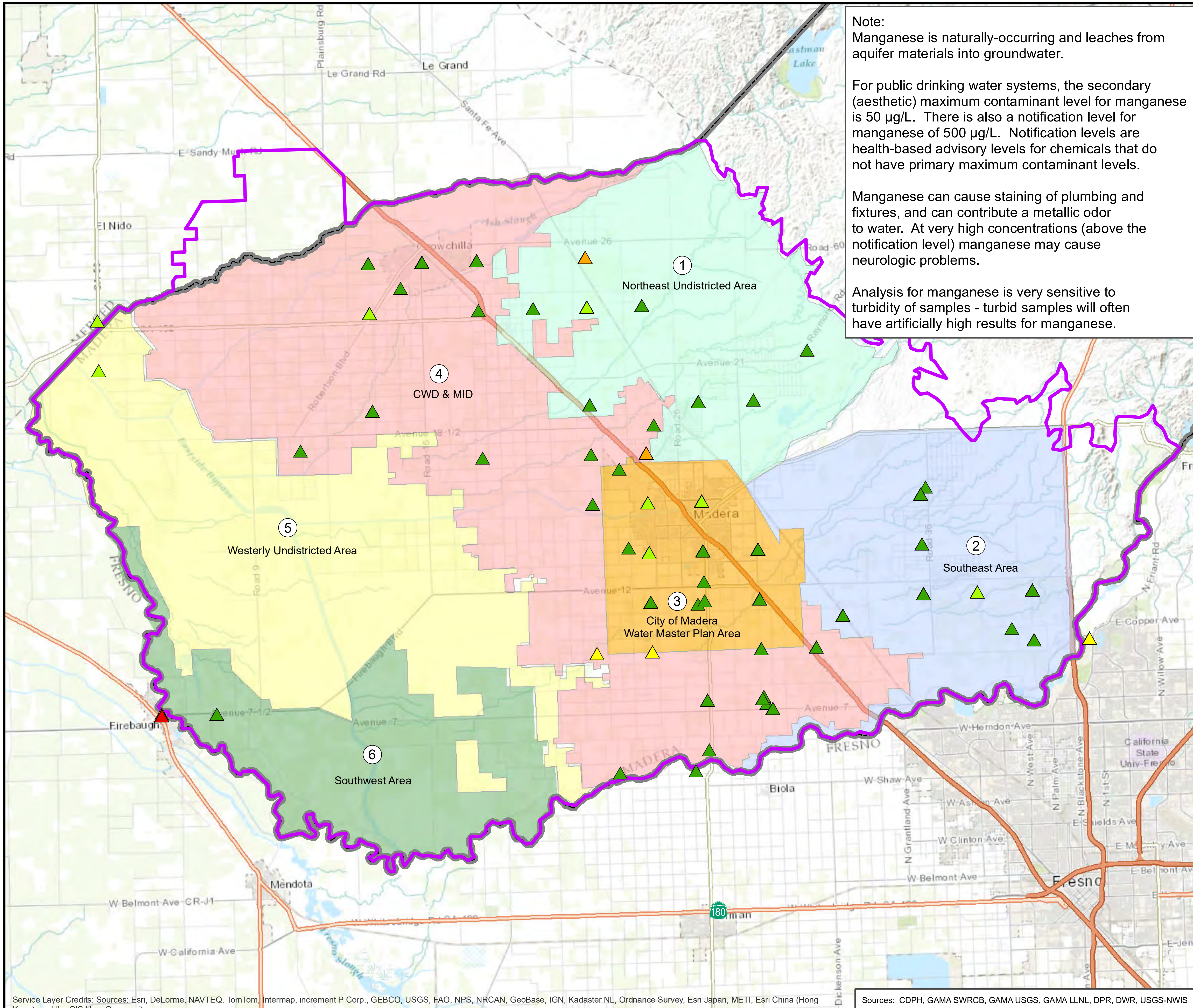
MAP OF MANGANESE CONCENTRATION IN WELLS OF UNKNOWN DEPTH

MADERA REGIONAL
GROUNDWATER MANAGEMENT PLAN
APRIL 2014



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Analysis for manganese is very sensitive to turbidity of samples - turbid samples will often have artificially high results for manganese.

Manganese (µg/L) in Other USGS GAMA Wells

- < 25
- 25 - 50
- 50 - 150
- 150 - 500
- > 500
- Groundwater Management Plan Boundary
- Madera County Boundary

Note: Well construction records were not available for these wells. Some wells may have screen perforations that connect two or more aquifers and may therefore represent composite water quality.

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Sources: CDPH, GAMA SWRCB, GAMA USGS, GAMA LLNL, DPR, DWR, USGS-NWIS

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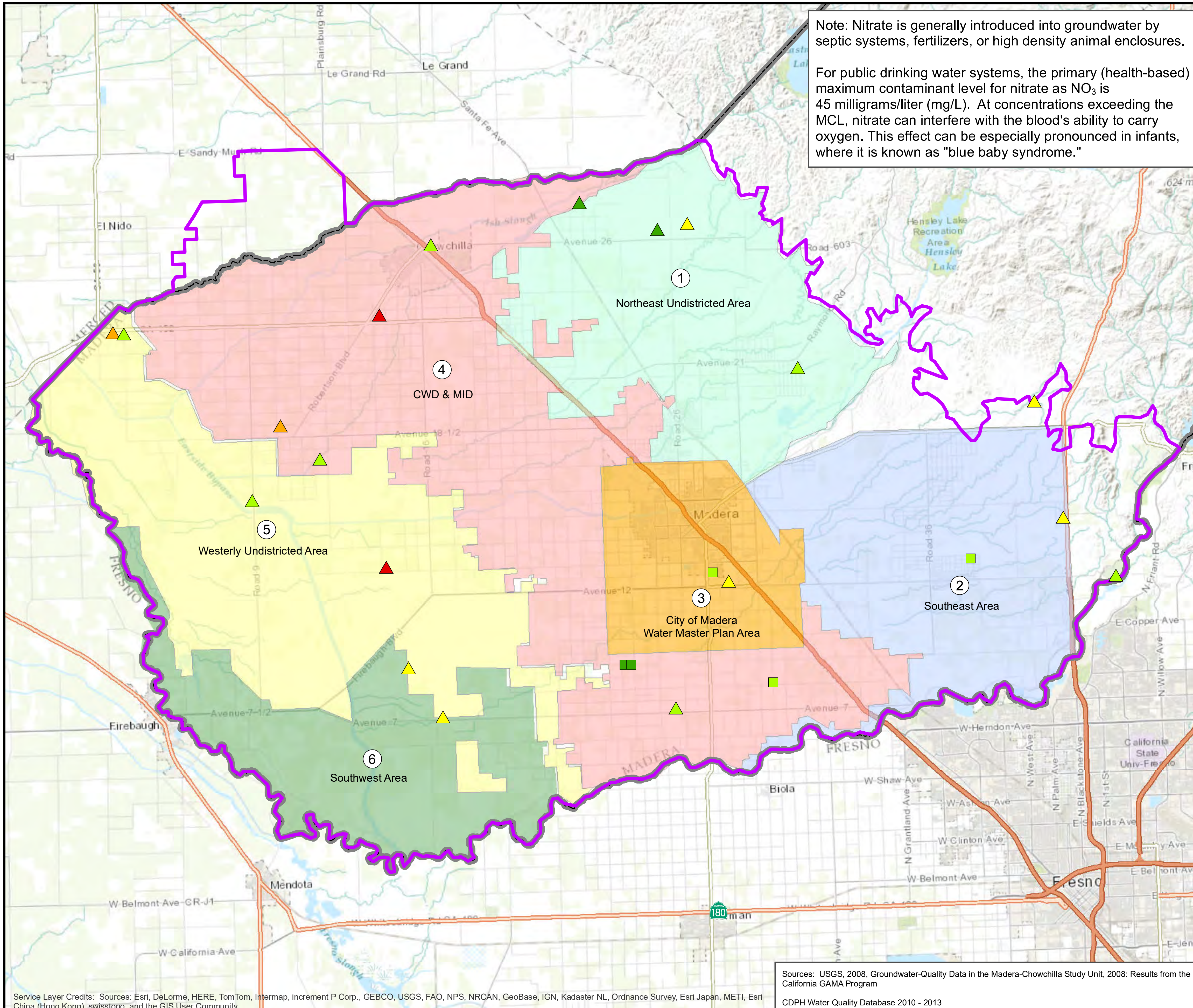

Note: Nitrate is generally introduced into groundwater by septic systems, fertilizers, or high density animal enclosures.

For public drinking water systems, the primary (health-based) maximum contaminant level for nitrate as NO_3 is 45 milligrams/liter (mg/L). At concentrations exceeding the MCL, nitrate can interfere with the blood's ability to carry oxygen. This effect can be especially pronounced in infants, where it is known as "blue baby syndrome."

MAP OF NITRATE (AS NO_3) CONCENTRATION IN SHALLOW WELLS

MADERA REGIONAL
GROUNDWATER MANAGEMENT PLAN
APRIL 2014

NORTH

0 2 4
MILES

Nitrate as NO3 (mg/L) in City Wells < 400 feet

- < 5
- 5 - 15
- 15 - 30
- 30 - 45
- > 45

Nitrate as NO3 (mg/L) in County Wells < 400 feet

- < 5
- 5 - 15
- 15 - 30
- 30 - 45
- > 45

Nitrate as NO3 (mg/L) in USGS GAMA Wells < 400 feet

- < 5
- 5 - 15
- 15 - 30
- 30 - 45
- > 45

Groundwater Management Plan Boundary

Madera County Boundary

Sources: USGS, 2008, Groundwater-Quality Data in the Madera-Chowchilla Study Unit, 2008: Results from the California GAMA Program

CDPH Water Quality Database 2010 - 2013

Service Layer Credits: Sources: Esri, DeLorme, HERE, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

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MAP OF NITRATE (AS NO_3) CONCENTRATION IN INTERMEDIATE WELLS

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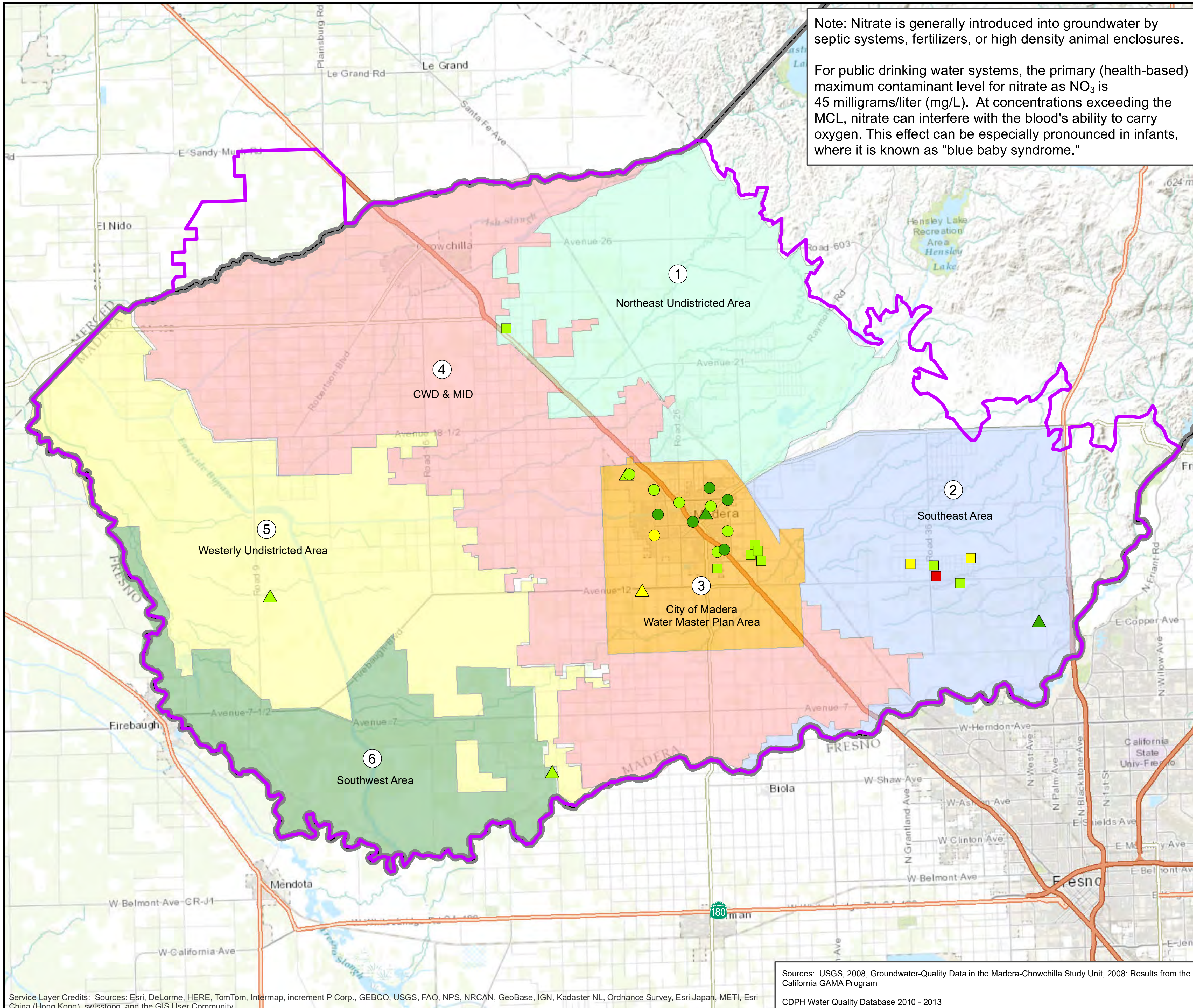
GROUNDWATER MANAGEMENT PLAN
APRIL 2014



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For public drinking water systems, the primary (health-based) maximum contaminant level for nitrate as NO_3 is 45 milligrams/liter (mg/L). At concentrations exceeding the MCL, nitrate can interfere with the blood's ability to carry oxygen. This effect can be especially pronounced in infants, where it is known as "blue baby syndrome."

NORTH

0 2 4
MILES

Nitrate as NO_3 (mg/L) in City Wells 400-600 feet
- < 5
- 5 - 15
- 15 - 30
- 30 - 45
- > 45

Nitrate as NO_3 (mg/L) in County Wells 400-600 feet
- < 5
- 5 - 15
- 15 - 30
- 30 - 45
- > 45

Nitrate as NO_3 (mg/L) in USGS GAMA Wells 400-600 feet
- < 5
- 5 - 15
- 15 - 30
- 30 - 45
- > 45

Groundwater Management Plan Boundary

Madera County Boundary

Note: All wells are classified by total well depth. Some wells may have screen perforations that begin shallower than the depth classification and therefore represent composite water quality across two or more aquifers.

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APPENDIX 2.F. WATER BUDGET INFORMATION

Prepared as part of the

Joint Groundwater Sustainability Plan

Madera Subbasin

January 2020

GSP Team:

Davids Engineering, Inc
Luhdorff & Scalmanini
ERA Economics
Stillwater Sciences and
California State University, Sacramento

2.F. Water Budget Information

APPENDIX 2.F. WATER BUDGET INFORMATION

2.F.a. Surface Water System Water Budget: City of Madera GSA

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

GSP Team:

Davids Engineering, Inc
Luhdorff & Scalmanini
ERA Economics
Stillwater Sciences and
California State University, Sacramento

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1 INTRODUCTION

To ensure sustainable groundwater management throughout California's groundwater basins, the Sustainable Groundwater Management Act of 2014 (SGMA) requires Groundwater Sustainability Agencies (GSAs) to prepare and adopt Groundwater Sustainability Plans (GSPs) with strategies to achieve subbasin groundwater sustainability within 20 years of plan adoption. Integral to each GSP is a water budget used to quantify the subbasin's groundwater overdraft (if applicable) and sustainable yield.

In 2017, City of Madera (CM) GSA formed to manage approximately 10,000 acres of the Madera Subbasin. This document presents results of the surface water system (SWS) water budgets developed for historical and current land use conditions in CM GSA. The CM GSA water budgets were integrated with separate water budgets developed for the other six (6) GSAs in Madera Subbasin to prepare a boundary water budget for the Madera Subbasin SWS. Results of the subbasin boundary water budget are reported in the Madera Subbasin GSP Section 2.2.3 and were integrated with a subbasin groundwater model (GSP Appendix 6.D) to estimate subbasin sustainable yield (GSP Section 2.2.3).

2 WATER BUDGET CONCEPTUAL MODEL

A water budget is defined as a complete accounting of all water flowing into and out of a defined volume (e.g., a subbasin or a GSA) over a specified period of time. The conceptual model (or structure) of the CM GSA water budget developed for this investigation is consistent with the GSP Regulations defined under Title 23 of California Code of Regulations[1] (CCR) and adheres to sound water budget principles and practices defined by California Department of Water Resources (DWR) in the Water Budget Best Management Practice (BMP) guidelines (DWR, 2016).

The lateral extent of CM GSA is defined by the boundaries indicated in Figure A2.F.a-1. The vertical extent of CM GSA are the land surface (top) and the base of fresh water at the bottom of the basin (bottom), as described in the hydrogeologic conceptual model (HCM) developed in GSP Section 2.2.1. The vertical extent of Madera Subbasin and its GSAs is subdivided into a surface water system (SWS) and the underlying groundwater system (GWS), with separate but related water budgets prepared for each that together represent the overall subbasin water budget.

A conceptual representation of the CM GSA water budget is represented in Figure A2.F.a-2. This document details only the SWS portion of the CM GSA water budget. The SWS is divided into two primary accounting centers: the Land Surface System and the Rivers and Streams System. The Land Surface System is further divided into three accounting centers representing CM GSA's water use sectors: Agricultural Land, Native Vegetation Land, and Urban Land (urban, industrial, and semi-agricultural).

Water budget components, or directional flow of water between accounting centers and across the SWS boundary, are indicated by arrows. Inflows and outflows were calculated using measurements and other historical data or were calculated as the water budget closure term – the difference between all other estimated or measured inflows and outflows from each accounting center or water use sector (bold arrows).

[1] California Code of Regulations Title 23. Waters, Division 2. Department of Water Resources, Chapter 1.5. Groundwater Management, Subchapter 2. Groundwater Sustainability Plans.

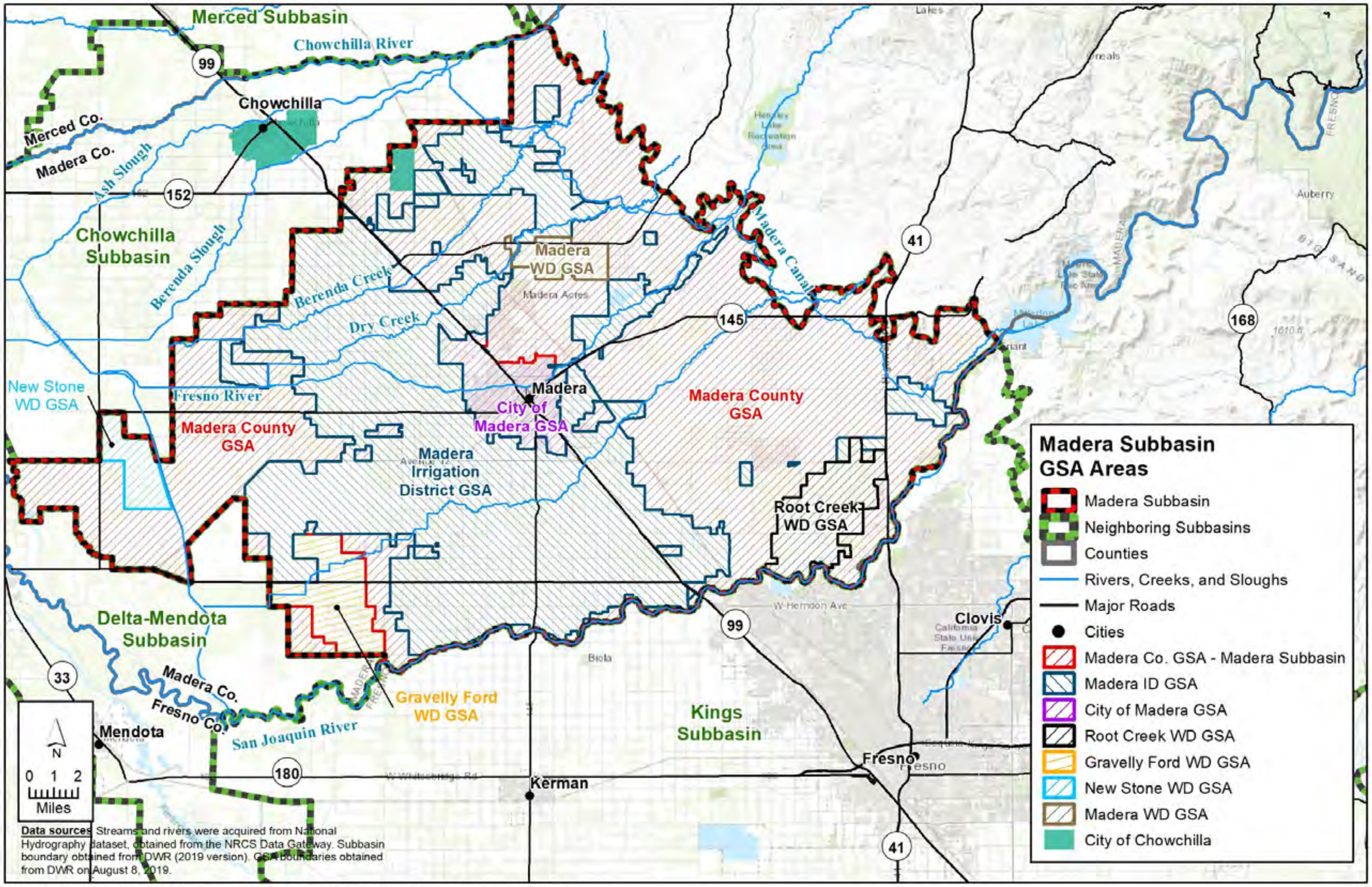

Figure A2.F.a-1. Madera Subbasin GSAs Map.

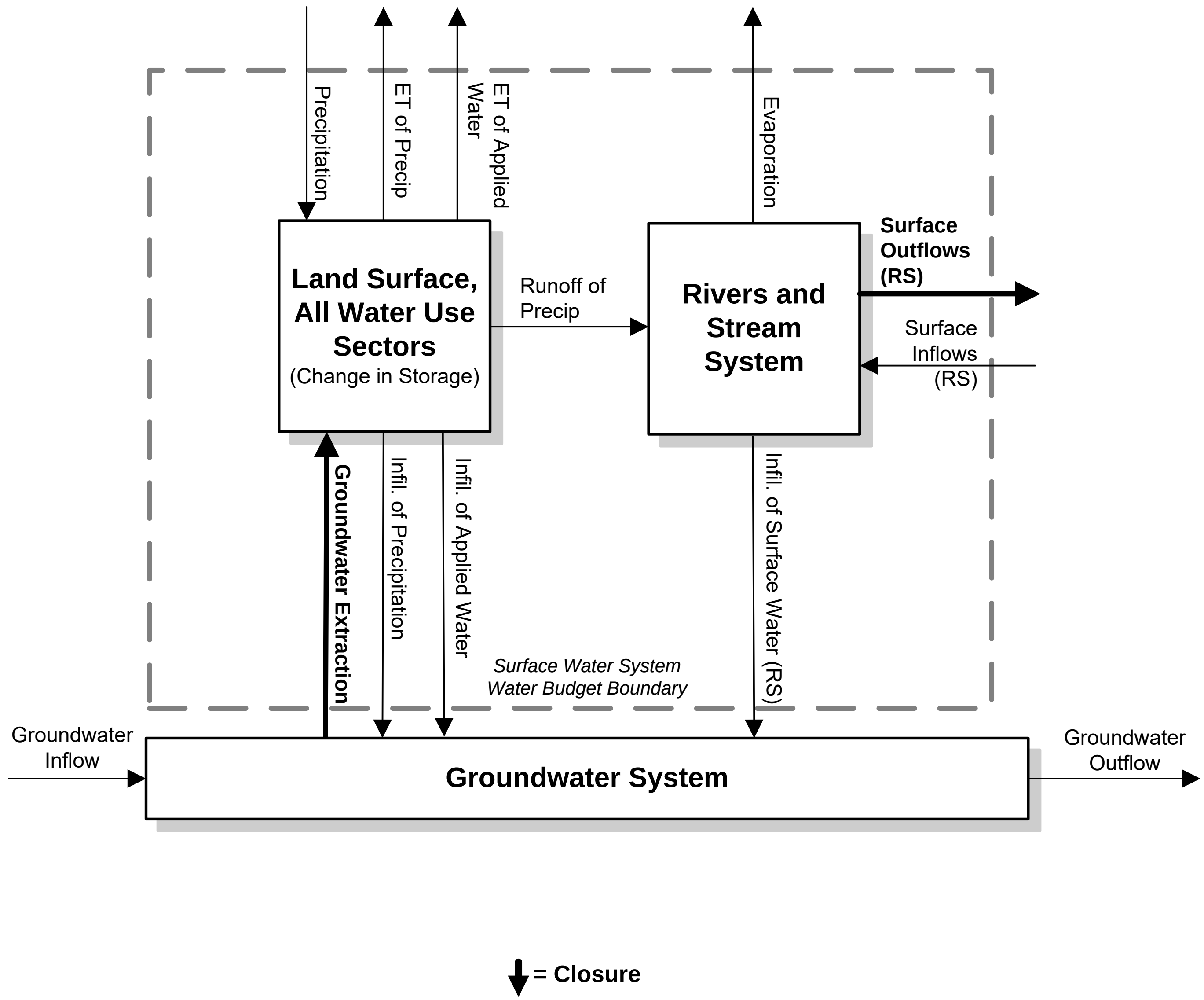

Figure A2.F.a-2. City of Madera GSA Water Budget Structure.

Inflows to the SWS include precipitation, surface water inflows (in various canals and streams), and groundwater extraction. Outflows from the SWS include evapotranspiration (ET), surface water outflows (in various canals and streams), and infiltration to the groundwater system (seepage and deep percolation). Also represented in Figure A2.F.a-2 are inflows and outflows from the GWS, which are discussed and quantified at the subbasin level in the GWS water budget in GSP Section 2.2.3. Subsurface GWS inflows and outflows are not quantified on the water budget subregion scale.

Inflows and outflows were quantified following the process described in GSP Section 2.2.3 on a monthly time step for water years in the historical water budget base period (1989-2014 hydrologic and land use conditions), the current water budget (2015 land use using 1989-2014 average hydrologic conditions), and projected water budget. Four projected water budgets were prepared for the years 2019 through 2090 based on 1965 through 2015 hydrologic conditions:

1. Historical hydrologic conditions
    a. Without projects and management actions, and
    b. With projects and management actions
2. Historical hydrologic conditions adjusted for anticipated climate change per DWR-provided 2030 climate change factors
    a. Without projects and management actions, and
    b. With projects and management actions.

3 WATER BUDGET ANALYSIS

The historical water budget and current land use water budget for CM GSA are presented below following a summary of land use data relevant to water budget development. Land use data is provided for the 1989-2014 historical water budget period and for 2015, the land use period used for current water budget development.

3.1 Land Use

Land use estimates for 1989-2015 corresponding to water use sectors are summarized in Figure A2.F.a-3 and Table A2.F.a-1 for CM GSA. According to GSP Regulations (23 CCR § 351(al)):

> *"Water use sector" refers to 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.*

In CM GSA, water use sectors include agricultural, native vegetation, and urban land use. The urban land use category includes urban and semi-agricultural[2] lands as well as industrial land, which covers only a small area in the subbasin.

Urban lands in CM GSA gradually expanded between 1989 and 2014, from approximately 5,700 acres to 8,000 acres. This expansion was only interrupted by a slight decline in urban lands in the late 1990s and early 2000s, which may be attributed to changes in DWR's delineation of urban lands. Besides a slight increase in native vegetation coinciding with this drop in urban lands, native vegetation has remained

[2] As defined in the DWR county land use surveys, semi-agricultural land use subclasses include farmsteads, livestock feed lot operations, dairies, poultry farms, and miscellaneous semi-agricultural land use incidental to agriculture (small roads, ditches, non-planted areas of cropped fields (DWR, 2009).

relatively constant over time, averaging approximately 1,000 acres between 1989 and 2014. Over the same period agricultural lands decreased from 3,400 acres to just 1,600 acres.

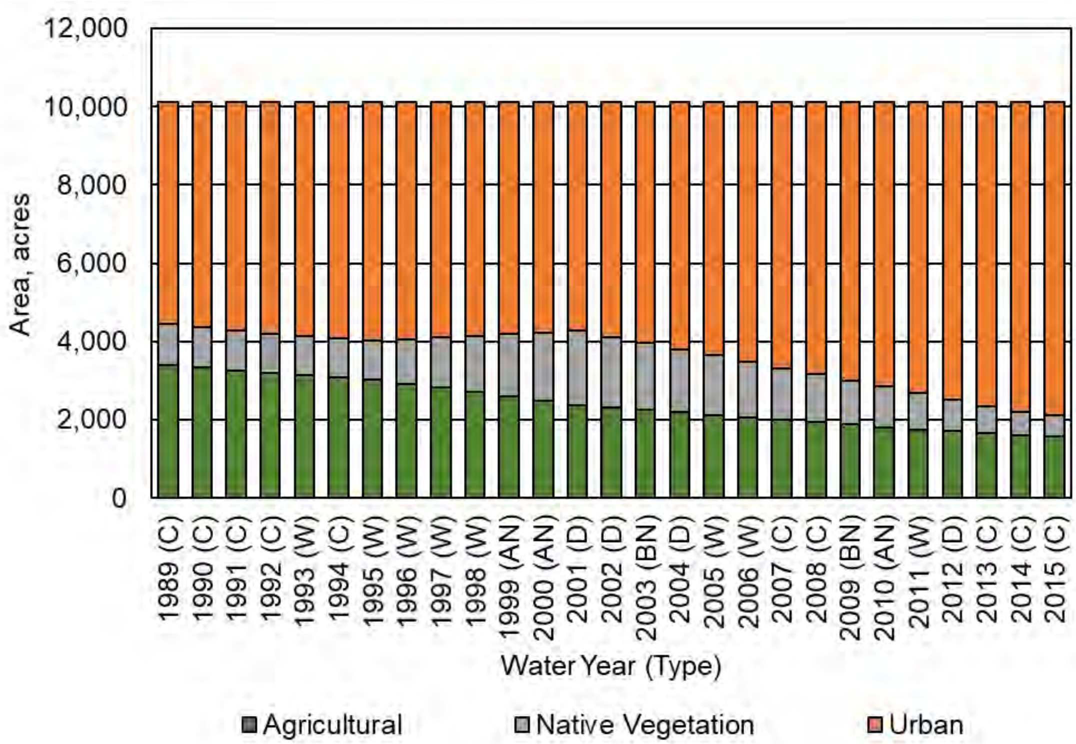

Figure A2.F.a-3. City of Madera GSA Land Use Areas.

Table A2.F.a-1. City of Madera GSA Land Use Areas (Acres).

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
1989 (C)	3,392	1,064	5,650	10,106
1990 (C)	3,331	1,042	5,733	10,106
1991 (C)	3,260	1,028	5,818	10,106
1992 (C)	3,208	999	5,900	10,106
1993 (W)	3,150	986	5,971	10,106
1994 (C)	3,092	976	6,038	10,106
1995 (W)	3,038	978	6,090	10,106
1996 (W)	2,928	1,132	6,047	10,106
1997 (W)	2,817	1,286	6,003	10,106
1998 (W)	2,707	1,440	5,959	10,106
1999 (AN)	2,597	1,594	5,915	10,106
2000 (AN)	2,487	1,748	5,872	10,106
2001 (D)	2,376	1,902	5,828	10,106
2002 (D)	2,314	1,806	5,987	10,106
2003 (BN)	2,251	1,709	6,146	10,106

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
2004 (D)	2,189	1,613	6,305	10,106
2005 (W)	2,126	1,516	6,464	10,106
2006 (W)	2,063	1,420	6,623	10,106
2007 (C)	2,001	1,324	6,782	10,106
2008 (C)	1,938	1,227	6,940	10,106
2009 (BN)	1,876	1,131	7,100	10,106
2010 (AN)	1,813	1,034	7,259	10,106
2011 (W)	1,751	938	7,418	10,106
2012 (D)	1,706	817	7,583	10,106
2013 (C)	1,661	695	7,750	10,106
2014 (C)	1,617	574	7,915	10,106
2015 (C)	1,584	537	7,986	10,106
Average (1989-2014)	2,450	1,230	6,427	10,106

[1] Area includes land classified as native vegetation and water surfaces.

[2] Area includes land classified as urban, industrial, and semi-agricultural.

Agricultural land uses are further detailed in Figure A2.F.a-4 and Table A2.F.a-2. Historically, grapes have been the predominant crop within CM GSA, though in recent years orchard crops have notably increased.

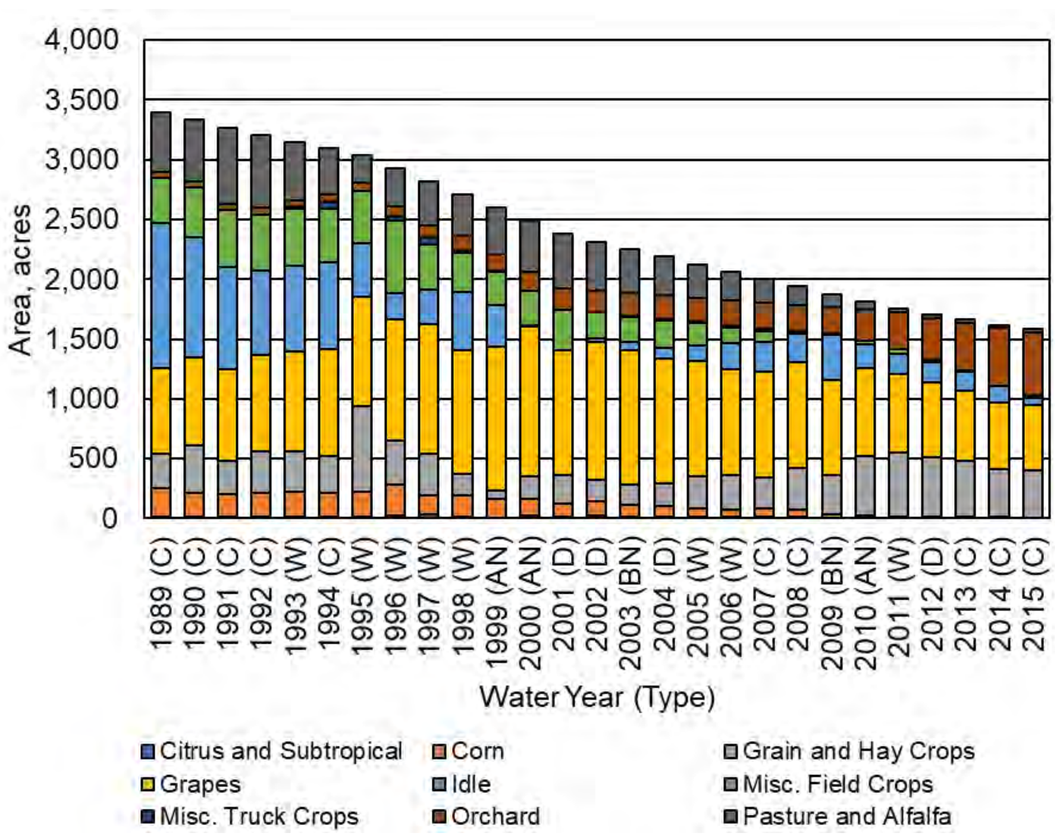

Figure A2.F.a-4. City of Madera GSA Agricultural Land Use Areas.

Table A2.F.a-2. City of Madera GSA Agricultural Land Use Areas (Acres).

Water Year (Type)	Citrus and Subtropical	Corn	Grain and Hay Crops	Grapes	Idle	Misc. Field Crops	Misc. Truck Crops	Orchard	Pasture and Alfalfa	Total
1989 (C)	14	234	291	722	1,205	386	0	42	500	3,392
1990 (C)	15	201	398	734	1,005	419	0	47	512	3,331
1991 (C)	17	184	280	761	858	478	1	52	628	3,260
1992 (C)	17	200	345	805	703	465	9	51	614	3,208
1993 (W)	18	207	340	831	720	472	20	51	491	3,150
1994 (C)	19	193	312	889	727	447	67	53	387	3,092
1995 (W)	17	203	722	913	443	437	0	69	234	3,038
1996 (W)	27	251	371	1,010	223	610	33	79	324	2,928
1997 (W)	39	156	344	1,082	295	379	54	99	369	2,817
1998 (W)	17	172	182	1,037	483	324	24	116	351	2,707
1999 (AN)	7	161	70	1,201	345	280	10	135	388	2,597
2000 (AN)	25	142	189	1,251	6	291	2	157	423	2,487
2001 (D)	18	106	237	1,040	0	343	2	174	456	2,376
2002 (D)	23	115	179	1,156	28	218	4	177	413	2,314
2003 (BN)	16	102	166	1,118	74	213	6	187	370	2,251
2004 (D)	14	85	193	1,048	85	228	14	193	327	2,189
2005 (W)	15	71	268	965	127	188	10	198	285	2,126
2006 (W)	13	65	280	888	219	129	22	205	242	2,063
2007 (C)	13	69	263	878	256	82	26	215	199	2,001
2008 (C)	11	62	350	885	238	19	3	214	156	1,938
2009 (BN)	9	22	336	788	379	2	6	221	113	1,876
2010 (AN)	9	13	499	733	204	23	7	255	71	1,813
2011 (W)	13	0	536	654	177	34	7	303	28	1,751
2012 (D)	7	8	501	621	167	15	6	348	33	1,706
2013 (C)	6	10	461	588	163	3	6	400	25	1,661
2014 (C)	13	0	399	555	137	3	2	487	21	1,617
2015 (C)	7	0	398	549	60	0	11	535	25	1,584
Average (1989-2014)	16	117	327	890	356	249	13	174	306	2,450

3.2 Surface Water System Water Budget

This section presents surface water system water budget components within CM GSA as per GSP regulations. These are followed by a summary of the water budget results by accounting center.

3.2.1 Inflows

3.2.1.1 Surface Water Inflow by Water Source Type

Surface water inflows include surface water flowing into the basin across the basin boundary. Per the Regulations, surface inflows 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.*

Additionally, runoff of precipitation from upgradient areas adjacent to the subregion represents a potential source of surface water inflow.

Local Supplies

Primary surface water inflows to CM GSA include local supplies along Fresno River that flow into and out of City of Madera. Some water along Fresno River is diverted by water rights users in the subbasin.

Local Imported Supplies

CM GSA does not receive local imported supplies for irrigation purposes.

CVP Supplies

CM GSA does not receive CVP supplies for irrigation purposes.

Recycling and Reuse

Recycling and reuse are not a significant source of supply within CM GSA.

Other Surface Inflows

For the water budgets presented herein, precipitation runoff from outside the subregion is considered relatively minimal and is expected to pass through the waterways accounted above following relatively large storm events. Precipitation runoff from lands inside the subregion is internal to the surface water system and is thus not considered as surface inflows to the subregion boundary.

Summary of Surface Inflows

Surface water inflows in the Fresno River are summarized by water year type in Figure A2.F.a-5 and Table A2.F.a-3. The City of Madera does not have water rights to Fresno River water, thus, what doesn't seep or evaporate from the River as it traverses the City of Madera becomes an outflow from the GSA. During the study period, surface water supplies vary greatly with water year type, with substantial local supply inflows during wet years that are reduced during all other years. Total surface water inflows range from less than 6 thousand acre-feet (taf) during dry and critical years to 116 taf during wet years.

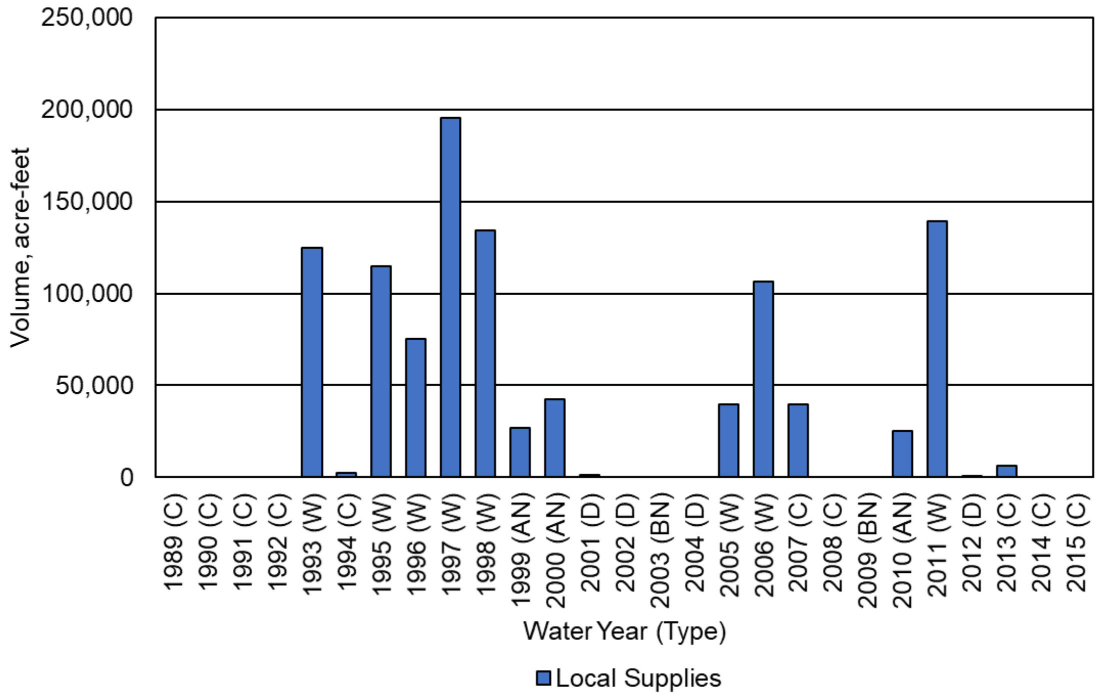

Figure A2.F.a-5. City of Madera GSA Surface Water Inflows by Water Source Type.

Table A2.F.a-3. City of Madera GSA Surface Water Inflows by Water Source Type (Acre-Feet).

Water Year (Type)	Local Supply	CVP Supply[1]	Other Surface Inflows	Total
1989 (C)	0	0	0	0
1990 (C)	0	0	0	0
1991 (C)	0	0	0	0
1992 (C)	0	0	0	0
1993 (W)	124,660	0	0	124,660
1994 (C)	2,520	0	0	2,520
1995 (W)	115,059	0	0	115,059
1996 (W)	75,230	0	0	75,230
1997 (W)	195,455	0	0	195,455
1998 (W)	134,172	0	0	134,172
1999 (AN)	26,759	0	0	26,759
2000 (AN)	42,375	0	0	42,375
2001 (D)	1,514	0	0	1,514
2002 (D)	0	0	0	0
2003 (BN)	0	0	0	0
2004 (D)	0	0	0	0
2005 (W)	39,960	0	0	39,960
2006 (W)	106,267	0	0	106,267
2007 (C)	39,896	0	0	39,896
2008 (C)	0	0	0	0

Water Year (Type)	Local Supply	CVP Supply[1]	Other Surface Inflows	Total
2009 (BN)	0	0	0	0
2010 (AN)	25,241	0	0	25,241
2011 (W)	139,506	0	0	139,506
2012 (D)	365	0	0	365
2013 (C)	6,222	0	0	6,222
2014 (C)	0	0	0	0
2015 (C)	0	0	0	0
Average (1989-2014)	41,354	0	0	41,354
Average (1989-2014) W	116,289	0	0	116,289
Average (1989-2014) AN	31,458	0	0	31,458
Average (1989-2014) BN	0	0	0	0
Average (1989-2014) D	470	0	0	470
Average (1989-2014) C	5,404	0	0	5,404

[1]CVP Supply is considered as all water supply released from CVP storage facilities. The volume of CVP Supply includes CVP deliveries to CVP contractors/water users, and flood releases from CVP facilities that largely pass through the subbasin.

3.2.1.2 Precipitation

Precipitation estimates for the CM GSA are provided in Figure A2.F.a-6 and Table A2.F.a-4. Precipitation estimates are reported by water use sector.

Total precipitation is variable between years in the study area, ranging from approximately 7 taf (8.6 inches) during critical years to 12 taf (14.4 inches) during wet years.

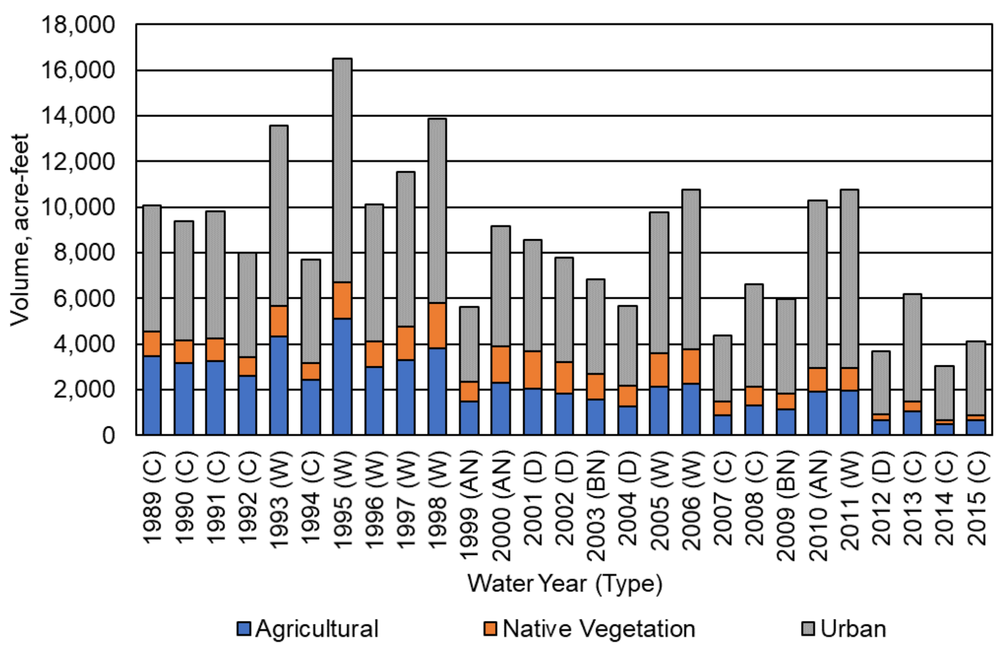

Figure A2.F.a-6. City of Madera GSA Precipitation by Water Use Sector.

Table A2.F.a-4. City of Madera GSA Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	3,467	1,061	5,545	10,073
1990 (C)	3,176	970	5,247	9,393
1991 (C)	3,247	998	5,565	9,810
1992 (C)	2,610	792	4,616	8,018
1993 (W)	4,339	1,326	7,919	13,584
1994 (C)	2,413	744	4,541	7,698
1995 (W)	5,086	1,599	9,839	16,524
1996 (W)	2,993	1,130	5,974	10,097
1997 (W)	3,292	1,469	6,780	11,541
1998 (W)	3,801	1,977	8,096	13,874
1999 (AN)	1,476	888	3,261	5,625
2000 (AN)	2,305	1,587	5,280	9,172
2001 (D)	2,053	1,610	4,892	8,555
2002 (D)	1,819	1,386	4,560	7,765
2003 (BN)	1,556	1,153	4,113	6,822
2004 (D)	1,259	904	3,505	5,668
2005 (W)	2,114	1,467	6,198	9,779
2006 (W)	2,261	1,513	6,995	10,769
2007 (C)	890	571	2,899	4,360
2008 (C)	1,313	805	4,512	6,630
2009 (BN)	1,149	671	4,168	5,988
2010 (AN)	1,911	1,052	7,319	10,282
2011 (W)	1,936	999	7,828	10,763
2012 (D)	642	297	2,725	3,664
2013 (C)	1,059	426	4,704	6,189
2014 (C)	503	172	2,349	3,024
2015 (C)	675	219	3,234	4,128
Average (1989-2014)	2,257	1,060	5,363	8,680
Average (1989-2014) W	3,228	1,435	7,454	12,116
Average (1989-2014) AN	1,897	1,176	5,287	8,360
Average (1989-2014) BN	1,353	912	4,141	6,405
Average (1989-2014) D	1,443	1,049	3,921	6,413
Average (1989-2014) C	2,075	727	4,442	7,244

3.2.1.3 Groundwater Extraction by Water Use Sector

Estimates of groundwater extraction by water use sector are provided in Figure A2.F.a-7 and Table A2.F.a-5. For agricultural and urban (urban, semi-agricultural, industrial) lands, groundwater extraction represents pumping, while for native lands, groundwater extraction by riparian vegetation was considered to be negligible. For the urban lands water budget, measured groundwater pumping volumes from CM SCADA records were available for 2013-2015 and were found to be reasonably similar to the groundwater extraction water budget closure term. Groundwater extraction varies between years depending on surface water supplies and crop water demands or urban land consumptive use requirements. However, between 1989 and 2014 groundwater extraction was, on average, similar across agricultural and urban lands, averaging approximately 5 taf per year.

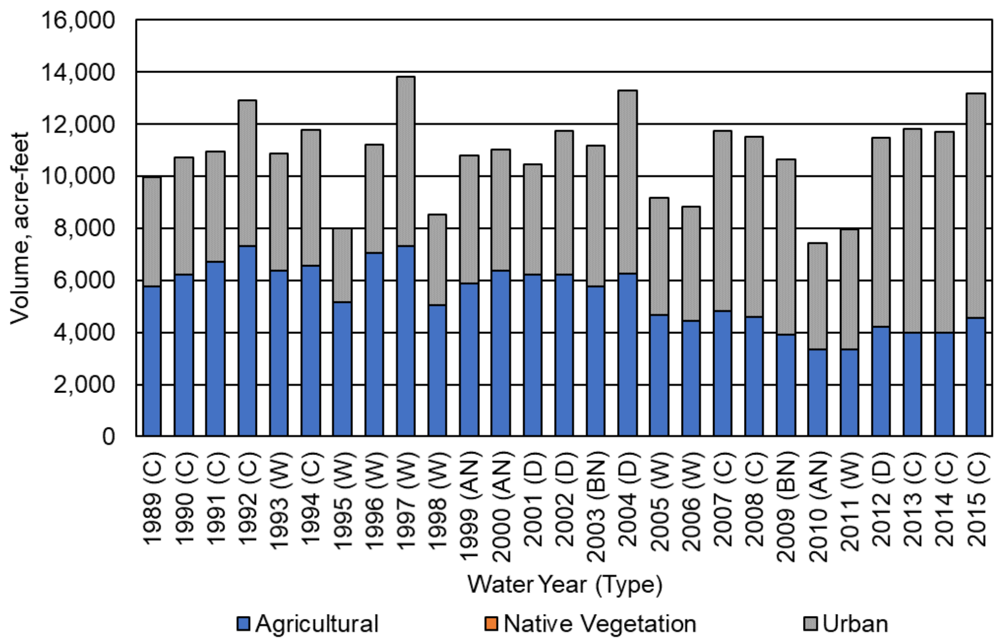

Figure A2.F.a-7. City of Madera GSA Groundwater Extraction by Water Use Sector.

Table A2.F.a-5. City of Madera GSA Groundwater Extraction by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	5,777	0	4,205	9,982
1990 (C)	6,211	0	4,522	10,733
1991 (C)	6,703	0	4,226	10,929
1992 (C)	7,323	0	5,610	12,933
1993 (W)	6,386	0	4,472	10,858
1994 (C)	6,567	0	5,207	11,774
1995 (W)	5,147	0	2,866	8,013
1996 (W)	7,044	0	4,184	11,228
1997 (W)	7,314	0	6,508	13,822
1998 (W)	5,038	0	3,485	8,523
1999 (AN)	5,891	0	4,924	10,815
2000 (AN)	6,353	0	4,673	11,026
2001 (D)	6,200	0	4,249	10,449
2002 (D)	6,202	0	5,525	11,727
2003 (BN)	5,775	0	5,398	11,173
2004 (D)	6,270	0	7,014	13,284
2005 (W)	4,685	0	4,493	9,178
2006 (W)	4,458	0	4,370	8,828
2007 (C)	4,834	0	6,899	11,733
2008 (C)	4,583	0	6,921	11,504
2009 (BN)	3,926	0	6,727	10,653
2010 (AN)	3,330	0	4,099	7,429
2011 (W)	3,347	0	4,623	7,970
2012 (D)	4,223	0	7,259	11,482
2013 (C)	3,989	0	7,833	11,822

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2014 (C)	3,987	0	7,711	11,698
2015 (C)	4,537	0	8,645	13,182
Average (1989-2014)	5,445	0	5,308	10,753
Average (1989-2014) W	5,427	0	4,375	9,803
Average (1989-2014) AN	5,191	0	4,565	9,757
Average (1989-2014) BN	4,851	0	6,063	10,913
Average (1989-2014) D	5,724	0	6,012	11,736
Average (1989-2014) C	5,553	0	5,904	11,456

3.2.1.4 Groundwater Discharge to Surface Water Sources

The depth to groundwater is greater than 100-200 ft across much of the Madera Subbasin. Given the depth to the water table in the Madera Subbasin, groundwater discharge to surface water sources is negligible.

3.2.2 Outflows

3.2.2.1 Evapotranspiration by Water Use Sector

Evapotranspiration (ET) by water use sector is reported in Figures A2.F.a-8 to A2.F.a-10 and Tables A2.F.a-6 to A2.F.a-8. First, total ET is reported, followed by ET from applied water and ET from precipitation.

Total ET varies between years but has remained relatively steady over time, ranging from a low of approximately 12 taf in 2012 to a high of 15 taf in 1992. As agricultural area has decreased and urban land has increased over time, ET has similarly decreased and increased for each respective water use sector.

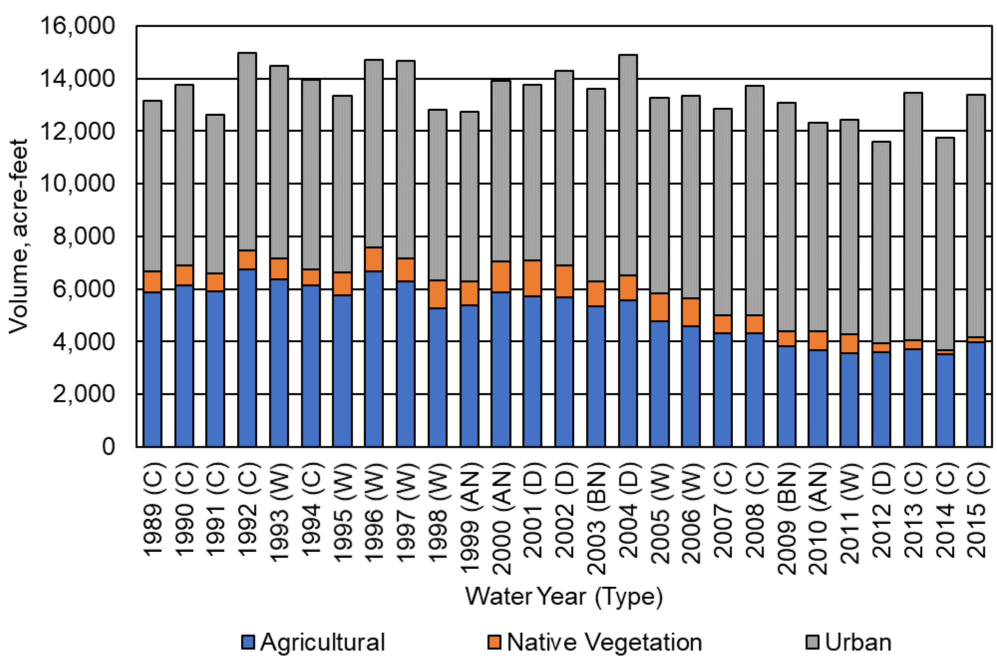

Figure A2.F.a-8. City of Madera GSA Evapotranspiration by Water Use Sector.

Table A2.F.a-6. City of Madera GSA Evapotranspiration by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	5,864	795	6,500	13,159
1990 (C)	6,133	770	6,858	13,761
1991 (C)	5,912	662	6,065	12,639
1992 (C)	6,744	728	7,509	14,981
1993 (W)	6,380	792	7,301	14,473
1994 (C)	6,132	614	7,217	13,963
1995 (W)	5,770	848	6,716	13,334
1996 (W)	6,686	893	7,115	14,694
1997 (W)	6,307	847	7,523	14,677
1998 (W)	5,276	1,054	6,494	12,824
1999 (AN)	5,393	900	6,430	12,723
2000 (AN)	5,891	1,164	6,865	13,920
2001 (D)	5,704	1,369	6,670	13,743
2002 (D)	5,668	1,216	7,394	14,278
2003 (BN)	5,347	955	7,298	13,600
2004 (D)	5,569	944	8,377	14,890
2005 (W)	4,756	1,073	7,447	13,276
2006 (W)	4,568	1,072	7,694	13,334
2007 (C)	4,334	673	7,849	12,856
2008 (C)	4,304	693	8,721	13,718
2009 (BN)	3,842	551	8,668	13,061
2010 (AN)	3,671	731	7,910	12,312
2011 (W)	3,566	700	8,175	12,441
2012 (D)	3,612	325	7,677	11,614
2013 (C)	3,697	368	9,372	13,437
2014 (C)	3,510	166	8,070	11,746
2015 (C)	3,989	181	9,225	13,395
Average (1989-2014)	5,178	804	7,458	13,441
Average (1989-2014) W	5,414	910	7,308	13,632
Average (1989-2014) AN	4,985	932	7,068	12,985
Average (1989-2014) BN	4,595	753	7,983	13,331
Average (1989-2014) D	5,138	964	7,530	13,631
Average (1989-2014) C	5,181	608	7,573	13,362

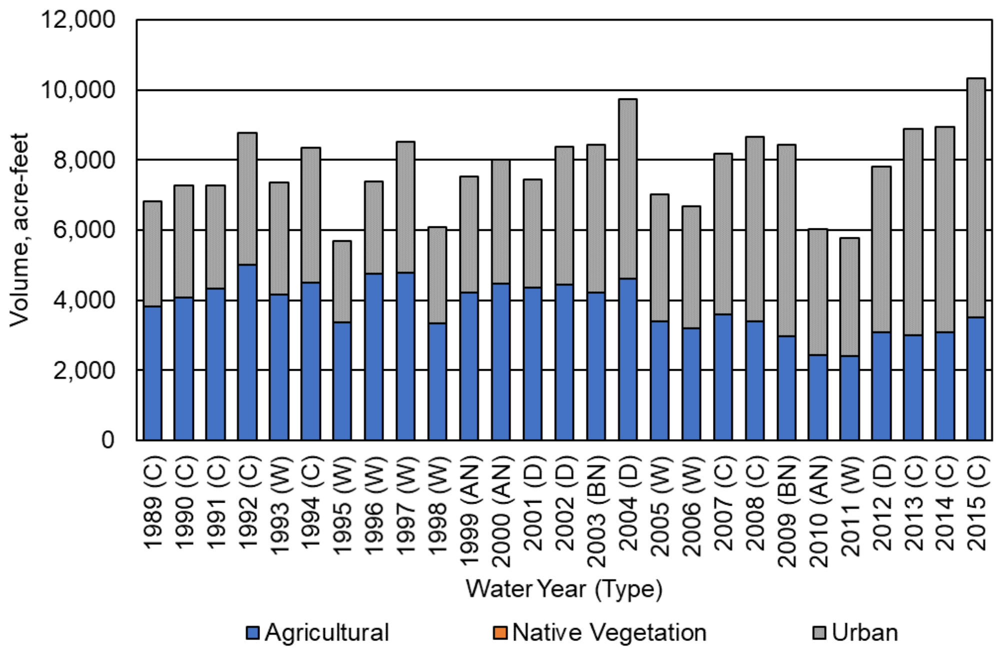

Figure A2.F.a-9. City of Madera GSA Evapotranspiration of Applied Water by Water Use Sector.

Table A2.F.a-7. City of Madera GSA Evapotranspiration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	3,821	0	3,012	6,833
1990 (C)	4,082	0	3,190	7,272
1991 (C)	4,322	0	2,965	7,287
1992 (C)	5,017	0	3,762	8,779
1993 (W)	4,167	0	3,199	7,366
1994 (C)	4,514	0	3,845	8,359
1995 (W)	3,368	0	2,325	5,693
1996 (W)	4,755	0	2,644	7,399
1997 (W)	4,777	0	3,737	8,514
1998 (W)	3,335	0	2,766	6,101
1999 (AN)	4,233	0	3,289	7,522
2000 (AN)	4,489	0	3,534	8,023
2001 (D)	4,365	0	3,086	7,451
2002 (D)	4,446	0	3,923	8,369
2003 (BN)	4,231	0	4,211	8,442
2004 (D)	4,607	0	5,128	9,735
2005 (W)	3,394	0	3,624	7,018
2006 (W)	3,191	0	3,478	6,669
2007 (C)	3,597	0	4,584	8,181
2008 (C)	3,401	0	5,258	8,659
2009 (BN)	2,980	0	5,471	8,451
2010 (AN)	2,447	0	3,581	6,028
2011 (W)	2,413	0	3,357	5,770
2012 (D)	3,092	0	4,718	7,810

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2013 (C)	3,005	0	5,873	8,878
2014 (C)	3,080	0	5,865	8,945
2015 (C)	3,516	0	6,815	10,331
Average (1989-2014)	3,813	0	3,863	7,675
Average (1989-2014) W	3,675	0	3,141	6,816
Average (1989-2014) AN	3,723	0	3,468	7,191
Average (1989-2014) BN	3,606	0	4,841	8,447
Average (1989-2014) D	4,128	0	4,214	8,341
Average (1989-2014) C	3,871	0	4,262	8,133

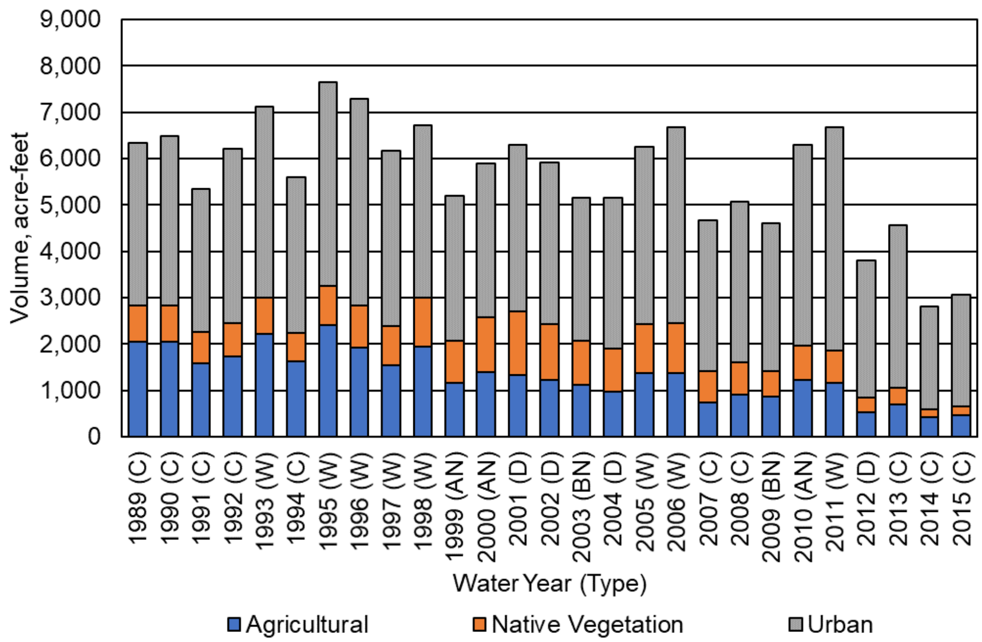

Figure A2.F.a-10. City of Madera GSA Evapotranspiration of Precipitation by Water Use Sector.

Table A2.F.a-8. City of Madera GSA Evapotranspiration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	2,043	795	3,488	6,326
1990 (C)	2,051	770	3,668	6,489
1991 (C)	1,590	662	3,100	5,352
1992 (C)	1,727	728	3,747	6,202
1993 (W)	2,213	792	4,102	7,107
1994 (C)	1,618	614	3,372	5,604
1995 (W)	2,402	848	4,391	7,641
1996 (W)	1,931	893	4,471	7,295
1997 (W)	1,530	847	3,786	6,163
1998 (W)	1,941	1,054	3,728	6,723
1999 (AN)	1,160	900	3,141	5,201
2000 (AN)	1,402	1,164	3,331	5,897
2001 (D)	1,339	1,369	3,584	6,292

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2002 (D)	1,222	1,216	3,471	5,909
2003 (BN)	1,116	955	3,087	5,158
2004 (D)	962	944	3,249	5,155
2005 (W)	1,362	1,073	3,823	6,258
2006 (W)	1,377	1,072	4,216	6,665
2007 (C)	737	673	3,265	4,675
2008 (C)	903	693	3,463	5,059
2009 (BN)	862	551	3,197	4,610
2010 (AN)	1,224	731	4,329	6,284
2011 (W)	1,153	700	4,818	6,671
2012 (D)	520	325	2,959	3,804
2013 (C)	692	368	3,499	4,559
2014 (C)	430	166	2,205	2,801
2015 (C)	473	181	2,410	3,064
Average (1989-2014)	1,366	804	3,596	5,765
Average (1989-2014) W	1,739	910	4,167	6,815
Average (1989-2014) AN	1,262	932	3,600	5,794
Average (1989-2014) BN	989	753	3,142	4,884
Average (1989-2014) D	1,011	964	3,316	5,290
Average (1989-2014) C	1,310	608	3,312	5,230

In addition to ET from land surfaces, estimates of evaporation from rivers and streams are reported in Figure A2.F.a-11 and Table A2.F.a-9. Evaporation from the Rivers and Streams System includes evaporation of both surface inflows and of precipitation runoff within local sloughs and depressions. Evaporation is highest in wet years when surface water inflows are typically higher, averaging approximately 0.9 taf per wet year.

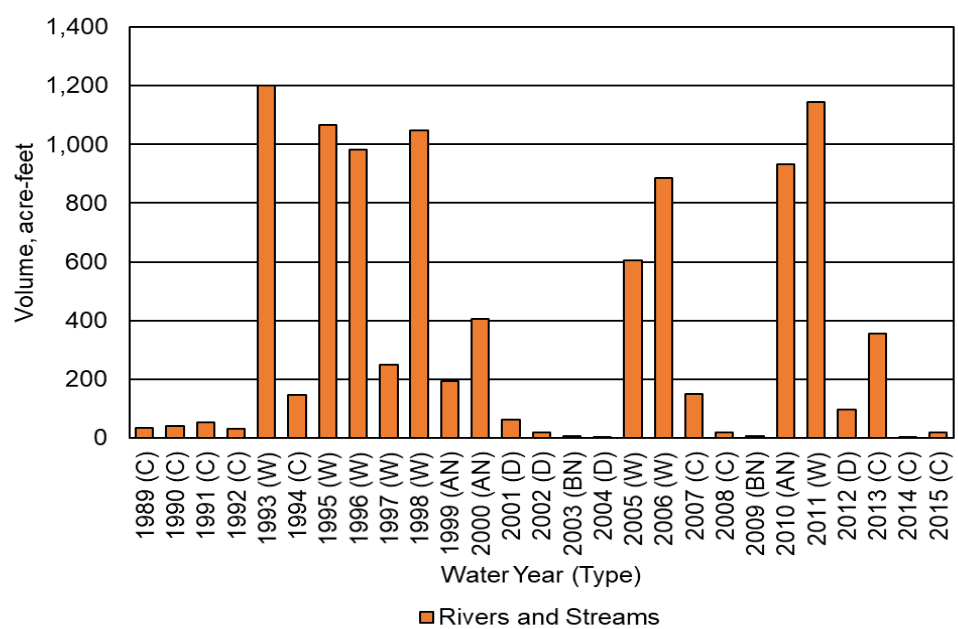

Figure A2.F.a-11. City of Madera GSA Evaporation from the Surface Water System.

Table A2.F.a-9. City of Madera GSA Evaporation from the Surface Water System (Acre-Feet).

Water Year (Type)	Rivers and Streams[1]
1989 (C)	33
1990 (C)	41
1991 (C)	54
1992 (C)	31
1993 (W)	1,200
1994 (C)	146
1995 (W)	1,067
1996 (W)	981
1997 (W)	249
1998 (W)	1,047
1999 (AN)	194
2000 (AN)	406
2001 (D)	62
2002 (D)	18
2003 (BN)	8
2004 (D)	5
2005 (W)	604
2006 (W)	885
2007 (C)	151
2008 (C)	19
2009 (BN)	6
2010 (AN)	933
2011 (W)	1,144
2012 (D)	95
2013 (C)	356
2014 (C)	2
2015 (C)	18
Average (1989-2014)	374
Average (1989-2014) W	897
Average (1989-2014) AN	511
Average (1989-2014) BN	7
Average (1989-2014) D	45
Average (1989-2014) C	92

[1] Includes evaporation of surface inflows and of precipitation runoff.

3.2.2.2 Surface Water Outflow by Water Source Type

Surface water outflows by water source type are summarized in Figure A2.F.a-12 and Table A2.F.a-10. In CM GSA, runoff of applied water is assumed negligible and runoff of precipitation is collected in waterways within CM GSA, reentering the groundwater system through infiltration except during the largest storm events. Thus, surface outflows primarily from local supplies along Fresno River are expected to leave the subregion. These outflows are significantly higher in wet years, averaging approximately 112 taf during wet years and less than 5 taf during dry and critical years.

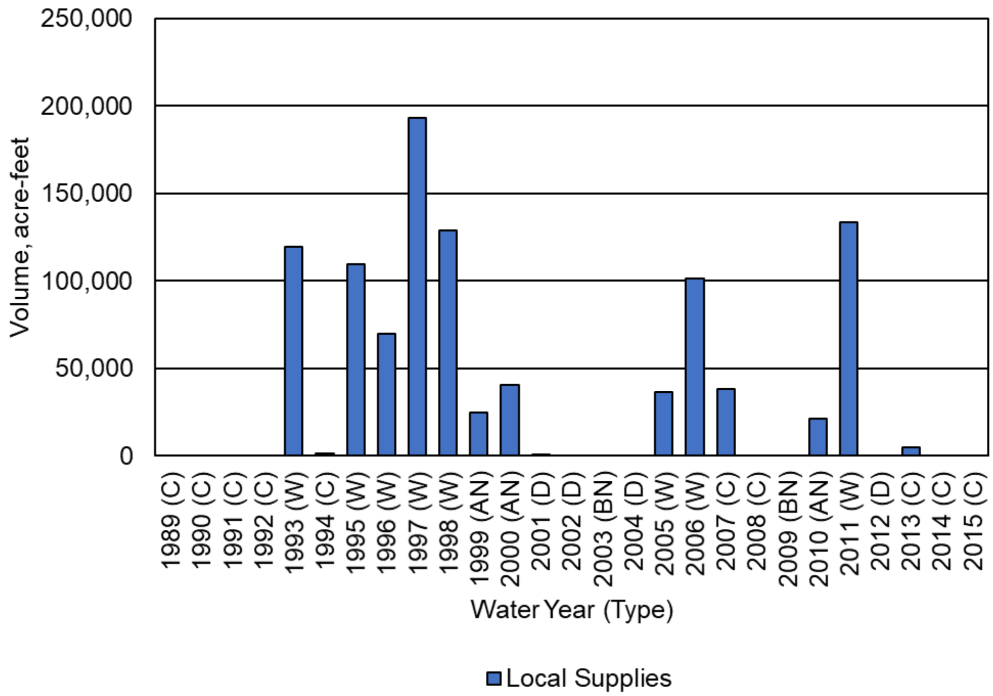

Figure A2.F.a-12. City of Madera GSA Surface Outflows by Water Source Type.

Table A2.F.a-10. City of Madera GSA Surface Outflows by Water Source Type (Acre-Feet).

Water Year (Type)	Local Supplies	CVP Supplies	Total
1989 (C)	0	0	0
1990 (C)	0	0	0
1991 (C)	0	0	0
1992 (C)	0	0	0
1993 (W)	119,286	0	119,286
1994 (C)	1,334	0	1,334
1995 (W)	109,676	0	109,676
1996 (W)	69,695	0	69,695
1997 (W)	193,339	0	193,339
1998 (W)	128,982	0	128,982
1999 (AN)	24,801	0	24,801
2000 (AN)	40,412	0	40,412
2001 (D)	975	0	975
2002 (D)	0	0	0
2003 (BN)	0	0	0
2004 (D)	0	0	0
2005 (W)	36,774	0	36,774
2006 (W)	101,319	0	101,319
2007 (C)	38,159	0	38,159
2008 (C)	0	0	0
2009 (BN)	0	0	0
2010 (AN)	21,412	0	21,412
2011 (W)	133,723	0	133,723

Water Year (Type)	Local Supplies	CVP Supplies	Total
2012 (D)	0	0	0
2013 (C)	4,821	0	4,821
2014 (C)	0	0	0
2015 (C)	0	0	0
Average (1989-2014)	39,412	0	39,412
Average (1989-2014) W	111,599	0	111,599
Average (1989-2014) AN	28,875	0	28,875
Average (1989-2014) BN	0	0	0
Average (1989-2014) D	244	0	244
Average (1989-2014) C	4,924	0	4,924

3.2.2.3 Infiltration of Precipitation

Estimated infiltration of precipitation (deep percolation of precipitation) by water use sector is provided in Figure A2.F.a-13 and Table A2.F.a-11. Infiltration of precipitation to the groundwater system is highly variable from year to year due to variation in the timing and amount of precipitation, ranging from over 4 taf on average during wet years to less than 2 taf annually during other year types.

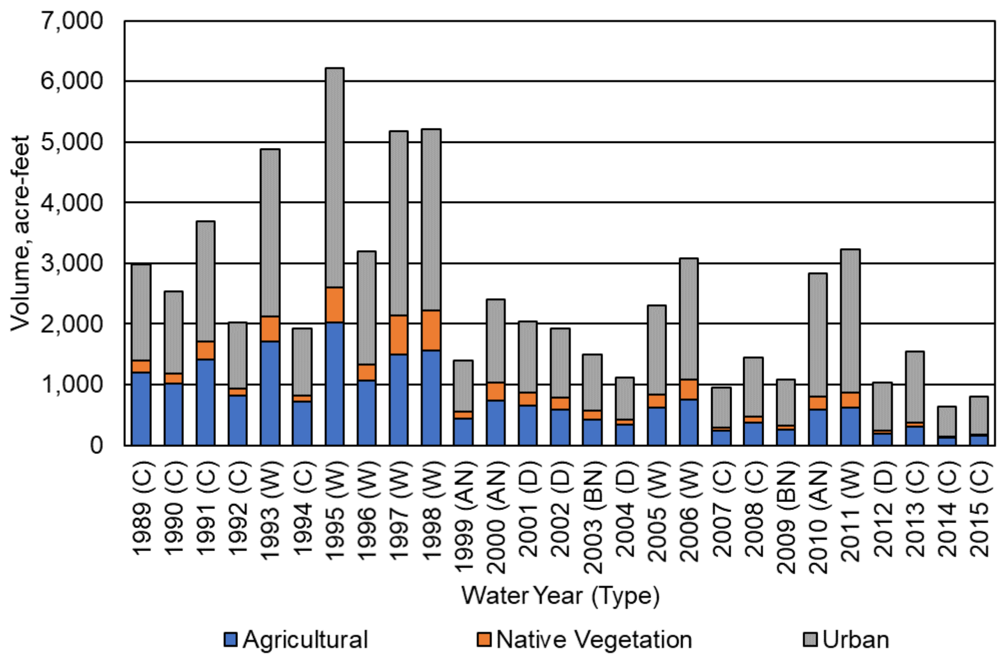

Figure A2.F.a-13. City of Madera GSA Infiltration of Precipitation by Water Use Sector.

Table A2.F.a-11. City of Madera GSA Infiltration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	1,194	202	1,581	2,977
1990 (C)	1,009	168	1,365	2,542
1991 (C)	1,420	283	1,992	3,695
1992 (C)	825	110	1,096	2,031
1993 (W)	1,713	403	2,771	4,887
1994 (C)	716	95	1,111	1,922
1995 (W)	2,018	578	3,617	6,213
1996 (W)	1,073	263	1,857	3,193
1997 (W)	1,492	651	3,026	5,169
1998 (W)	1,554	670	2,982	5,206
1999 (AN)	445	113	842	1,400
2000 (AN)	736	295	1,380	2,411
2001 (D)	651	225	1,158	2,034
2002 (D)	580	201	1,150	1,931
2003 (BN)	428	143	925	1,496
2004 (D)	337	92	695	1,124
2005 (W)	620	210	1,474	2,304
2006 (W)	755	335	1,998	3,088
2007 (C)	237	59	663	959
2008 (C)	366	109	968	1,443
2009 (BN)	265	57	768	1,090
2010 (AN)	581	228	2,017	2,826
2011 (W)	628	244	2,351	3,223
2012 (D)	194	42	798	1,034
2013 (C)	305	67	1,172	1,544
2014 (C)	125	14	497	636
2015 (C)	157	24	614	795
Average (1989-2014)	780	225	1,548	2,553
Average (1989-2014) W	1,232	419	2,510	4,160
Average (1989-2014) AN	587	212	1,413	2,212
Average (1989-2014) BN	347	100	847	1,293
Average (1989-2014) D	441	140	950	1,531
Average (1989-2014) C	689	123	1,161	1,972

3.2.2.4 Infiltration of Surface Water

Estimated infiltration of surface water (seepage) by source is provided in Figure A2.F.a-14 and Table A2.F.a-12. Seepage from the Rivers and Streams System includes seepage of both surface inflows and of precipitation runoff into local sloughs and depressions. Seepage from rivers and streams exhibits substantial variability over time, similar to the annual variability of surface water inflows.

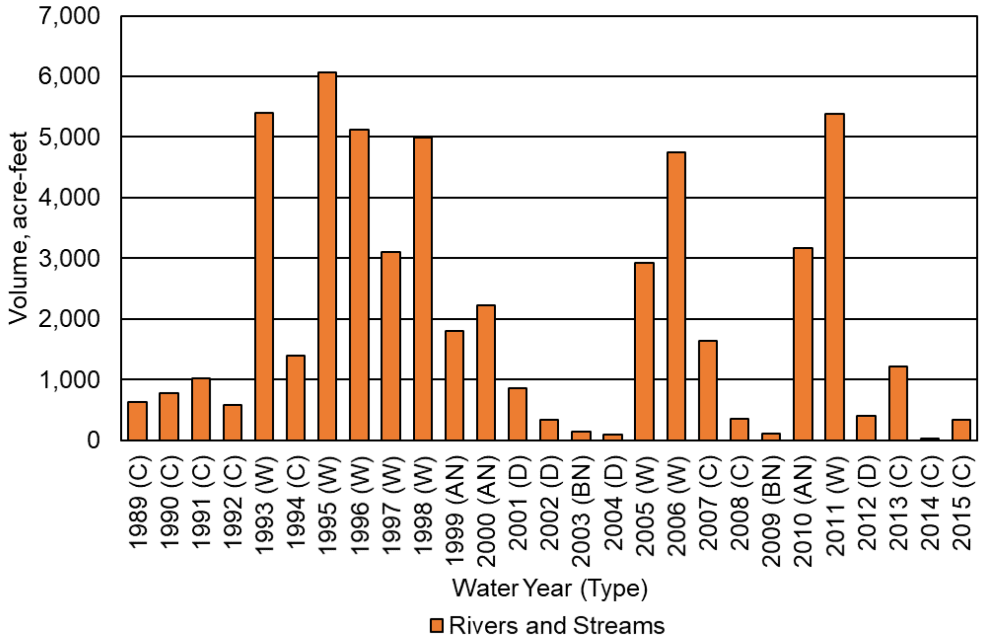

Figure A2.F.a-14. City of Madera GSA Infiltration of Surface Water.

Table A2.F.a-12. City of Madera GSA Infiltration of Surface Water (Acre-Feet).

Water Year (Type)	Rivers and Streams[1]
1989 (C)	628
1990 (C)	776
1991 (C)	1,026
1992 (C)	581
1993 (W)	5,392
1994 (C)	1,390
1995 (W)	6,061
1996 (W)	5,127
1997 (W)	3,101
1998 (W)	4,994
1999 (AN)	1,800
2000 (AN)	2,228
2001 (D)	858
2002 (D)	334
2003 (BN)	145
2004 (D)	89
2005 (W)	2,924
2006 (W)	4,742
2007 (C)	1,640
2008 (C)	361
2009 (BN)	109
2010 (AN)	3,170
2011 (W)	5,389
2012 (D)	402

Water Year (Type)	Rivers and Streams[1]
2013 (C)	1,219
2014 (C)	34
2015 (C)	340
Average (1989-2014)	2,097
Average (1989-2014) W	4,716
Average (1989-2014) AN	2,399
Average (1989-2014) BN	127
Average (1989-2014) D	421
Average (1989-2014) C	851

[1] Includes infiltration of surface inflows and of precipitation runoff.

3.2.2.5 Infiltration of Applied Water

Estimated infiltration of applied water (deep percolation of applied water) by water use sector is provided in Figure A2.F.a-15 and Table A2.F.a-13. Prior to the mid-2000s, infiltration of applied water was dominated by agricultural irrigation, which provided an average of approximately 1.9 taf per year to the groundwater system between 1989 and 2005. Since 2005, infiltration of applied water on urban lands has exceeded agricultural lands, averaging 1.5 taf per year between 2005 and 2014.

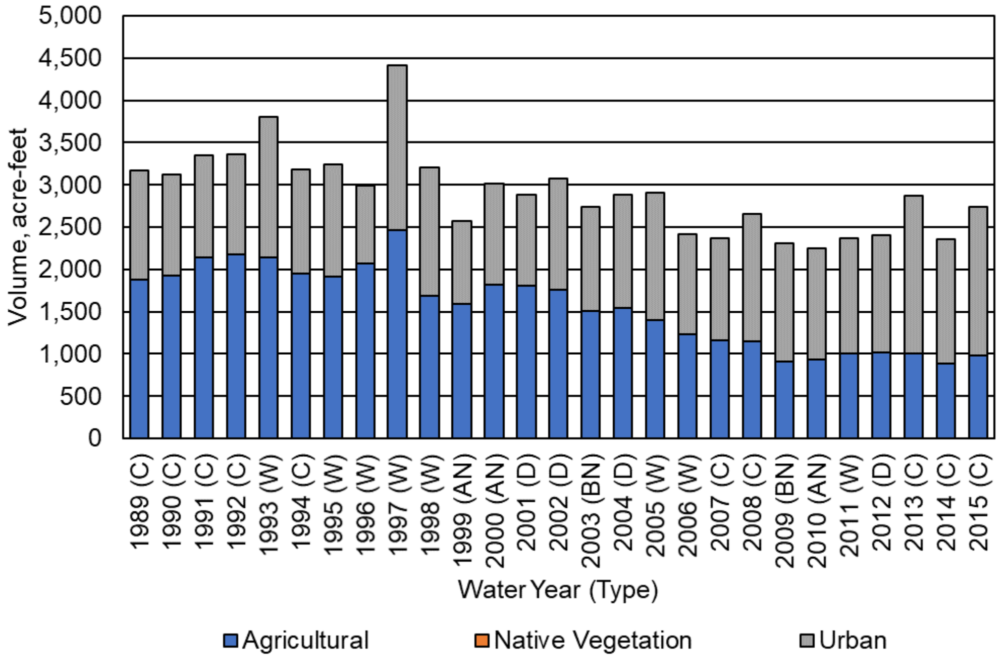

Figure A2.F.a-15. City of Madera GSA Infiltration of Applied Water by Water Use Sector.

Table A2.F.a-13. City of Madera GSA Infiltration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	1,875	0	1,292	3,167
1990 (C)	1,927	0	1,194	3,121
1991 (C)	2,137	0	1,210	3,347
1992 (C)	2,173	0	1,187	3,360
1993 (W)	2,142	0	1,659	3,801
1994 (C)	1,955	0	1,226	3,181
1995 (W)	1,915	0	1,322	3,237
1996 (W)	2,074	0	922	2,996
1997 (W)	2,461	0	1,955	4,416
1998 (W)	1,691	0	1,521	3,212
1999 (AN)	1,589	0	989	2,578
2000 (AN)	1,822	0	1,195	3,017
2001 (D)	1,802	0	1,078	2,880
2002 (D)	1,757	0	1,313	3,070
2003 (BN)	1,508	0	1,232	2,740
2004 (D)	1,548	0	1,331	2,879
2005 (W)	1,404	0	1,509	2,913
2006 (W)	1,238	0	1,180	2,418
2007 (C)	1,159	0	1,215	2,374
2008 (C)	1,143	0	1,515	2,658
2009 (BN)	904	0	1,407	2,311
2010 (AN)	928	0	1,317	2,245
2011 (W)	1,000	0	1,374	2,374
2012 (D)	1,020	0	1,383	2,403
2013 (C)	1,005	0	1,871	2,876
2014 (C)	883	0	1,469	2,352
2015 (C)	978	0	1,756	2,734
Average (1989-2014)	1,579	0	1,341	2,920
Average (1989-2014) W	1,741	0	1,430	3,171
Average (1989-2014) AN	1,446	0	1,167	2,613
Average (1989-2014) BN	1,206	0	1,320	2,526
Average (1989-2014) D	1,532	0	1,276	2,808
Average (1989-2014) C	1,584	0	1,353	2,937

3.2.3 Change in Surface Water System Storage

Estimates of change in SWS storage are provided in Figure A2.F.a-16 and Table A2.F.a-14. Inter-annual changes in storage within the surface water system consist primarily of root zone soil moisture storage changes, are relatively small, and tend to average near zero over many years.

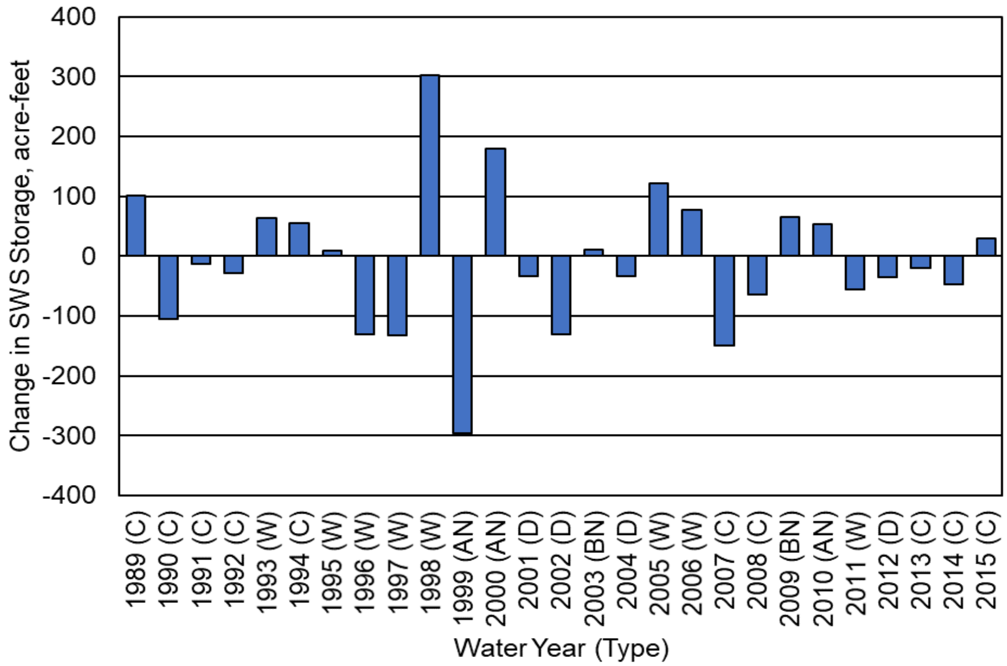

Figure A2.F.a-16. City of Madera GSA Change in Surface Water System Storage.

Table A2.F.a-14. City of Madera GSA Change in Surface Water System Storage (Acre-Feet).

Water Year (Type)	Change in SWS Storage
1989 (C)	101
1990 (C)	-106
1991 (C)	-13
1992 (C)	-29
1993 (W)	63
1994 (C)	55
1995 (W)	9
1996 (W)	-131
1997 (W)	-133
1998 (W)	303
1999 (AN)	-296
2000 (AN)	179
2001 (D)	-34
2002 (D)	-131
2003 (BN)	10
2004 (D)	-34
2005 (W)	122
2006 (W)	78
2007 (C)	-150
2008 (C)	-65
2009 (BN)	66
2010 (AN)	53
2011 (W)	-55
2012 (D)	-35

Water Year (Type)	Change in SWS Storage
2013 (C)	-20
2014 (C)	-48
2015 (C)	29
Average (1989-2014)	-9
Average (1989-2014) W	32
Average (1989-2014) AN	-21
Average (1989-2014) BN	38
Average (1989-2014) D	-59
Average (1989-2014) C	-31

3.3 Historical Water Budget Summary

Annual inflows, outflows, and change in SWS storage during the historical water budget period (1989-2014) are summarized in Figure A2.F.a-17 and Table A2.F.a-15. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values. Review of the variability in component volumes across years provides insight into the impacts of hydrology on the surface water system water budget.

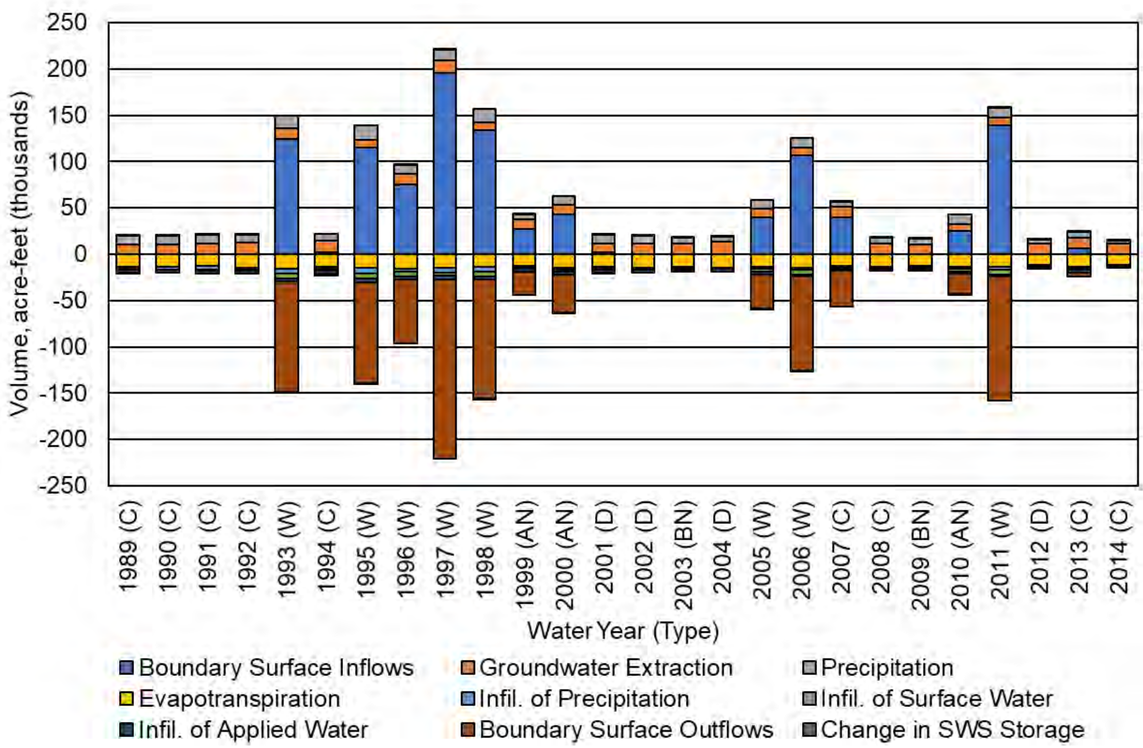

Figure A2.F.a-17. City of Madera GSA Surface Water System Historical Water Budget, 1989-2014.

Table A2.F.a-15. City of Madera GSA Surface Water System Historical Water Budget, 1989-2014 (Acre-Feet).

Water Year (Type)	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Evapo-transpiration[1]	Infil. of Precipitation	Infil. of Surface Water	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	0	9,982	10,073	-13,192	-2,977	-628	-3,167	10	-101
1990 (C)	0	10,733	9,393	-13,802	-2,542	-776	-3,121	9	106
1991 (C)	0	10,929	9,810	-12,693	-3,695	-1,026	-3,347	9	13
1992 (C)	0	12,933	8,018	-15,012	-2,031	-581	-3,360	4	29
1993 (W)	124,660	10,858	13,584	-15,673	-4,887	-5,392	-3,801	-119,286	-63
1994 (C)	2,520	11,774	7,698	-14,109	-1,922	-1,390	-3,181	-1,334	-55
1995 (W)	115,059	8,013	16,524	-14,401	-6,213	-6,061	-3,237	-109,676	-9
1996 (W)	75,230	11,228	10,097	-15,675	-3,193	-5,127	-2,996	-69,695	131
1997 (W)	195,455	13,822	11,541	-14,926	-5,169	-3,101	-4,416	-193,339	133
1998 (W)	134,172	8,523	13,874	-13,871	-5,206	-4,994	-3,212	-128,982	-303
1999 (AN)	26,759	10,815	5,625	-12,917	-1,400	-1,800	-2,578	-24,801	296
2000 (AN)	42,375	11,026	9,172	-14,326	-2,411	-2,228	-3,017	-40,412	-179
2001 (D)	1,514	10,449	8,555	-13,805	-2,034	-858	-2,880	-975	34
2002 (D)	0	11,727	7,765	-14,296	-1,931	-334	-3,070	8	131
2003 (BN)	0	11,173	6,822	-13,608	-1,496	-145	-2,740	4	-10
2004 (D)	0	13,284	5,668	-14,895	-1,124	-89	-2,879	1	34
2005 (W)	39,960	9,178	9,779	-13,880	-2,304	-2,924	-2,913	-36,774	-122
2006 (W)	106,267	8,828	10,769	-14,219	-3,088	-4,742	-2,418	-101,319	-78
2007 (C)	39,896	11,733	4,360	-13,007	-959	-1,640	-2,374	-38,159	150
2008 (C)	0	11,504	6,630	-13,737	-1,443	-361	-2,658	0	65
2009 (BN)	0	10,653	5,988	-13,067	-1,090	-109	-2,311	2	-66
2010 (AN)	25,241	7,429	10,282	-13,245	-2,826	-3,170	-2,245	-21,412	-53
2011 (W)	139,506	7,970	10,763	-13,585	-3,223	-5,389	-2,374	-133,723	55
2012 (D)	365	11,482	3,664	-11,709	-1,034	-402	-2,403	2	35
2013 (C)	6,222	11,822	6,189	-13,793	-1,544	-1,219	-2,876	-4,821	20
2014 (C)	0	11,698	3,024	-11,748	-636	-34	-2,352	0	48
Average (1989-2014)	41,354	10,753	8,680	-13,815	-2,553	-2,097	-2,920	-39,410	9
Average (1989-2014) W	116,289	9,803	12,116	-14,529	-4,160	-4,716	-3,171	-111,599	-32
Average (1989-2014) AN	31,458	9,757	8,360	-13,496	-2,212	-2,399	-2,613	-28,875	21
Average (1989-2014) BN	0	10,913	6,405	-13,337	-1,293	-127	-2,526	3	-38
Average (1989-2014) D	470	11,736	6,413	-13,676	-1,531	-421	-2,808	-241	59
Average (1989-2014) C	5,404	11,456	7,244	-13,455	-1,972	-851	-2,937	-4,920	31

[1]Includes ET of applied water, ET of precipitation, and evaporation from rivers and streams .

3.4 Current Water Budget Summary

The current water budget was developed following a similar process to the historical water budget using the 2015 land use in Table A2.F.a-1 and the same 1989-2014 average hydrologic conditions of the historical base period, including surface water flows, precipitation, and weather parameters. This allowed quantification of groundwater inflows and outflows for current consumptive use in the context of average water supply conditions.

Annual inflows, outflows, and change in SWS storage from the current water budget are summarized in Figure A2.F.a-18 and Table A2.F.a-16. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values.

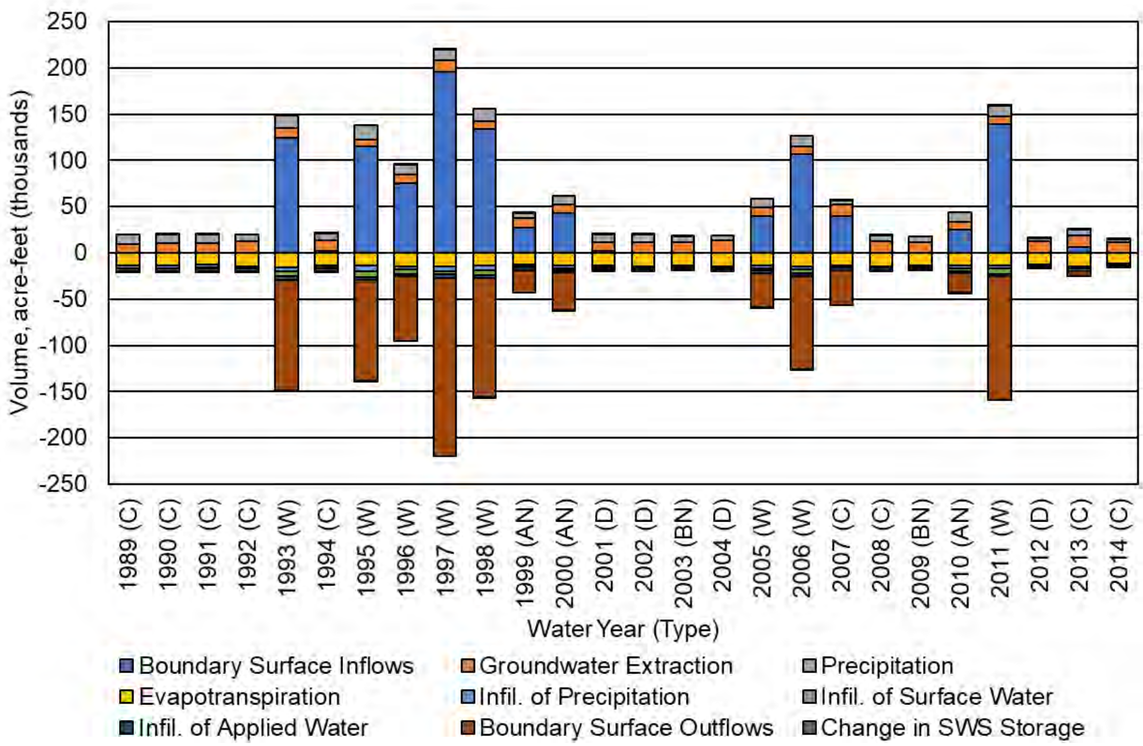

Figure A2.F.a-18. City of Madera GSA Surface Water System Current Water Budget, 1989-2014.

Table A2.F.a-16. City of Madera GSA Surface Water System Current Water Budget, 1989-2014 (Acre-Feet).

Water Year (Type)	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Evapo-transpiration[1]	Infil. of Precipitation	Infil. of Surface Water	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	0	9,840	10,072	-13,483	-2,873	-373	-2,975	-109	-99
1990 (C)	0	10,355	9,390	-13,990	-2,436	-557	-2,767	-88	93
1991 (C)	0	9,940	9,811	-12,535	-3,539	-823	-2,845	-73	64
1992 (C)	0	12,070	8,018	-14,873	-1,914	-453	-2,698	-49	-100
1993 (W)	124,660	9,965	13,584	-15,426	-4,779	-5,334	-3,407	-119,219	-45
1994 (C)	2,520	10,996	7,697	-14,044	-1,848	-1,286	-2,672	-1,376	12
1995 (W)	115,059	6,927	16,523	-13,984	-6,092	-6,035	-2,775	-109,594	-30
1996 (W)	75,230	9,424	10,098	-14,796	-3,102	-5,120	-2,182	-69,675	123
1997 (W)	195,455	13,127	11,538	-14,683	-5,134	-3,099	-3,918	-193,343	58
1998 (W)	134,172	8,008	13,871	-13,729	-5,101	-4,977	-3,097	-128,967	-180
1999 (AN)	26,759	10,643	5,626	-12,919	-1,424	-1,793	-2,296	-24,802	205
2000 (AN)	42,375	10,311	9,171	-13,996	-2,385	-2,228	-2,654	-40,490	-105
2001 (D)	1,514	9,779	8,556	-13,521	-2,023	-858	-2,470	-1,020	42
2002 (D)	0	11,547	7,765	-14,260	-1,950	-334	-2,781	-34	48
2003 (BN)	0	11,110	6,822	-13,727	-1,521	-145	-2,567	-13	41
2004 (D)	0	13,501	5,668	-15,218	-1,135	-90	-2,689	-6	-31
2005 (W)	39,960	9,206	9,778	-14,016	-2,321	-2,924	-2,849	-36,796	-37
2006 (W)	106,267	9,031	10,771	-14,511	-3,058	-4,742	-2,374	-101,333	-52
2007 (C)	39,896	12,501	4,362	-13,654	-978	-1,635	-2,376	-38,160	44
2008 (C)	0	12,313	6,628	-14,470	-1,442	-359	-2,718	-3	52
2009 (BN)	0	11,852	5,988	-14,112	-1,103	-91	-2,508	-6	-20
2010 (AN)	25,241	7,953	10,283	-13,772	-2,808	-3,159	-2,315	-21,413	-10
2011 (W)	139,506	8,482	10,763	-14,079	-3,205	-5,382	-2,429	-133,717	62
2012 (D)	365	12,022	3,663	-12,207	-1,030	-395	-2,424	-1	7
2013 (C)	6,222	12,271	6,190	-14,202	-1,537	-1,210	-2,927	-4,825	17
2014 (C)	0	11,935	3,023	-11,947	-636	-30	-2,393	-1	49
Average (1989-2014)	41,354	10,581	8,679	-13,929	-2,514	-2,055	-2,696	-39,427	8
Average (1989-2014) W	116,289	9,271	12,116	-14,403	-4,099	-4,702	-2,879	-111,580	-13
Average (1989-2014) AN	31,458	9,636	8,360	-13,563	-2,206	-2,393	-2,421	-28,901	30
Average (1989-2014) BN	0	11,481	6,405	-13,919	-1,312	-118	-2,538	-10	11
Average (1989-2014) D	470	11,712	6,413	-13,802	-1,535	-419	-2,591	-265	16
Average (1989-2014) C	5,404	11,358	7,244	-13,689	-1,911	-747	-2,708	-4,965	15

[1]Includes ET of applied water, ET of precipitation, and evaporation from rivers and streams.

3.5 Net Recharge from SWS

Overdraft is defined in DWR Bulletin 118 as "the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions" (DWR 2003). The Madera Subbasin water budget indicates that overdraft conditions occurred during the 1989-2014 historical base period. Per 23 CCR Section 354.18(b)(5), the subbasin overdraft has been quantified for this base period. The evaluation of overdraft conditions includes estimates of recharge from subsurface flows. However, estimates of recharge from subsurface flows are less accurate when estimated for areas less than an entire subbasin. Thus, for estimates of GSA level contribution to overdraft, the term net recharge from the SWS, is defined as groundwater recharge minus groundwater extraction. Net recharge from the SWS is useful for understanding and analyzing the combined effects of land surface processes on the underlying GWS.

When calculated from the historical water budget, average net recharge from the SWS represents the average recharge (when positive) or shortage of recharge (when negative) based on historical cropping, land use practices, and average hydrologic conditions. When calculated from the current land use water budget, average net recharge represents the average recharge or shortage (negative net recharge) based on current cropping, land use practices, and average hydrologic conditions.

Average net recharge from the SWS is presented below for the CM GSA portion of the Madera Subbasin. Table 17 shows the average net recharge from the SWS for 1989-2014 based on the historical water budget, and Table 18 shows the same for the current water budget. Under both historical and current land use conditions, average annual net recharge from CM GSA is approximately -3 taf, indicating that groundwater extraction exceeds recharge from the surface water system.

The Madera County (MC) GSA recognizes that groundwater users within its boundaries want to understand potential future limitations on groundwater resources available to meet their beneficial uses. As shown in both Table A2.F.a-17 and Table A2.F.a-18, average values for infiltration of precipitation and infiltration of surface water are provided (columns "b" and "c"). The slight variation between the tables reflects the modified land use conditions. Together, these values represent the sustainable native groundwater for the MC GSA, a value of about 90,000 acre-feet per year.

While the MC GSA has not determined whether an allocation approach, or other methods, will best allow the MC GSA to achieve needed reductions in the consumptive use of groundwater (see GSP Chapter 4). However, the MC GSA recognizes the correlative nature of overlying groundwater rights, which, when coupled with appropriated groundwater use, provides that all the users share in the sustainable quantity of native groundwater. For purposes of analyzing the availability of sustainable quantities of native groundwater for all lands within the GSA, the estimated total quantity of sustainable native groundwater – estimated at 90,000 acre-feet per year – can be calculated to be approximately 0.5 acre-feet per acre within the GSA (based upon estimates of about 90,000 acre-feet of total sustainable native groundwater available for about 185,000 acres within the MC GSA). The achievement of sustainability may or may not involve an equal allocation across the MC GSA, and the MC GSA will use its SGMA-granted authority to manage the basin so as to achieve this end. Furthermore, other GSAs within the Madera Subbasin may choose to manage their proportion of the estimated sustainable native groundwater differently than the MC GSA, but they are also subject to the overall subbasin sustainability requirements.

Table A2.F.a-17. Historical Water Budget: Average Net Recharge from SWS by Water Year Type, 1989-2014 (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	3,171	4,160	4,716	9,803	2,245
AN	3	2,613	2,212	2,399	9,757	-2,532
BN	2	2,526	1,293	127	10,913	-6,967
D	4	2,808	1,531	421	11,736	-6,976
C	9	2,937	1,972	851	11,456	-5,696
Annual Average (1989-2014)	26	2,920	2,553	2,097	10,753	-3,182

Table A2.F.a-18. Current Water Budget: Average Net Recharge from SWS by Water Year Type (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	2,879	4,099	4,702	9,271	2,408
AN	3	2,421	2,206	2,393	9,636	-2,615
BN	2	2,538	1,312	118	11,481	-7,513
D	4	2,591	1,535	419	11,712	-7,167
C	9	2,708	1,911	747	11,358	-5,991
Annual Average (1989-2014)	26	2,696	2,514	2,055	10,581	-3,315

3.6 Uncertainties in Water Budget Components

Uncertainties associated with each water budget component were estimated as a percentage representing approximately a 95% confidence interval following the procedure described by Clemmens and Burt (1997). Uncertainties for all independently measured or estimated water budget components were estimated based on the measurement accuracy, typical values reported in technical literature, typical values calculated in other water budgets, and professional judgement.

Table A2.F.a-19 provides a summary of typical uncertainty values associated with major SWS inflow and outflow components. These uncertainties provide a basis for evaluating confidence in water budget results and help to identify data needs that may be addressed during GSP implementation.

Table A2.F.a-19. Estimated Uncertainty of GSA Water Budget Components.

Flowpath Direction (SWS Boundary)	Water Budget Component	Data Source	Estimated Uncertainty (%)	Source
Inflows	Surface Water Inflows	Calculation	20%	Estimated streamflow measurement accuracy and adjustment for losses.
	Precipitation	Calculation	30%	Clemmens, A.J. and C.M. Burt, 1997.
	Groundwater Extraction	Closure	20%	Typical uncertainty calculated for Land Surface System water balance closure.
Outflows	Surface Water Outflows	Closure	20%	Typical uncertainty calculated for Rivers and Streams System water balance closure.
	Evaporation	Calculation	20%	Estimated accuracy of calculation based on CIMIS reference ET and free water surface evaporation coefficient.
	ET of Applied Water	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, estimated crop coefficients from SEBAL energy balance, and annual land use.
	ET of Precipitation	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, precipitation, estimated crop coefficients from SEBAL energy balance, and annual land use.
	Infiltration of Applied Water	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use and NRCS soils characteristics.
	Infiltration of Precipitation	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use, NRCS soils characteristics, and CIMIS precipitation.
	Infiltration of Surface Water	Calculation	15%	Estimated accuracy of daily seepage calculation using NRCS soils characteristics and measured streamflow data.
	Change in SWS Storage	Calculation	50%	Professional Judgment.
Net Recharge from SWS		Calculation	25%	Estimated water budget accuracy; typical value calculated for GSA-level net recharge from SWS.

APPENDIX 2.F. WATER BUDGET INFORMATION

2.F.b. Surface Water System Water Budget: Madera County GSA

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

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1 INTRODUCTION

To ensure sustainable groundwater management throughout California's groundwater basins, the Sustainable Groundwater Management Act of 2014 (SGMA) requires Groundwater Sustainability Agencies (GSAs) to prepare and adopt Groundwater Sustainability Plans (GSPs) with strategies to achieve subbasin groundwater sustainability within 20 years of plan adoption. Integral to each GSP is a water budget used to quantify the subbasin's groundwater overdraft (if applicable) and sustainable yield.

In 2017, Madera County (MC) GSA formed to manage approximately 178,000 acres of the Madera Subbasin. This document presents results of the surface water system (SWS) water budgets developed for historical and current land use conditions in MC GSA. The MC GSA water budgets were integrated with separate water budgets developed for the other six (6) GSAs in Madera Subbasin to prepare a boundary water budget for the Madera Subbasin SWS. Results of the subbasin boundary water budget are reported in the Madera Subbasin GSP Section 2.2.3 and were integrated with a subbasin groundwater model (GSP Appendix 6.D) to estimate subbasin sustainable yield (GSP Section 2.2.3).

2 WATER BUDGET CONCEPTUAL MODEL

A water budget is defined as a complete accounting of all water flowing into and out of a defined volume (e.g., a subbasin or a GSA) over a specified period of time. The conceptual model (or structure) of the MC GSA water budget developed for this investigation is consistent with the GSP Regulations defined under Title 23 of California Code of Regulations[1] (CCR) and adheres to sound water budget principles and practices defined by California Department of Water Resources (DWR) in the Water Budget Best Management Practice (BMP) guidelines (DWR, 2016).

The lateral extent of MC GSA is defined by the boundaries indicated in Figure A2.F.b-1. The vertical extent of MC GSA is the land surface (top) and the base of fresh water at the bottom of the basin (bottom), as described in the hydrogeologic conceptual model (HCM) developed in GSP Section 2.2.1. The vertical extent of Madera Subbasin and its GSAs is subdivided into a surface water system (SWS) and the underlying groundwater system (GWS), with separate but related water budgets prepared for each that together represent the overall subbasin water budget.

A conceptual representation of the MC GSA water budget is represented in Figure A2.F.b-2. This document details only the SWS portion of the MC GSA water budget. The SWS is divided into two primary accounting centers: the Land Surface System and the Rivers and Streams System. The Land Surface System is further divided into three accounting centers representing MC GSA's water use sectors: Agricultural Land, Native Vegetation Land, and Urban Land (urban, industrial, and semi-agricultural).

Water budget components, or directional flow of water between accounting centers and across the SWS boundary, are indicated by arrows. Inflows and outflows were calculated using measurements and other historical data or were calculated as the water budget closure term – the difference between all other estimated or measured inflows and outflows from each accounting center or water use sector (bold arrows).

[1] California Code of Regulations Title 23. Waters, Division 2. Department of Water Resources, Chapter 1.5. Groundwater Management, Subchapter 2. Groundwater Sustainability Plans.

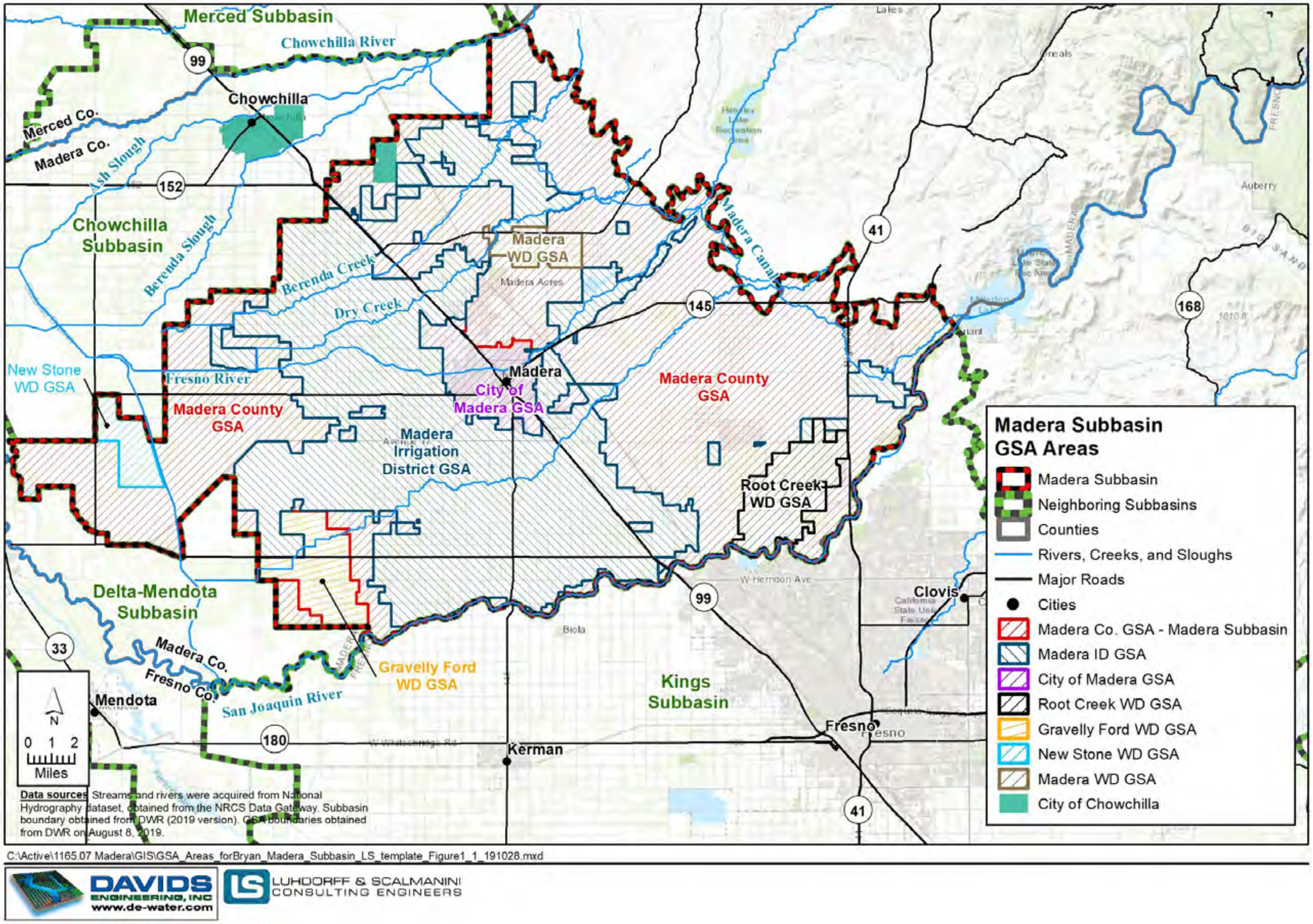

Figure A2.F.b-1. Madera Subbasin GSAs Map.

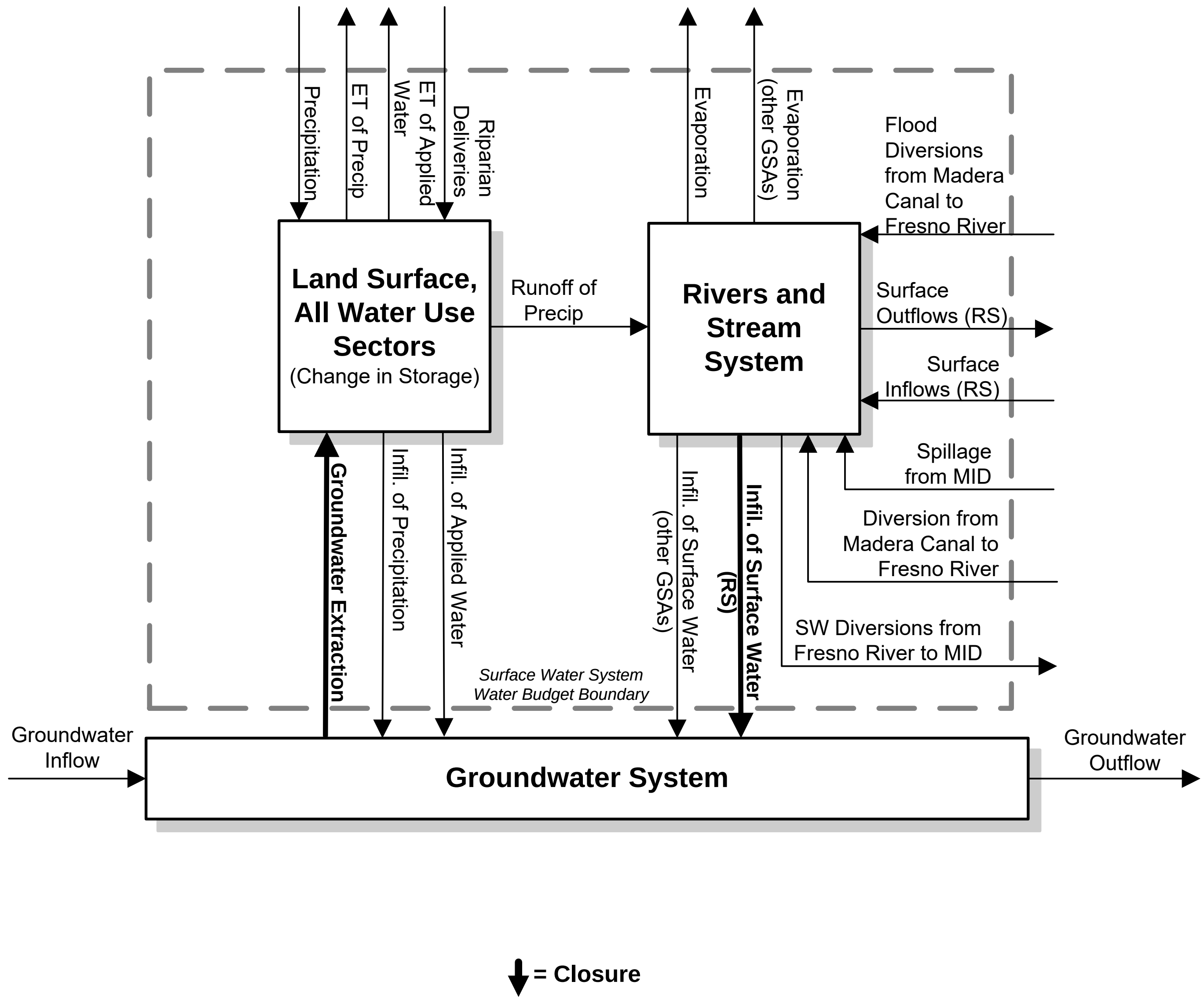

Figure A2.F.b-2. Madera County GSA Water Budget Structure.

Inflows to the SWS include precipitation, surface water inflows (in various canals and streams), and groundwater extraction. Outflows from the SWS include evapotranspiration (ET), surface water outflows (in various canals and streams), and infiltration to the groundwater system (seepage and deep percolation). Also represented in Figure A2.F.b-2 are inflows and outflows from the GWS, which are discussed and quantified at the subbasin level in the GWS water budget in GSP Section 2.2.3. Subsurface GWS inflows and outflows are not quantified on the water budget subregion scale.

Inflows and outflows were quantified following the process described in GSP Section 2.2.3 on a monthly time step for water years in the historical water budget base period (1989-2014 hydrologic and land use conditions), the current water budget (2015 land use using 1989-2014 average hydrologic conditions), and projected water budget. Four projected water budgets were prepared for the years 2019 through 2090 based on 1965 through 2015 hydrologic conditions:

1. Historical hydrologic conditions
    a. Without projects and management actions, and
    b. With projects and management actions
2. Historical hydrologic conditions adjusted for anticipated climate change per DWR-provided 2030 climate change factors
    a. Without projects and management actions, and
    b. With projects and management actions.

3 WATER BUDGET ANALYSIS

The historical water budget and current land use water budget for MC GSA are presented below following a summary of land use data relevant to water budget development. Land use data is provided for the 1989-2014 historical water budget period and for 2015, the current land use water budget period.

3.1 Land Use

Land use estimates for 1989 through 2015 corresponding to water use sectors are summarized in Figure A2.F.b-3 and Table A2.F.b-1 for MC GSA. According to GSP Regulations (23 CCR § 351(al)):

> *"Water use sector" refers to 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.*

In MC GSA, water use sectors include agricultural, native vegetation, and urban land use. The urban land use category includes urban and semi-agricultural[2] lands as well as industrial land, which covers only a small area in the subbasin.

As indicated, agricultural lands have remained relatively steady since 1989, covering approximately 80,000 acres, on average, during the 1989 through 2014 historical base period. Native vegetation remained similarly constant between 1989 and 2012 followed by a slight decrease through 2015 that coincided with slight increases in agricultural and urban areas. Native vegetation covered approximately 78,000 acres on average between 1989 and 2014. Urban lands have historically represented a much smaller portion of the subbasin, averaging only approximately 18,000 acres during the same historical base period. However,

[2] As defined in the DWR county land use surveys, semi-agricultural land use subclasses include farmsteads, livestock feed lot operations, dairies, poultry farms, and miscellaneous semi-agricultural land use incidental to agriculture (small roads, ditches, non-planted areas of cropped fields (DWR, 2009).

urban areas have increased from approximately 15,000 acres in the early 1990s to over 20,000 acres in recent years. This is due in part to urban encroachment and changes in DWR's delineation of urban and semi-agricultural lands in land use surveys over time.

Agricultural land uses are further detailed in Figure A2.F.b-4 and Table A2.F.b-2. Most notable is orchard acreage, which has more than doubled between 1989 and 2015, with corresponding decreases in miscellaneous field crops, pasture and alfalfa, and idle land.

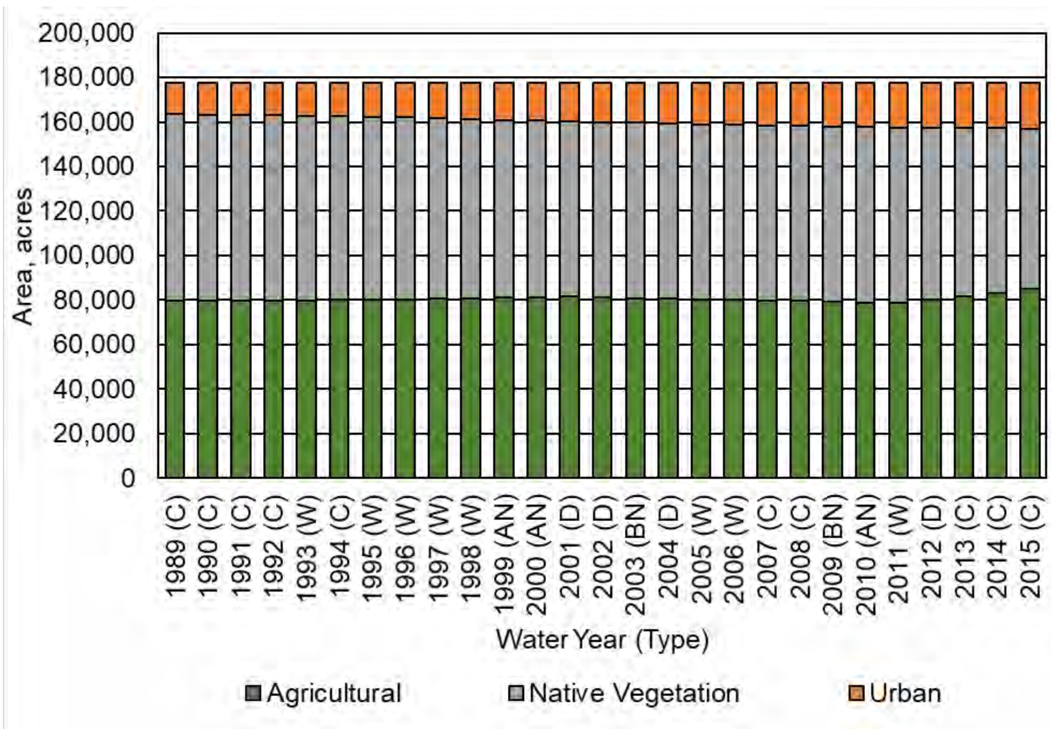

Figure A2.F.b-3. Madera County GSA Land Use Areas.

Table A2.F.b-1. Madera County GSA Land Use Areas (Acres).

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
1989 (C)	79,728	83,756	14,332	177,816
1990 (C)	79,807	83,489	14,520	177,816
1991 (C)	79,786	83,328	14,702	177,816
1992 (C)	79,862	83,071	14,883	177,816
1993 (W)	79,891	82,852	15,072	177,816
1994 (C)	79,977	82,567	15,272	177,816
1995 (W)	80,144	82,179	15,493	177,816
1996 (W)	80,356	81,609	15,851	177,816
1997 (W)	80,573	81,034	16,209	177,816
1998 (W)	80,786	80,464	16,566	177,816
1999 (AN)	81,002	79,891	16,923	177,816
2000 (AN)	81,215	79,320	17,281	177,816

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
2001 (D)	81,432	78,745	17,639	177,816
2002 (D)	81,157	78,737	17,922	177,816
2003 (BN)	80,883	78,728	18,205	177,816
2004 (D)	80,608	78,720	18,488	177,816
2005 (W)	80,333	78,710	18,772	177,816
2006 (W)	80,059	78,702	19,056	177,816
2007 (C)	79,784	78,693	19,339	177,816
2008 (C)	79,510	78,683	19,622	177,816
2009 (BN)	79,235	78,675	19,906	177,816
2010 (AN)	78,960	78,665	20,190	177,816
2011 (W)	78,686	78,657	20,473	177,816
2012 (D)	80,192	77,133	20,491	177,816
2013 (C)	81,701	75,605	20,510	177,816
2014 (C)	83,208	74,080	20,528	177,816
2015 (C)	84,869	72,190	20,757	177,816
Average (1989-2014)	80,341	79,850	17,625	177,816

[1] Area includes land classified as native vegetation and water surfaces.

[2] Area includes land classified as urban, industrial, and semi-agricultural.

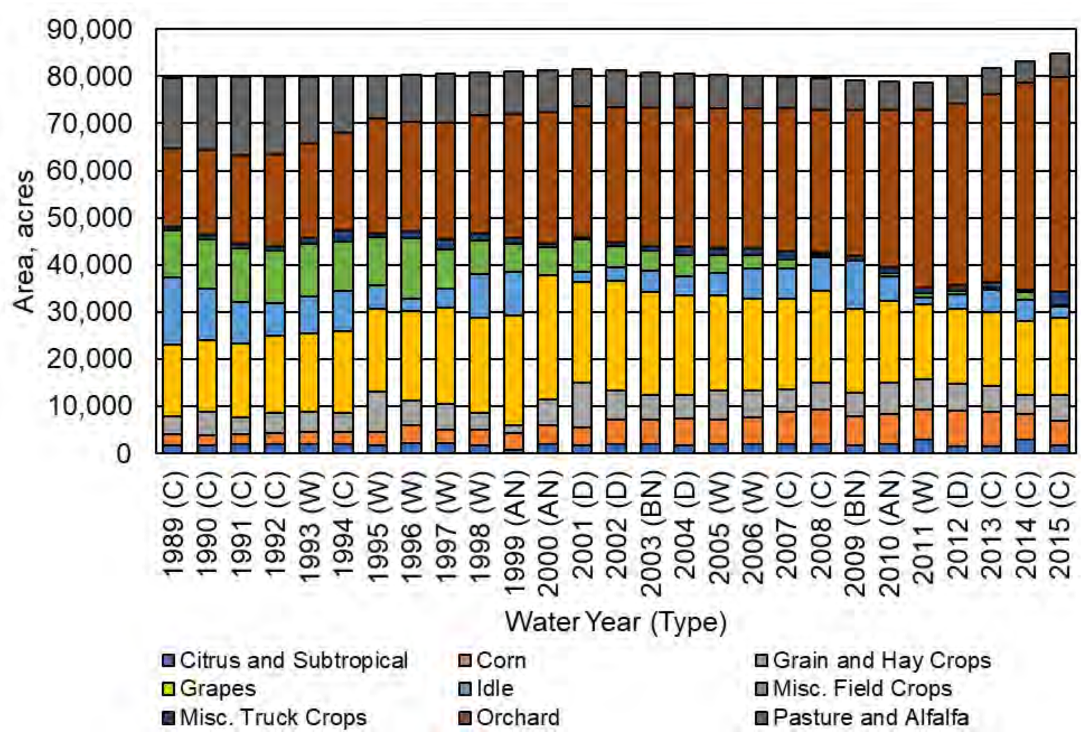

Figure A2.F.b-4. Madera County GSA Agricultural Land Use Areas.

Table A2.F.b-2. Madera County GSA Agricultural Land Use Areas

Water Year (Type)	Citrus and Subtropical	Corn	Grain and Hay Crops	Grapes	Idle	Misc. Field Crops	Misc. Truck Crops	Orchard	Pasture and Alfalfa	Total
1989 (C)	1,646	2,532	3,782	15,246	14,068	10,090	568	16,789	15,005	79,807
1990 (C)	1,699	2,270	4,811	15,337	10,866	10,553	945	18,005	15,322	79,786
1991 (C)	1,891	2,165	3,605	15,692	8,699	11,526	905	18,820	16,483	79,862
1992 (C)	1,890	2,408	4,252	16,351	6,994	11,069	1,067	19,438	16,393	79,891
1993 (W)	1,935	2,594	4,236	16,627	7,892	11,109	1,300	20,062	14,135	79,977
1994 (C)	2,000	2,549	3,962	17,407	8,678	10,465	2,345	20,615	11,956	80,144
1995 (W)	1,781	2,794	8,490	17,639	5,016	10,147	704	24,579	8,994	80,356
1996 (W)	2,137	3,965	5,050	18,950	2,744	12,814	1,382	23,326	9,989	80,573
1997 (W)	2,182	2,871	5,444	20,413	4,063	8,415	2,061	24,614	10,509	80,786
1998 (W)	1,692	3,405	3,472	20,244	9,260	6,997	1,456	25,188	9,072	81,002
1999 (AN)	695	3,634	1,665	23,168	9,473	5,863	1,210	26,316	8,977	81,215
2000 (AN)	2,011	3,965	5,586	26,143	210	5,896	608	28,112	8,686	81,432
2001 (D)	1,675	3,827	9,496	21,468	2,155	6,699	598	27,679	7,835	81,157
2002 (D)	1,976	5,136	6,175	23,313	2,997	4,282	788	28,855	7,635	80,883
2003 (BN)	1,861	5,443	5,009	21,884	4,555	4,227	965	29,504	7,436	80,608
2004 (D)	1,767	5,572	5,099	21,043	4,114	4,589	1,555	29,635	7,236	80,333
2005 (W)	2,028	5,189	6,226	20,219	4,718	3,832	1,302	29,783	7,036	80,059
2006 (W)	1,934	5,732	5,776	19,309	6,585	2,678	1,620	29,588	6,836	79,784
2007 (C)	2,059	6,709	4,842	19,271	6,448	1,747	1,661	30,410	6,637	79,510
2008 (C)	1,964	7,374	5,759	19,499	7,020	431	584	30,442	6,437	79,235
2009 (BN)	1,770	6,087	4,972	17,950	10,073	53	1,041	31,051	6,237	78,960
2010 (AN)	1,874	6,518	6,613	17,396	5,283	603	1,106	33,530	6,038	78,686
2011 (W)	2,852	6,551	6,402	15,819	1,360	1,135	1,151	37,578	5,838	80,192
2012 (D)	1,590	7,507	5,788	15,769	3,036	844	1,140	38,405	6,111	81,701
2013 (C)	1,431	7,316	5,554	15,719	4,796	331	1,242	40,004	5,307	83,208
2014 (C)	2,932	5,417	3,997	15,670	4,606	1,692	472	43,803	4,619	84,869
2015 (C)	1,632	5,368	5,410	16,417	2,420	53	3,061	45,422	5,087	80,341
Average (1989-2014)	1,895	4,597	5,233	18,752	5,989	5,696	1,145	27,928	9,106	79,807

3.2 Surface Water System Water Budget

This section presents surface water system water budget components within MC GSA as per GSP regulations. These are followed by a summary of the water budget results by accounting center.

3.2.1 Inflows

3.2.1.1 Surface Water Inflow by Water Source Type

Surface water inflows include surface water flowing into the basin across the basin boundary. Per the Regulations, surface inflows 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.*

Additionally, runoff of precipitation from upgradient areas adjacent to the subregion represents a potential source of surface water inflow.

Local Supplies

Surface water inflows to MC GSA include local supplies along Berenda Creek, Dry Creek, Cottonwood Creek, Chowchilla Bypass, and riparian diversions from the San Joaquin and Fresno Rivers.

Local Imported Supplies

MC GSA does not receive local imported supplies for irrigation purposes. These supplies are not used by MC GSA, but are included as inflow and outflow in the water budgets (Table A2.F.b-3 and A2.F.b-10).

CVP Supplies

MC GSA has a contract with USBR for 200 AF of CVP supplies. Additionally, significant quantities of CVP supplies are released from Hidden Dam or diverted from Madera Canal into Fresno River and pass through MC GSA before being diverted to MID. These supplies are not used by MC GSA, but are included as inflow and outflow in the water budgets (Table A2.F.b-3 and A2.F.b-10).

Recycling and Reuse

Recycling and reuse are not a significant source of supply within MC GSA.

Other Surface Inflows

For the water budgets presented herein, precipitation runoff from outside the subregion is considered relatively minimal and is expected to pass through the waterways accounted above following relatively large storm events. Precipitation runoff from lands inside the subregion is internal to the surface water system and is thus not considered as surface inflows to the subregion boundary.

Only spillage from the MID conveyance system are included as other surface inflows.

Summary of Surface Inflows

The surface water inflows described above are summarized by water source type in Figure A2.F.b-5 and Table A2.F.b-3. During the study period, surface water supplies vary greatly with water year type, with substantial local supply inflows during wet years that are reduced in above normal years and remain relatively constant during all other year types. Total surface water inflows range from approximately 53 taf during average critical years to 846 taf during average wet years.

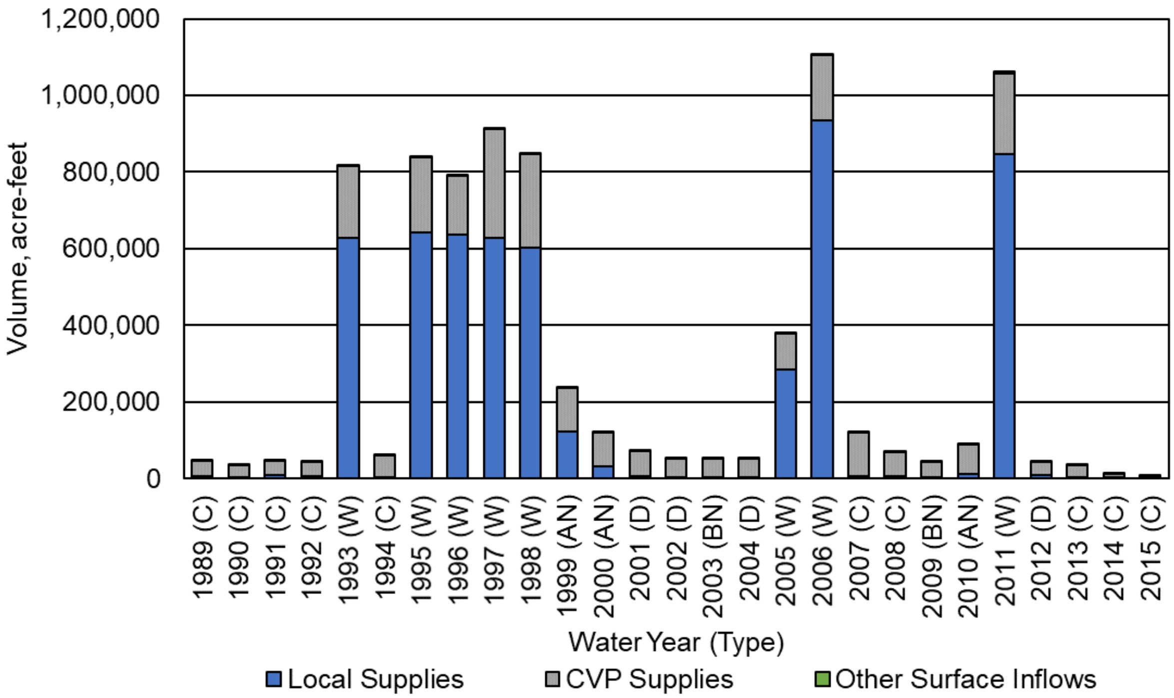

Figure A2.F.b-5. Madera County GSA Surface Water Inflows by Water Source Type.

Table A2.F.b-3. Madera County GSA Surface Water Inflows by Water Source Type (Acre-Feet)*.

Water Year (Type)	Local Supply	CVP Supply[1]	Other Surface Inflows	Total
1989 (C)	7,343	39,589	1,321	48,253
1990 (C)	2,331	31,501	1,168	35,000
1991 (C)	8,791	36,429	1,509	46,729
1992 (C)	5,222	38,514	1,321	45,057
1993 (W)	629,214	184,855	1,937	816,007
1994 (C)	2,106	57,604	1,734	61,444
1995 (W)	642,257	196,616	2,111	840,985
1996 (W)	635,211	155,611	2,336	793,158
1997 (W)	627,196	284,512	2,070	913,778
1998 (W)	602,712	243,716	2,070	848,497
1999 (AN)	123,541	111,324	2,173	237,038
2000 (AN)	32,503	88,744	1,880	123,126
2001 (D)	5,234	65,144	1,869	72,246
2002 (D)	4,313	48,809	1,509	54,631
2003 (BN)	2,331	48,628	1,736	52,695
2004 (D)	2,331	50,077	1,869	54,277
2005 (W)	284,500	94,968	2,962	382,430
2006 (W)	934,446	170,375	3,453	1,108,275

Water Year (Type)	Local Supply	CVP Supply[1]	Other Surface Inflows	Total
2007 (C)	6,893	112,799	2,598	122,290
2008 (C)	6,600	61,648	1,886	70,134
2009 (BN)	2,576	40,278	1,525	44,379
2010 (AN)	12,134	75,396	2,628	90,159
2011 (W)	846,835	209,558	4,757	1,061,150
2012 (D)	7,976	36,350	1,888	46,214
2013 (C)	4,484	29,435	1,342	35,261
2014 (C)	3,960	6,686	17	10,664
2015 (C)	3,685	1,621	263	5,569
Average (1989-2014)	209,348	96,891	1,987	308,226
Average (1989-2014) W	650,296	192,526	2,712	845,535
Average (1989-2014) AN	56,059	91,821	2,227	150,108
Average (1989-2014) BN	2,453	44,453	1,631	48,537
Average (1989-2014) D	4,964	50,095	1,784	56,842
Average (1989-2014) C	5,303	46,023	1,433	52,759

[1]CVP Supply is considered as all water supply released from CVP storage facilities. The volume of CVP Supply includes CVP deliveries to CVP contractors/water users, and flood releases from CVP facilities that largely pass through the subbasin.

3.2.1.2 Precipitation

Precipitation estimates for MC GSA subregion are provided in Figure A2.F.b-6 and Table A2.F.b-4. Precipitation estimates are reported by water use sector.

Total precipitation is highly variable between years in the study area, ranging from approximately 127 taf (8.6 inches) during average critical years to 213 taf during average wet years (14.4 inches).

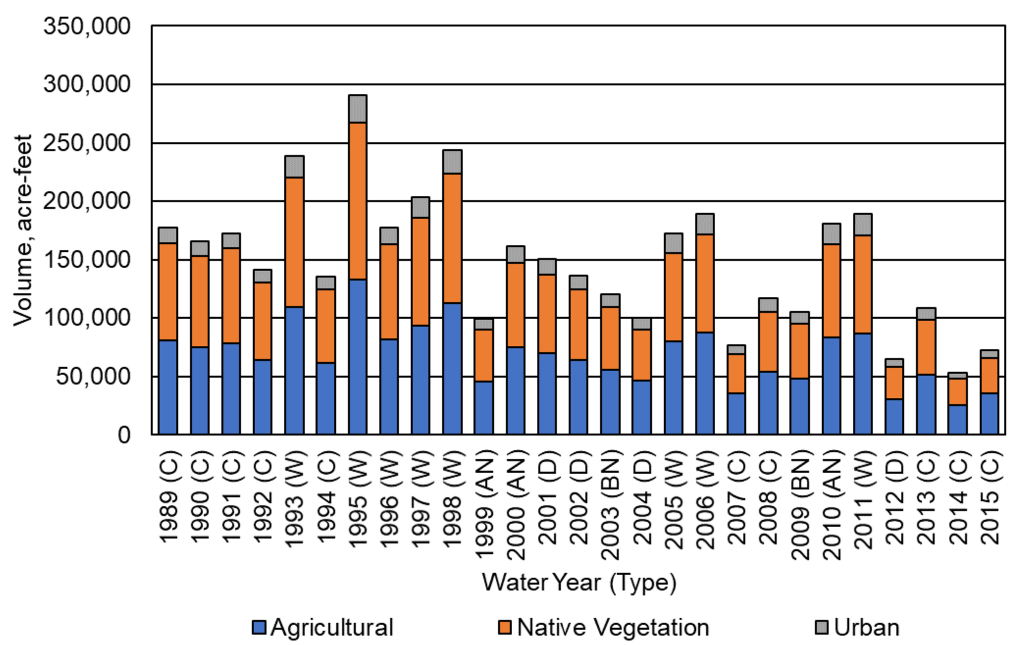

Figure A2.F.b-6. Madera County GSA Precipitation by Water Use Sector.

Table A2.F.b-4. Madera County GSA Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	80,615	83,475	13,133	177,223
1990 (C)	75,245	77,576	12,402	165,223
1991 (C)	78,620	80,899	13,113	172,632
1992 (C)	64,325	65,903	10,841	141,069
1993 (W)	109,068	111,366	18,581	239,015
1994 (C)	61,897	62,888	10,652	135,437
1995 (W)	133,199	134,361	23,166	290,726
1996 (W)	81,657	81,540	14,470	177,667
1997 (W)	93,601	92,513	16,894	203,008
1998 (W)	112,877	110,437	20,738	244,052
1999 (AN)	45,927	44,472	8,586	98,985
2000 (AN)	75,103	71,982	14,281	161,366
2001 (D)	70,289	66,671	13,590	150,550
2002 (D)	63,668	60,496	12,459	136,623
2003 (BN)	55,829	53,141	11,055	120,025
2004 (D)	46,300	44,149	9,277	99,726
2005 (W)	79,721	76,153	16,163	172,037
2006 (W)	87,661	83,882	17,979	189,522
2007 (C)	35,435	33,968	7,354	76,757
2008 (C)	53,736	51,603	11,277	116,616
2009 (BN)	48,455	46,614	10,286	105,355
2010 (AN)	83,054	80,042	17,831	180,927
2011 (W)	86,769	83,768	18,837	189,374
2012 (D)	30,080	27,962	6,419	64,461
2013 (C)	51,748	46,307	10,857	108,912
2014 (C)	25,726	22,162	5,308	53,196
2015 (C)	35,814	29,478	7,316	72,608
Average (1989-2014)	70,408	69,013	13,290	152,711
Average (1989-2014) W	98,069	96,753	18,354	213,175
Average (1989-2014) AN	68,028	65,499	13,566	147,093
Average (1989-2014) BN	52,142	49,878	10,671	112,690
Average (1989-2014) D	52,584	49,820	10,436	112,840
Average (1989-2014) C	58,594	58,309	10,549	127,452

3.2.1.3 Groundwater Extraction by Water Use Sector

Estimates of groundwater extraction by water use sector are provided in Figure A2.F.b-7 and Table A2.F.b-5. For agricultural and urban (urban, semi-agricultural, industrial) lands, groundwater extraction represents pumping, while for native lands, groundwater extraction by riparian vegetation was considered to be negligible. Groundwater extraction is dominated by irrigated agriculture, varying substantially from year to year based on variability in surface water supplies.

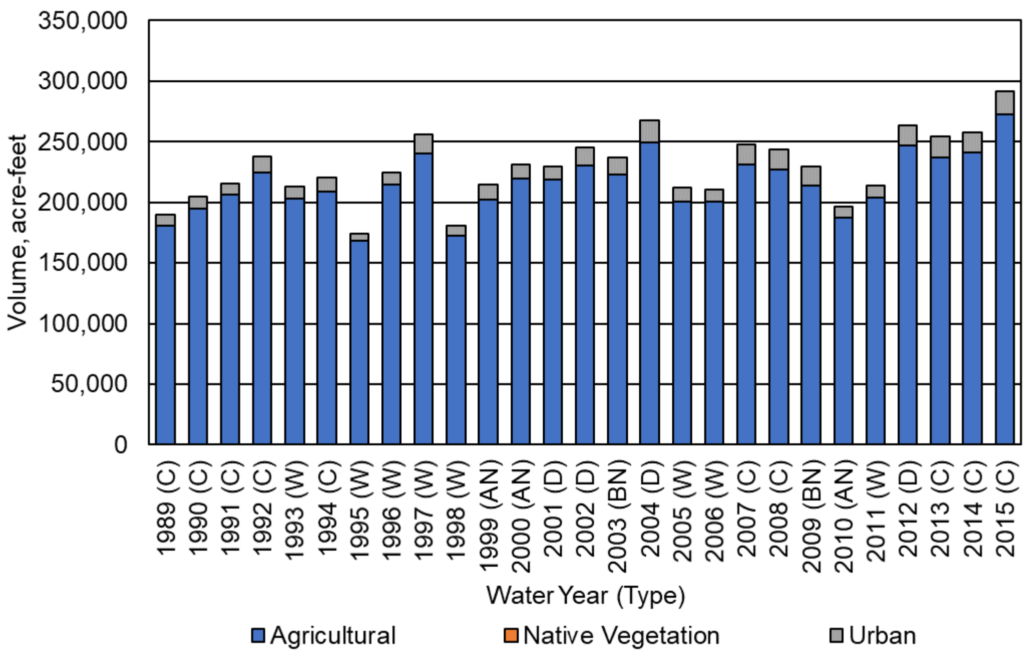

Figure A2.F.b-7. Madera County GSA Groundwater Extraction by Water Use Sector.

Table A2.F.b-5. Madera County GSA Groundwater Extraction by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	180,603	0	9,495	190,098
1990 (C)	194,567	0	10,044	204,611
1991 (C)	206,333	0	9,490	215,823
1992 (C)	224,951	0	12,624	237,575
1993 (W)	202,789	0	9,926	212,715
1994 (C)	208,522	0	11,656	220,178
1995 (W)	168,046	0	6,079	174,125
1996 (W)	215,050	0	9,608	224,658
1997 (W)	240,182	0	15,563	255,745
1998 (W)	172,054	0	8,410	180,464
1999 (AN)	202,181	0	12,613	214,794
2000 (AN)	219,571	0	11,907	231,478
2001 (D)	218,413	0	11,135	229,548
2002 (D)	230,507	0	14,389	244,896
2003 (BN)	222,971	0	13,894	236,865
2004 (D)	249,689	0	17,705	267,394
2005 (W)	200,840	0	11,013	211,853
2006 (W)	200,362	0	10,525	210,887
2007 (C)	231,077	0	16,657	247,734
2008 (C)	227,198	0	16,467	243,665
2009 (BN)	213,576	0	15,898	229,474
2010 (AN)	187,125	0	9,081	196,206
2011 (W)	203,776	0	10,230	214,006
2012 (D)	247,221	0	16,294	263,515
2013 (C)	236,847	0	17,127	253,974

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2014 (C)	240,994	0	16,625	257,619
2015 (C)	272,606	0	18,768	291,374
Average (1989-2014)	213,286	0	12,479	225,765
Average (1989-2014) W	200,387	0	10,169	210,556
Average (1989-2014) AN	202,959	0	11,200	214,159
Average (1989-2014) BN	218,274	0	14,896	233,170
Average (1989-2014) D	236,457	0	14,881	251,338
Average (1989-2014) C	216,788	0	13,354	230,142

3.2.1.4 Groundwater Discharge to Surface Water Sources

The depth to groundwater is greater than 100-200 ft across much of the Madera Subbasin. Given the depth to the water table in the Madera Subbasin, groundwater discharge to surface water sources is negligible.

3.2.2 Outflows

3.2.2.1 Evapotranspiration by Water Use Sector

Evapotranspiration (ET) by water use sector is reported in Figures A2.F.b-8 to A2.F.b-10 and Tables A2.F.b-6 to A2.F.b-8. First, total ET is reported, followed by ET from applied water and ET from precipitation.

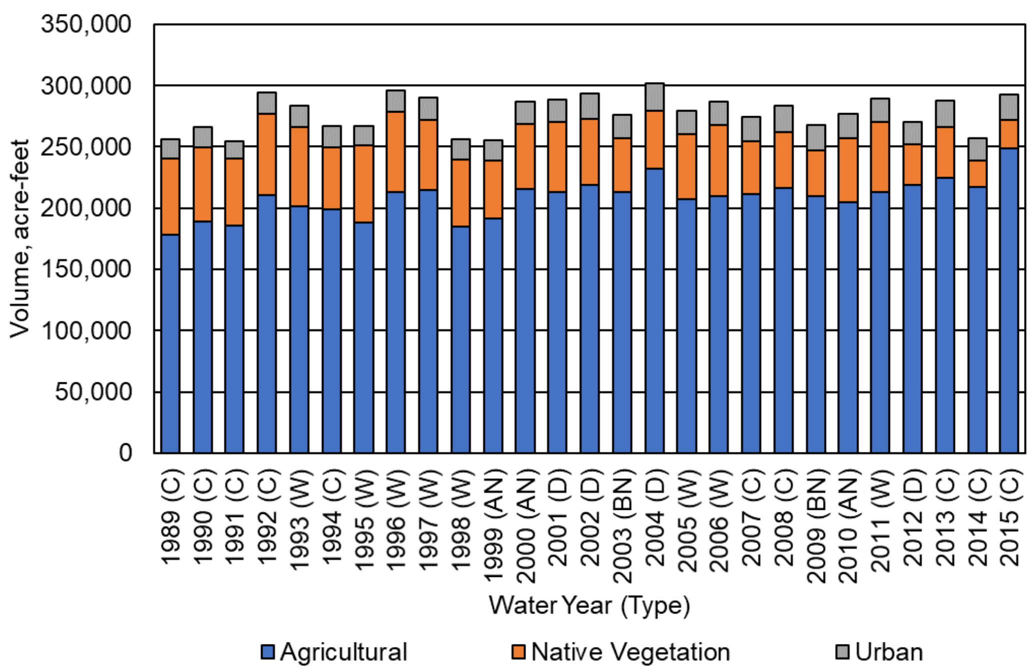

Figure A2.F.b-8. Madera County GSA Evapotranspiration by Water Use Sector.

Table A2.F.b-6. Madera County GSA Evapotranspiration by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	177,906	62,628	15,404	255,938
1990 (C)	188,951	60,803	16,189	265,943
1991 (C)	185,427	54,756	14,253	254,436
1992 (C)	210,748	65,771	17,630	294,149
1993 (W)	201,286	65,018	17,140	283,444
1994 (C)	198,734	51,207	16,875	266,816
1995 (W)	188,453	63,052	15,797	267,302
1996 (W)	212,835	65,550	17,262	295,647
1997 (W)	214,500	57,188	18,751	290,439
1998 (W)	185,024	54,199	16,666	255,889
1999 (AN)	191,411	47,043	16,961	255,415
2000 (AN)	215,287	53,199	18,525	287,011
2001 (D)	212,925	57,040	18,478	288,443
2002 (D)	218,982	53,998	20,192	293,172
2003 (BN)	213,367	43,366	19,564	276,297
2004 (D)	231,762	48,007	22,053	301,822
2005 (W)	206,910	53,424	19,382	279,716
2006 (W)	209,720	57,711	19,771	287,202
2007 (C)	211,618	43,242	19,756	274,616
2008 (C)	216,199	45,621	21,627	283,447
2009 (BN)	209,427	37,410	21,268	268,105
2010 (AN)	204,666	52,693	19,177	276,536
2011 (W)	212,818	57,334	19,556	289,708
2012 (D)	219,083	32,978	18,006	270,067
2013 (C)	224,502	41,598	21,476	287,576
2014 (C)	217,298	21,451	18,044	256,793
2015 (C)	248,312	23,910	20,682	292,904
Average (1989-2014)	206,917	51,780	18,454	277,151
Average (1989-2014) W	203,943	59,185	18,041	281,168
Average (1989-2014) AN	203,788	50,978	18,221	272,987
Average (1989-2014) BN	211,397	40,388	20,416	272,201
Average (1989-2014) D	220,688	48,006	19,682	288,376
Average (1989-2014) C	203,487	49,675	17,917	271,079

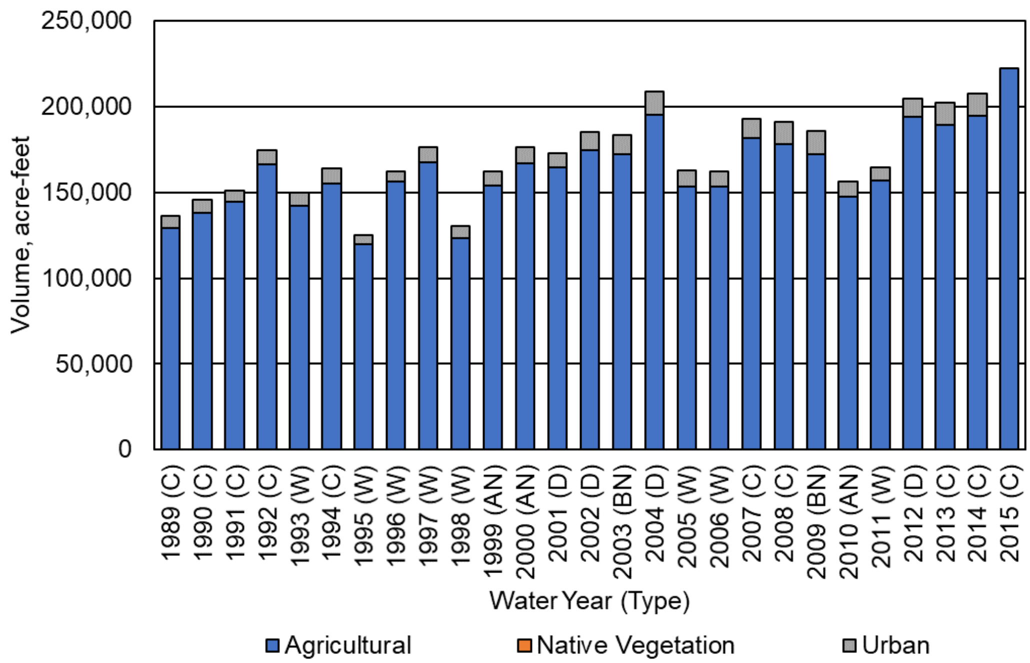

Figure A2.F.b-9. Madera County GSA Evapotranspiration of Applied Water by Water Use Sector.

Table A2.F.b-7. Madera County GSA Evapotranspiration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	129,021	0	7,035	136,056
1990 (C)	138,247	0	7,369	145,616
1991 (C)	144,393	0	6,815	151,208
1992 (C)	166,047	0	8,673	174,720
1993 (W)	142,257	0	7,452	149,709
1994 (C)	155,336	0	8,826	164,162
1995 (W)	119,570	0	5,379	124,949
1996 (W)	156,264	0	6,158	162,422
1997 (W)	167,616	0	8,937	176,553
1998 (W)	123,144	0	7,143	130,287
1999 (AN)	153,963	0	8,395	162,358
2000 (AN)	166,774	0	9,401	176,175
2001 (D)	164,685	0	8,404	173,089
2002 (D)	174,650	0	10,550	185,200
2003 (BN)	172,018	0	11,149	183,167
2004 (D)	195,478	0	13,274	208,752
2005 (W)	153,279	0	9,455	162,734
2006 (W)	153,241	0	8,804	162,045
2007 (C)	181,864	0	11,143	193,007
2008 (C)	177,972	0	12,860	190,832
2009 (BN)	172,270	0	13,332	185,602
2010 (AN)	147,439	0	8,604	156,043
2011 (W)	156,658	0	7,723	164,381

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2012 (D)	193,830	0	10,623	204,453
2013 (C)	189,237	0	13,204	202,441
2014 (C)	194,546	0	12,952	207,498
2015 (C)	222,221	0	15,171	237,392
Average (1989-2014)	161,146	0	9,372	170,518
Average (1989-2014) W	146,504	0	7,631	154,135
Average (1989-2014) AN	156,059	0	8,800	164,859
Average (1989-2014) BN	172,144	0	12,241	184,385
Average (1989-2014) D	182,161	0	10,713	192,874
Average (1989-2014) C	164,074	0	9,875	173,949

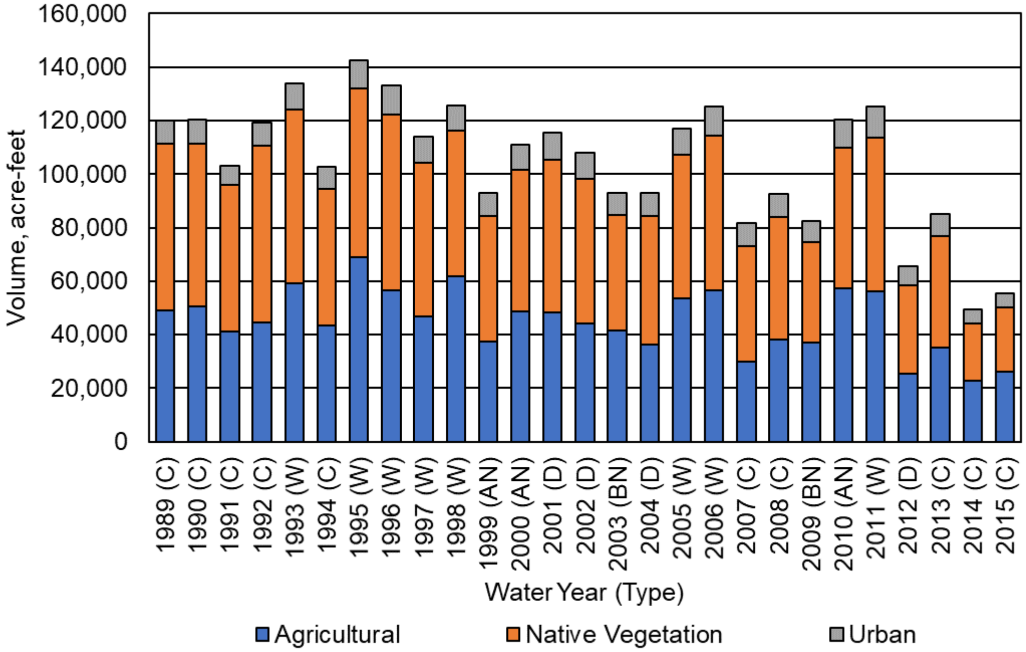

Figure A2.F.b-10. Madera County GSA Evapotranspiration of Precipitation by Water Use Sector.

Table A2.F.b-8. Madera County GSA Evapotranspiration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	48,885	62,628	8,369	119,882
1990 (C)	50,704	60,803	8,820	120,327
1991 (C)	41,034	54,756	7,438	103,228
1992 (C)	44,701	65,771	8,957	119,429
1993 (W)	59,029	65,018	9,688	133,735
1994 (C)	43,398	51,207	8,049	102,654
1995 (W)	68,883	63,052	10,418	142,353
1996 (W)	56,571	65,550	11,104	133,225
1997 (W)	46,884	57,188	9,814	113,886
1998 (W)	61,880	54,199	9,523	125,602

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1999 (AN)	37,448	47,043	8,566	93,057
2000 (AN)	48,513	53,199	9,124	110,836
2001 (D)	48,240	57,040	10,074	115,354
2002 (D)	44,332	53,998	9,642	107,972
2003 (BN)	41,349	43,366	8,415	93,130
2004 (D)	36,284	48,007	8,779	93,070
2005 (W)	53,631	53,424	9,927	116,982
2006 (W)	56,479	57,711	10,967	125,157
2007 (C)	29,754	43,242	8,613	81,609
2008 (C)	38,227	45,621	8,767	92,615
2009 (BN)	37,157	37,410	7,936	82,503
2010 (AN)	57,227	52,693	10,573	120,493
2011 (W)	56,160	57,334	11,833	125,327
2012 (D)	25,253	32,978	7,383	65,614
2013 (C)	35,265	41,598	8,272	85,135
2014 (C)	22,752	21,451	5,092	49,295
2015 (C)	26,091	23,910	5,511	55,512
Average (1989-2014)	45,771	51,780	9,082	106,633
Average (1989-2014) W	57,440	59,185	10,409	127,033
Average (1989-2014) AN	47,729	50,978	9,421	108,129
Average (1989-2014) BN	39,253	40,388	8,176	87,817
Average (1989-2014) D	38,527	48,006	8,970	95,503
Average (1989-2014) C	39,413	49,675	8,042	97,130

Total ET varies between years, with the lowest observed in 1991, at approximately 254 taf, and greatest in 2004, at approximately 302 taf. Agricultural ET tends to increase in drier years, while native ET decreases. Total ET has remained relatively steady over time.

In addition to ET from land surfaces, estimates of evaporation from rivers and streams in MC GSA are reported in Figure A2.F.b-11 and Table A2.F.b-9. Evaporation from the Rivers and Streams System includes evaporation of both surface inflows and of precipitation runoff within local sloughs and depressions. Evaporation is highest in wet years when surface water inflows are typically higher, averaging approximately 3.7 taf in wet years.

3.2.2.2 Surface Water Outflow by Water Source Type

Surface water outflows by water source type are summarized in Figure A2.F.b-12 and Table A2.F.b-10. In the MC GSA, runoff of applied water is assumed negligible and runoff of precipitation is collected in waterways within MC GSA, reentering the groundwater system through infiltration completely except during large storm events. Thus, surface outflows primarily from local supplies and CVP supplies are expected to leave the subregion. These outflows include natural flows along waterways and diversions of USBR CVP deliveries to MID that are routed along Fresno River through the Madera County GSA subregion. CVP supplies are relatively constant between years, averaging 85 taf per year, whereas surface outflows of local supplies are significantly higher in wet years, averaging approximately 600 taf per wet year.

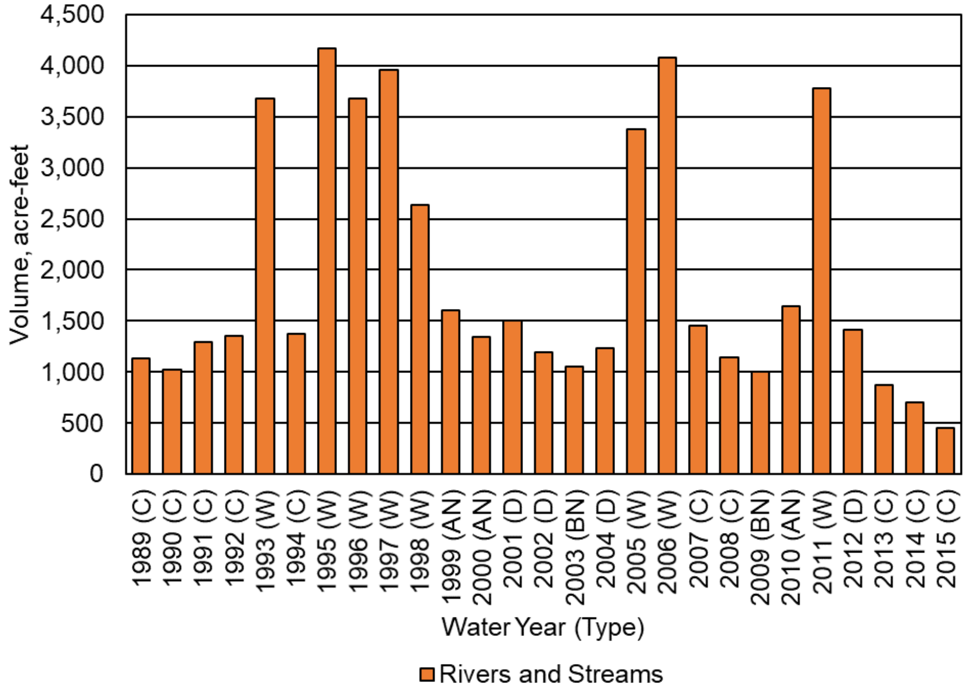

Figure A2.F.b-11. Madera County GSA Evaporation from the Surface Water System.

Table A2.F.b-9. Madera County GSA Evaporation from the Surface Water System (Acre-Feet).

Water Year (Type)	Rivers and Streams[1]
1989 (C)	1,134
1990 (C)	1,019
1991 (C)	1,289
1992 (C)	1,358
1993 (W)	3,677
1994 (C)	1,374
1995 (W)	4,163
1996 (W)	3,680
1997 (W)	3,961
1998 (W)	2,634
1999 (AN)	1,606
2000 (AN)	1,344
2001 (D)	1,507
2002 (D)	1,191
2003 (BN)	1,053
2004 (D)	1,234
2005 (W)	3,373
2006 (W)	4,076
2007 (C)	1,456
2008 (C)	1,147
2009 (BN)	1,004
2010 (AN)	1,647
2011 (W)	3,775

Water Year (Type)	Rivers and Streams[1]
2012 (D)	1,410
2013 (C)	871
2014 (C)	700
2015 (C)	454
Average (1989-2014)	1,988
Average (1989-2014) W	3,667
Average (1989-2014) AN	1,532
Average (1989-2014) BN	1,029
Average (1989-2014) D	1,336
Average (1989-2014) C	1,150

[1] Includes evaporation of surface inflows and of precipitation runoff.

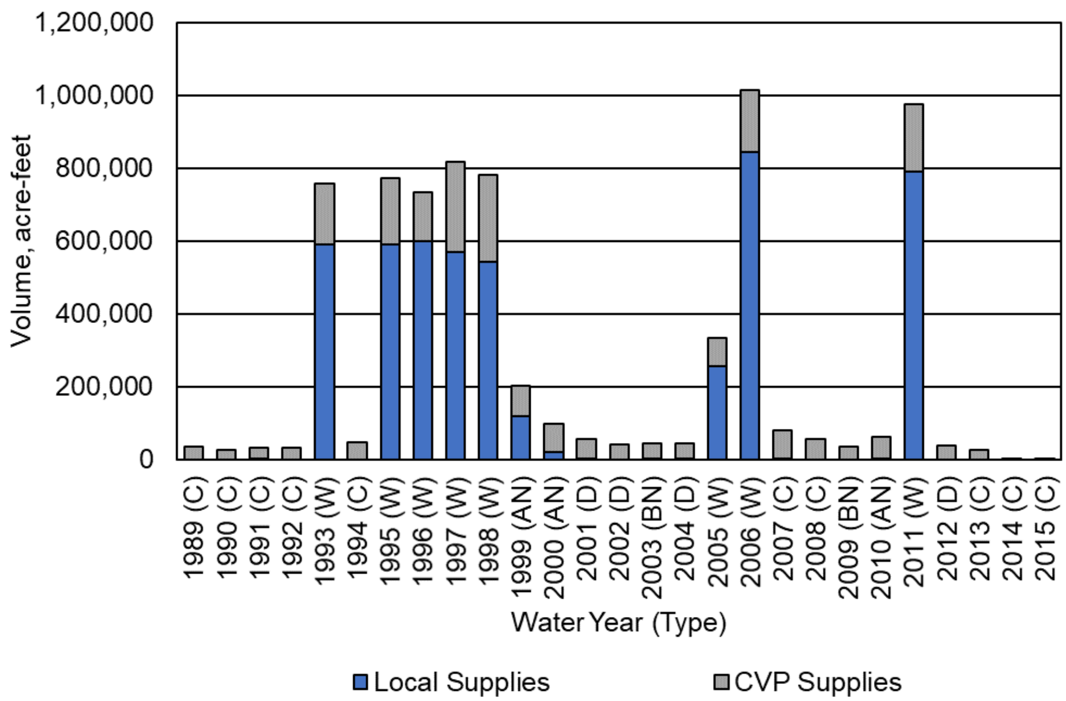

Figure A2.F.b-12. Madera County GSA Surface Outflows by Water Source Type.

Table A2.F.b-10. Madera County GSA Surface Outflows by Water Source Type (Acre-Feet).

Water Year (Type)	Local Supplies	CVP Supplies	Total
1989 (C)	1,642	35,080	36,722
1990 (C)	426	28,326	28,752
1991 (C)	2,472	32,313	34,785
1992 (C)	660	31,673	32,333
1993 (W)	591,021	165,581	756,602
1994 (C)	1,179	46,104	47,283
1995 (W)	591,599	180,841	772,440
1996 (W)	600,208	134,505	734,713
1997 (W)	570,330	246,357	816,686
1998 (W)	544,153	238,568	782,720
1999 (AN)	119,173	84,986	204,159
2000 (AN)	21,756	76,720	98,476
2001 (D)	4,381	52,127	56,508
2002 (D)	1,975	41,218	43,193
2003 (BN)	3,060	41,189	44,249
2004 (D)	2,779	41,122	43,901
2005 (W)	256,646	76,873	333,518
2006 (W)	845,338	167,924	1,013,262
2007 (C)	4,687	75,739	80,425
2008 (C)	1,444	55,096	56,540
2009 (BN)	1,882	34,817	36,699
2010 (AN)	4,520	57,869	62,389
2011 (W)	789,191	187,439	976,630
2012 (D)	1,781	36,220	38,001
2013 (C)	520	25,581	26,101
2014 (C)	528	4,262	4,790
2015 (C)	0	1,020	1,020
Average (1989-2014)	190,898	84,559	275,457
Average (1989-2014) W	598,561	174,761	773,322
Average (1989-2014) AN	48,483	73,192	121,675
Average (1989-2014) BN	2,471	38,003	40,474
Average (1989-2014) D	2,729	42,672	45,401
Average (1989-2014) C	1,506	37,130	38,637

3.2.2.3 Infiltration of Precipitation

Estimated infiltration of precipitation (deep percolation of precipitation) by water use sector is provided in Figure A2.F.b-13 and Table A2.F.b-11. Infiltration of precipitation to the groundwater system is highly variable from year to year due to variation in the timing and amount of precipitation, ranging from less than 20 taf annually during some critical and dry years to more than 100 taf during 1995.

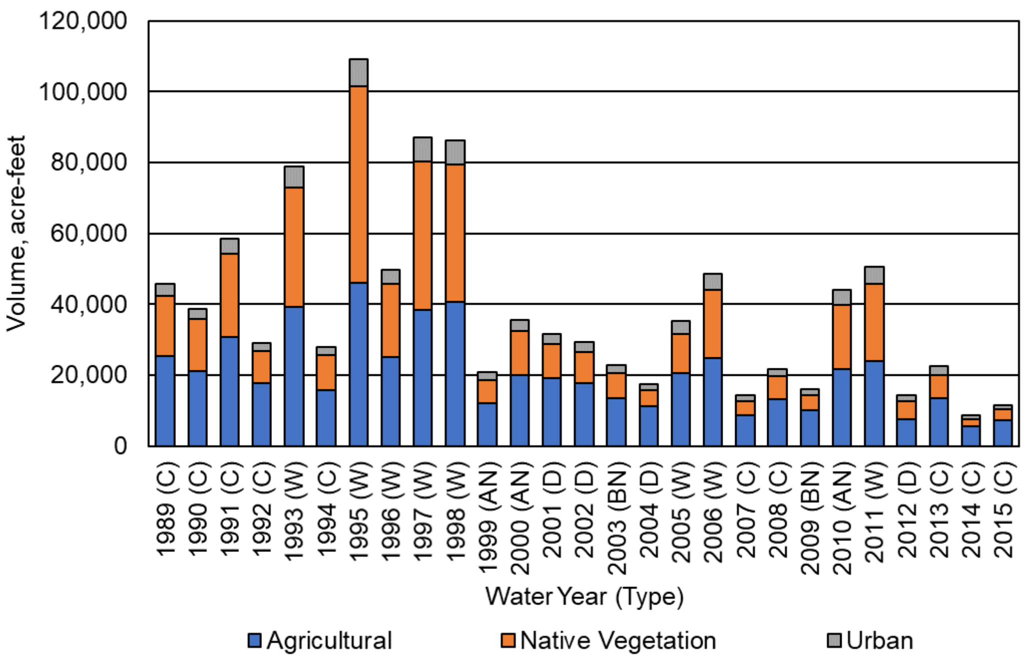

Figure A2.F.b-13. Madera County GSA Infiltration of Precipitation by Water Use Sector.

Table A2.F.b-11. Madera County GSA Infiltration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	25,321	16,963	3,337	45,621
1990 (C)	21,211	14,592	2,792	38,595
1991 (C)	30,851	23,399	4,114	58,364
1992 (C)	17,675	9,220	2,259	29,154
1993 (W)	39,122	33,822	5,779	78,723
1994 (C)	15,769	9,872	2,343	27,984
1995 (W)	46,028	55,566	7,554	109,148
1996 (W)	25,031	20,636	4,039	49,706
1997 (W)	38,318	41,876	6,812	87,006
1998 (W)	40,560	38,825	6,918	86,303
1999 (AN)	12,156	6,530	2,089	20,775
2000 (AN)	19,962	12,476	3,199	35,637
2001 (D)	19,067	9,658	2,814	31,539
2002 (D)	17,806	8,769	2,792	29,367
2003 (BN)	13,573	6,919	2,218	22,710
2004 (D)	11,202	4,525	1,688	17,415
2005 (W)	20,598	11,118	3,418	35,134
2006 (W)	24,848	19,143	4,500	48,491
2007 (C)	8,557	4,165	1,575	14,297
2008 (C)	13,270	6,361	2,111	21,742
2009 (BN)	10,103	4,175	1,686	15,964
2010 (AN)	21,714	17,993	4,378	44,085
2011 (W)	24,001	21,634	4,956	50,591

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2012 (D)	7,638	4,852	1,711	14,201
2013 (C)	13,332	6,789	2,424	22,545
2014 (C)	5,644	1,950	1,025	8,619
2015 (C)	7,112	3,222	1,196	11,530
Average (1989-2014)	20,898	15,840	3,405	40,143
Average (1989-2014) W	32,313	30,328	5,497	68,138
Average (1989-2014) AN	17,944	12,333	3,222	33,499
Average (1989-2014) BN	11,838	5,547	1,952	19,337
Average (1989-2014) D	13,928	6,951	2,251	23,131
Average (1989-2014) C	16,848	10,368	2,442	29,658

3.2.2.4 Infiltration of Surface Water

Estimated infiltration of surface water (seepage) by source is provided for MC GSA in Figure A2.F.b-14 and Table A2.F.b-12. Seepage from the Rivers and Streams System includes seepage of both surface inflows and of precipitation runoff into local sloughs and depressions. Seepage from rivers and streams exhibits substantial variability over time, matching the annual variability of surface water inflows. While flows in the San Joaquin River were not accounted directly as water budget components[3], boundary seepage from the San Joaquin River contributes an additional 38 taf per year on average to net recharge in MC GSA.

3.2.2.5 Infiltration of Applied Water

Estimated infiltration of applied water (deep percolation of applied water) by water use sector is provided in Figure A2.F.b-15 and Table A2.F.b-13. Infiltration of applied water is dominated by agricultural irrigation and has remained relatively steady over time, with the exception of 2014, when surface water supplies in the subbasin were significantly reduced due to drought conditions.

[3] The San Joaquin River does not cross the lateral boundaries of the Madera Subbasin, as defined above. Thus, San Joaquin River flows are not considered surface water inflows within this water budget. A portion of infiltration of surface water from the San Joaquin River is considered to cross the subbasin boundaries into the groundwater system and is included in the calculation of the subbasin estimates of overdraft and net recharge from SWS.

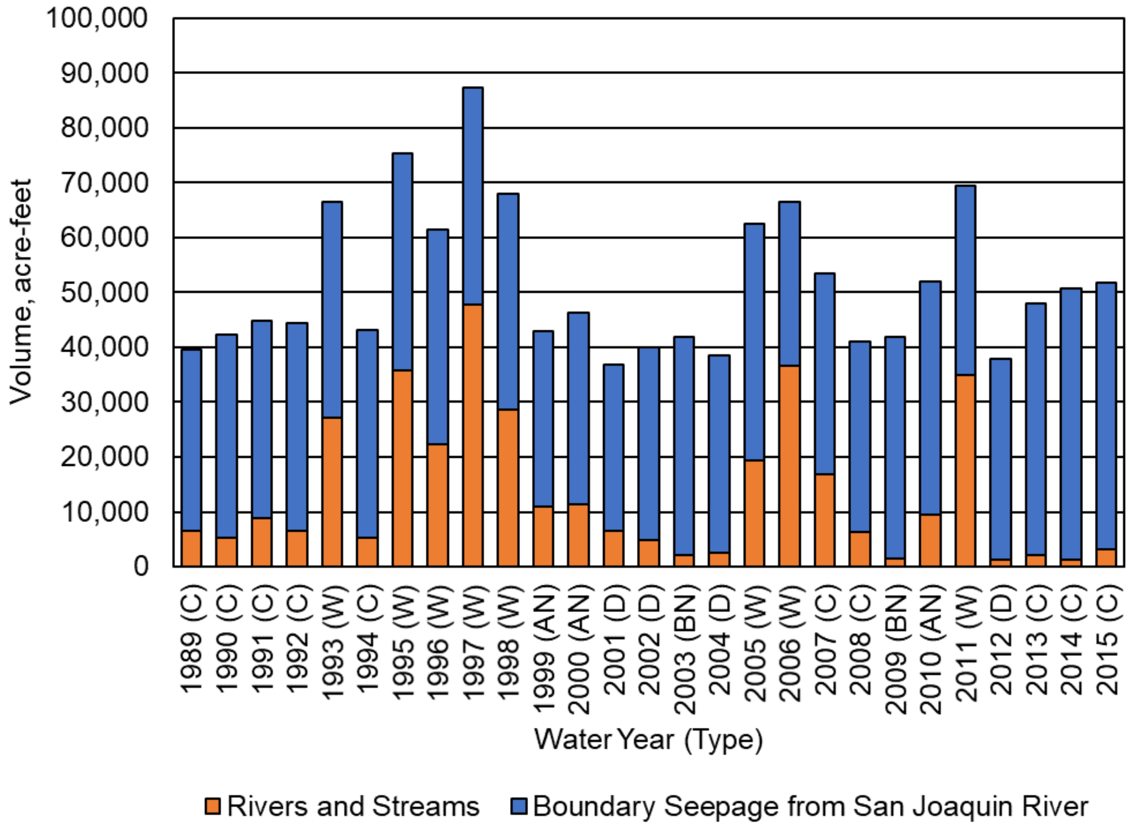

Figure A2.F.b-14. Madera County GSA Infiltration of Surface Water.

Table A2.F.b-12. Madera County GSA Infiltration of Surface Water (Acre-Feet).

Water Year (Type)	Rivers and Streams[1]	Boundary Seepage from San Joaquin River	Total
1989 (C)	6,636	33,028	39,664
1990 (C)	5,257	36,963	42,220
1991 (C)	8,890	36,043	44,933
1992 (C)	6,632	37,775	44,407
1993 (W)	27,077	39,521	66,598
1994 (C)	5,359	37,721	43,080
1995 (W)	35,751	39,521	75,272
1996 (W)	22,251	39,168	61,419
1997 (W)	47,851	39,521	87,372
1998 (W)	28,564	39,521	68,085
1999 (AN)	10,933	32,027	42,960
2000 (AN)	11,352	34,919	46,271
2001 (D)	6,623	30,292	36,915
2002 (D)	4,850	35,116	39,966
2003 (BN)	2,105	39,808	41,913
2004 (D)	2,456	36,099	38,555
2005 (W)	19,325	43,168	62,494
2006 (W)	36,651	29,962	66,613

Water Year (Type)	Rivers and Streams[1]	Boundary Seepage from San Joaquin River	Total
2007 (C)	16,872	36,645	53,517
2008 (C)	6,252	34,714	40,965
2009 (BN)	1,558	40,265	41,823
2010 (AN)	9,551	42,497	52,048
2011 (W)	34,903	34,602	69,505
2012 (D)	1,353	36,499	37,852
2013 (C)	2,178	45,719	47,898
2014 (C)	1,230	49,478	50,708
2015 (C)	3,076	48,722	51,799
Average (1989-2014)	13,941	37,715	51,656
Average (1989-2014) W	31,547	38,123	69,670
Average (1989-2014) AN	10,612	36,481	47,093
Average (1989-2014) BN	1,831	40,037	41,868
Average (1989-2014) D	3,821	34,501	38,322
Average (1989-2014) C	6,589	38,676	45,266

[1] Includes infiltration of surface inflows and of precipitation runoff.

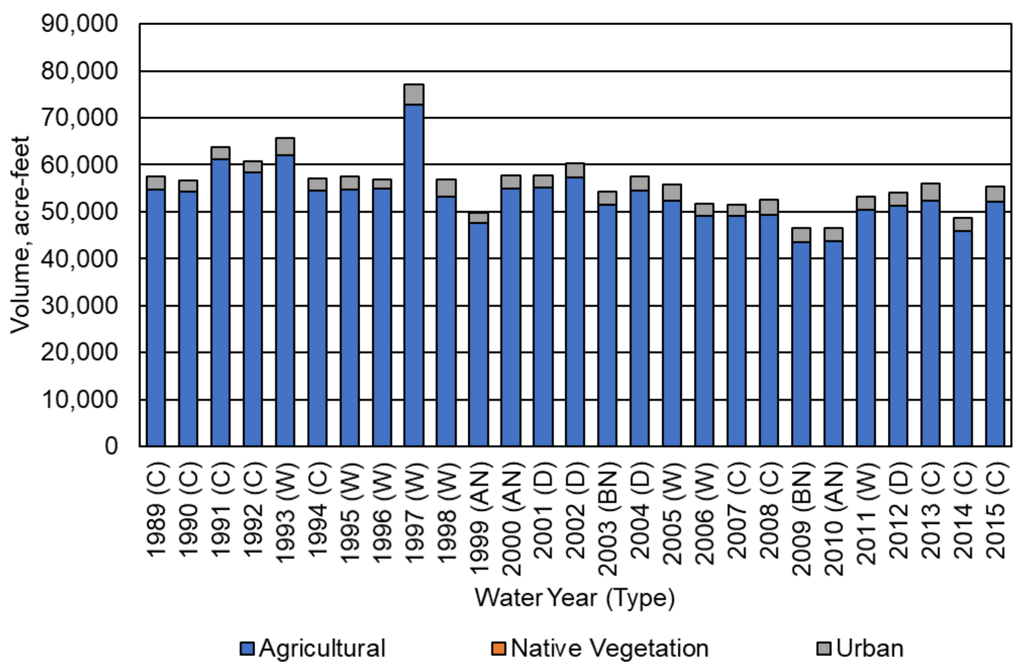

Figure A2.F.b-15. Madera County GSA Infiltration of Applied Water by Water Use Sector.

Table A2.F.b-13. Madera County GSA Infiltration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	54,741	0	2,668	57,409
1990 (C)	54,368	0	2,371	56,739
1991 (C)	61,253	0	2,546	63,799
1992 (C)	58,437	0	2,349	60,786
1993 (W)	62,031	0	3,588	65,619
1994 (C)	54,525	0	2,456	56,981
1995 (W)	54,771	0	2,799	57,570
1996 (W)	54,842	0	1,913	56,755
1997 (W)	72,780	0	4,312	77,092
1998 (W)	53,245	0	3,704	56,949
1999 (AN)	47,515	0	2,213	49,728
2000 (AN)	54,913	0	2,734	57,647
2001 (D)	55,222	0	2,466	57,688
2002 (D)	57,234	0	3,053	60,287
2003 (BN)	51,418	0	2,825	54,243
2004 (D)	54,503	0	2,971	57,474
2005 (W)	52,223	0	3,460	55,683
2006 (W)	49,051	0	2,634	51,685
2007 (C)	49,001	0	2,549	51,550
2008 (C)	49,289	0	3,191	52,480
2009 (BN)	43,495	0	2,948	46,443
2010 (AN)	43,650	0	2,805	46,455
2011 (W)	50,464	0	2,767	53,231
2012 (D)	51,286	0	2,672	53,958
2013 (C)	52,225	0	3,724	55,949
2014 (C)	45,927	0	2,779	48,706
2015 (C)	52,056	0	3,334	55,390
Average (1989-2014)	53,400	0	2,865	56,266
Average (1989-2014) W	56,176	0	3,147	59,323
Average (1989-2014) AN	48,693	0	2,584	51,277
Average (1989-2014) BN	47,457	0	2,887	50,343
Average (1989-2014) D	54,561	0	2,791	57,352
Average (1989-2014) C	53,307	0	2,737	56,044

3.2.3 Change in Surface Water System Storage

Estimates of change in SWS storage are provided in Figure A2.F.b-16 and Table A2.F.b-14. Inter-annual changes in storage within the surface water system consist primarily of root zone soil moisture storage changes, are relatively small, and tend to average near zero over many years.

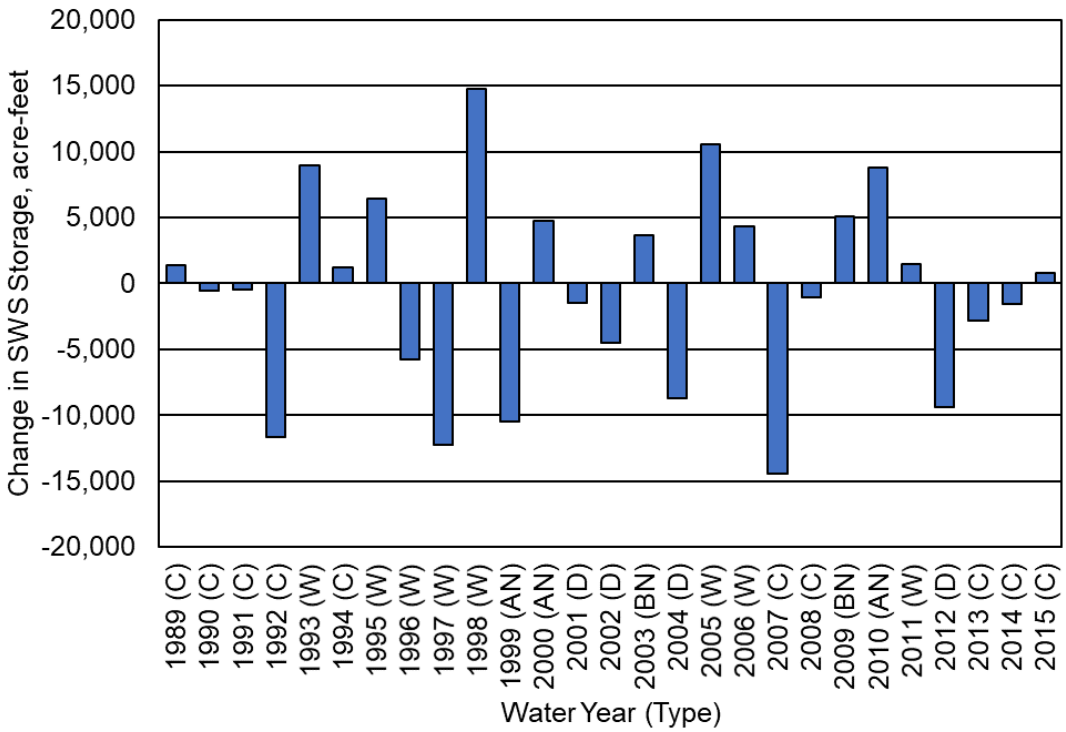

Figure A2.F.b-16. Madera County GSA Change in Surface Water System Storage.

Table A2.F.b-14. Madera County GSA Change in Surface Water System Storage (Acre-Feet).

Water Year (Type)	Change in SWS Storage
1989 (C)	1,400
1990 (C)	-579
1991 (C)	-489
1992 (C)	-11,697
1993 (W)	8,916
1994 (C)	1,257
1995 (W)	6,447
1996 (W)	-5,760
1997 (W)	-12,284
1998 (W)	14,801
1999 (AN)	-10,451
2000 (AN)	4,720
2001 (D)	-1,435
2002 (D)	-4,479
2003 (BN)	3,633
2004 (D)	-8,700
2005 (W)	10,570
2006 (W)	4,318
2007 (C)	-14,464
2008 (C)	-1,059
2009 (BN)	5,087
2010 (AN)	8,814

Water Year (Type)	Change in SWS Storage
2011 (W)	1,443
2012 (D)	-9,417
2013 (C)	-2,816
2014 (C)	-1,597
2015 (C)	792
Average (1989-2014)	-532
Average (1989-2014) W	3,556
Average (1989-2014) AN	1,028
Average (1989-2014) BN	4,360
Average (1989-2014) D	-6,008
Average (1989-2014) C	-3,338

3.3 Historical Water Budget Summary

Annual inflows, outflows, and change in SWS storage during the historical water budget period (1989-2014) are summarized in Figure A2.F.b-17 and Table A2.F.b-15. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values. Review of the variability in component volumes across years provides insight into the impacts of hydrology on the surface water system water budget.

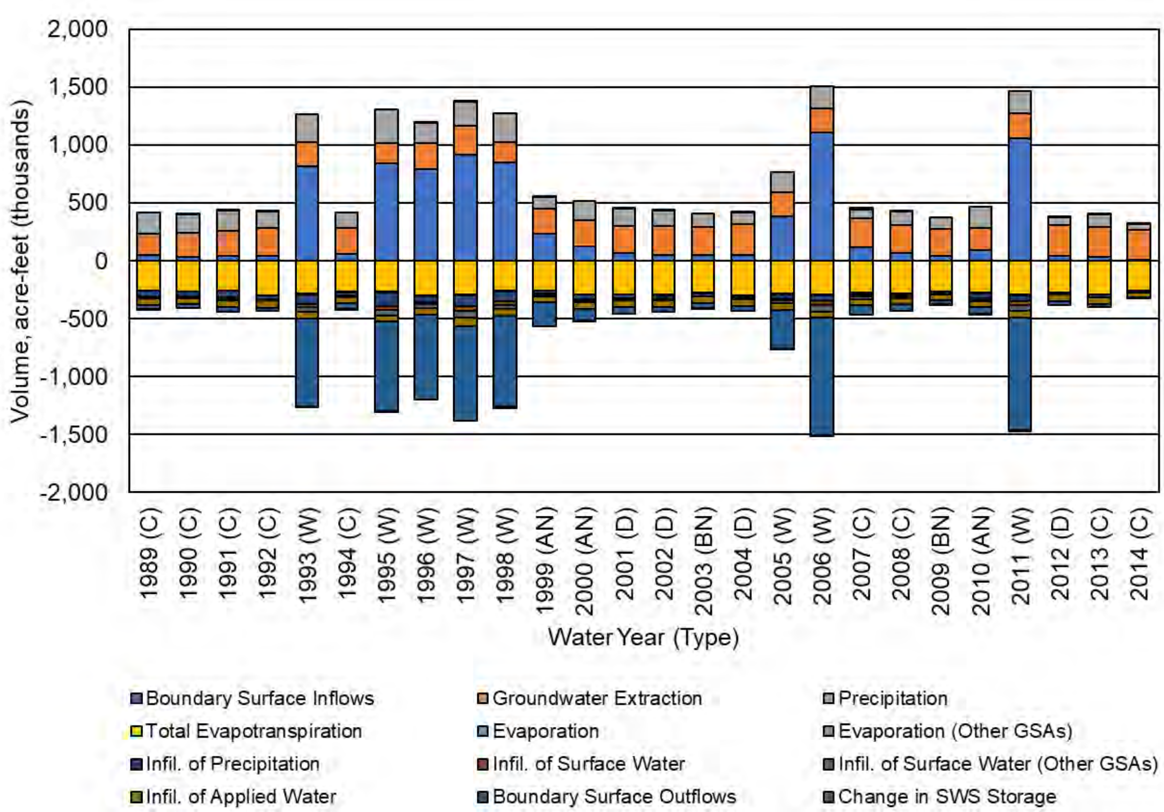

Figure A2.F.b-17. Madera County GSA Surface Water System Historical Water Budget, 1989-2014.

Table A2.F.b-15. Madera County GSA Surface Water System Historical Water Budget, 1989-2014 (Acre-Feet).

Water Year (Type)	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Total Evapo-transpiration	Evaporation	Evaporation (Other GSAs)	Infil. of Precipitation	Infil. of Surface Water	Infil. of Surface Water (Other GSAs)	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	48,253	190,101	177,223	-255,946	-1,134	-2,377	-45,621	-6,636	-8,328	-57,413	-36,722	-1,400
1990 (C)	35,000	204,610	165,223	-265,945	-1,019	-2,040	-38,595	-5,257	-7,063	-56,741	-28,752	579
1991 (C)	46,729	215,820	172,632	-254,436	-1,289	-2,733	-58,364	-8,890	-11,374	-63,799	-34,785	489
1992 (C)	45,057	237,577	141,069	-294,149	-1,358	-2,966	-29,154	-6,632	-8,022	-60,786	-32,333	11,697
1993 (W)	816,007	212,715	239,015	-283,444	-3,677	-5,645	-78,723	-27,077	-38,034	-65,619	-756,602	-8,916
1994 (C)	61,444	220,174	135,437	-266,816	-1,374	-2,715	-27,984	-5,359	-7,286	-56,981	-47,283	-1,257
1995 (W)	840,985	174,126	290,726	-267,302	-4,163	-5,120	-109,148	-35,751	-47,895	-57,570	-772,440	-6,447
1996 (W)	793,158	224,659	177,667	-295,647	-3,680	-5,411	-49,706	-22,251	-33,080	-56,755	-734,713	5,760
1997 (W)	913,778	255,748	203,008	-290,439	-3,961	-4,405	-87,006	-47,851	-57,378	-77,092	-816,686	12,284
1998 (W)	848,497	180,465	244,052	-255,889	-2,634	-5,169	-86,303	-28,564	-39,985	-56,949	-782,720	-14,801
1999 (AN)	237,038	214,793	98,985	-255,415	-1,606	-3,226	-20,775	-10,933	-15,424	-49,728	-204,159	10,451
2000 (AN)	123,126	231,479	161,366	-287,011	-1,344	-4,225	-35,637	-11,352	-15,559	-57,647	-98,476	-4,720
2001 (D)	72,246	229,546	150,550	-288,443	-1,507	-3,099	-31,539	-6,623	-8,370	-57,688	-56,508	1,435
2002 (D)	54,631	244,895	136,623	-293,172	-1,191	-2,752	-29,367	-4,850	-5,816	-60,287	-43,193	4,479
2003 (BN)	52,695	236,865	120,025	-276,297	-1,053	-2,641	-22,710	-2,105	-2,654	-54,243	-44,249	-3,633
2004 (D)	54,277	267,395	99,726	-301,822	-1,234	-2,862	-17,415	-2,456	-2,934	-57,474	-43,901	8,700
2005 (W)	382,430	211,852	172,037	-279,716	-3,373	-4,403	-35,134	-19,325	-24,596	-55,683	-333,518	-10,570
2006 (W)	1,108,275	210,890	189,522	-287,202	-4,076	-5,246	-48,491	-36,651	-57,755	-51,685	-1,013,262	-4,318
2007 (C)	122,290	247,735	76,757	-274,616	-1,456	-2,868	-14,297	-16,872	-19,163	-51,550	-80,425	14,464
2008 (C)	70,134	243,666	116,616	-283,447	-1,147	-2,501	-21,742	-6,252	-7,366	-52,480	-56,540	1,059
2009 (BN)	44,379	229,476	105,355	-268,105	-1,004	-2,298	-15,964	-1,558	-2,052	-46,443	-36,699	-5,087
2010 (AN)	90,159	196,206	180,927	-276,536	-1,647	-4,108	-44,085	-9,551	-13,706	-46,455	-62,389	-8,814
2011 (W)	1,061,150	214,004	189,374	-289,708	-3,775	-5,269	-50,591	-34,903	-48,977	-53,231	-976,630	-1,443
2012 (D)	46,214	263,511	64,461	-270,067	-1,410	-2,370	-14,201	-1,353	-2,243	-53,958	-38,001	9,417
2013 (C)	35,261	253,974	108,912	-287,576	-871	-1,938	-22,545	-2,178	-3,805	-55,949	-26,101	2,816
2014 (C)	10,664	257,621	53,196	-256,793	-700	-761	-8,619	-1,230	-1,480	-48,706	-4,790	1,597
Average (1989-2014)	308,226	225,765	152,711	-277,152	-1,988	-3,429	-40,143	-13,941	-18,859	-56,266	-275,457	532
W	845,535	210,557	213,175	-281,168	-3,667	-5,084	-68,138	-31,547	-43,462	-59,323	-773,322	-3,556
AN	150,108	214,159	147,093	-272,987	-1,532	-3,853	-33,499	-10,612	-14,897	-51,277	-121,675	-1,028
BN	48,537	233,171	112,690	-272,201	-1,029	-2,469	-19,337	-1,831	-2,353	-50,343	-40,474	-4,360
D	56,842	251,337	112,840	-288,376	-1,336	-2,771	-23,131	-3,821	-4,841	-57,352	-45,401	6,008
C	52,759	230,142	127,452	-271,080	-1,150	-2,322	-29,658	-6,589	-8,210	-56,045	-38,637	3,338

3.4 Current Water Budget Summary

The current water budget was developed following a similar process to the historical water budget using the 2015 land use in Table 1 and the same 1989-2014 average hydrologic conditions of the historical base period, including surface water flows, precipitation, and weather parameters. This allowed quantification of groundwater inflows and outflows for current consumptive use in the context of average water supply conditions.

Annual inflows, outflows, and change in SWS storage from the current water budget are summarized in Figure A2.F.b-18 and Table A2.F.b-16. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values.

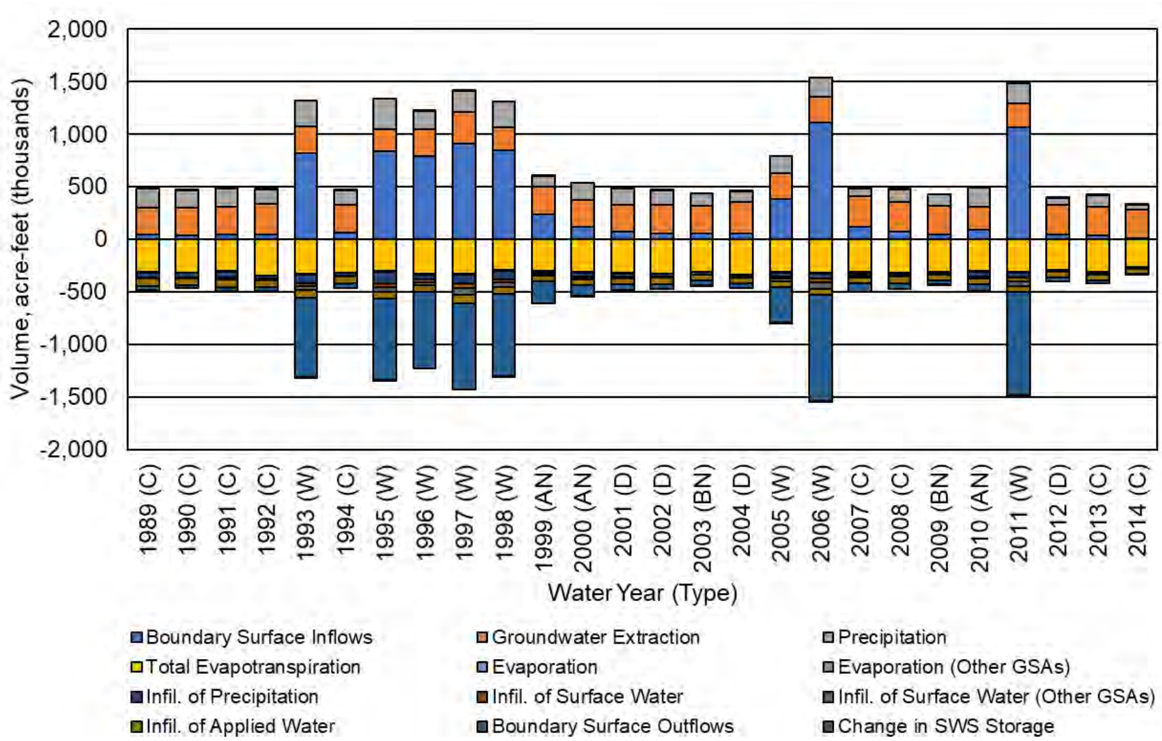

Figure A2.F.b-18. Madera County GSA Surface Water System Current Water Budget.

Table A2.F.b-16. Madera County GSA Surface Water System Current Water Budget (Acre-Feet).

Water Year (Type)	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Total Evapo-transpiration	Evaporation	Evaporation (Other GSAs)	Infil. of Precipitation	Infil. of Surface Water	Infil. of Surface Water (Other GSAs)	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	48,253	254,629	177,223	-311,531	-1,134	-1,891	-44,708	-6,073	-7,442	-69,768	-36,722	-838
1990 (C)	35,000	263,215	165,221	-318,356	-1,019	-1,781	-37,396	-4,728	-6,349	-65,121	-28,752	66
1991 (C)	46,729	266,427	172,630	-300,729	-1,289	-2,569	-56,568	-8,355	-10,797	-71,176	-34,785	482
1992 (C)	45,057	289,263	141,067	-341,704	-1,358	-2,600	-28,446	-6,450	-7,848	-64,748	-32,333	10,099
1993 (W)	816,007	261,260	239,014	-327,244	-3,677	-5,492	-77,604	-26,305	-37,391	-72,889	-756,602	-9,078
1994 (C)	61,444	268,425	135,436	-313,539	-1,374	-2,654	-26,894	-5,003	-6,846	-62,246	-47,283	534
1995 (W)	840,985	210,001	290,729	-302,091	-4,163	-4,931	-106,096	-35,091	-47,402	-63,626	-772,440	-5,875
1996 (W)	793,158	252,813	177,668	-325,899	-3,680	-4,822	-47,778	-22,230	-33,156	-56,575	-734,713	5,214
1997 (W)	913,778	294,349	203,007	-325,361	-3,961	-4,244	-85,533	-47,570	-57,284	-80,897	-816,686	10,403
1998 (W)	848,497	219,228	244,052	-291,337	-2,634	-3,516	-84,570	-28,544	-40,104	-65,282	-782,720	-13,069
1999 (AN)	237,038	261,793	98,984	-294,685	-1,606	-2,697	-20,374	-11,107	-15,569	-56,973	-204,159	9,356
2000 (AN)	123,126	255,557	161,368	-310,945	-1,344	-2,189	-34,663	-12,599	-16,983	-58,801	-98,476	-4,051
2001 (D)	72,246	258,336	150,551	-318,755	-1,507	-2,947	-30,167	-6,538	-8,407	-57,931	-56,508	1,626
2002 (D)	54,631	274,819	136,622	-321,924	-1,191	-2,289	-28,553	-4,986	-6,057	-61,552	-43,193	3,672
2003 (BN)	52,695	268,198	120,026	-306,374	-1,053	-2,365	-21,974	-2,115	-2,711	-56,654	-44,249	-3,423
2004 (D)	54,277	299,766	99,725	-333,917	-1,234	-2,766	-16,743	-2,405	-2,909	-58,549	-43,901	8,657
2005 (W)	382,430	242,308	172,037	-308,959	-3,373	-4,325	-34,416	-19,128	-24,460	-58,673	-333,518	-9,921
2006 (W)	1,108,275	243,592	189,522	-318,860	-4,076	-5,127	-47,179	-36,277	-57,395	-55,407	-1,013,262	-3,806
2007 (C)	122,290	284,683	76,757	-308,012	-1,456	-2,813	-13,704	-16,811	-19,096	-54,734	-80,425	13,321
2008 (C)	70,134	283,043	116,617	-319,252	-1,147	-1,954	-21,404	-6,261	-7,353	-56,484	-56,540	600
2009 (BN)	44,379	278,267	105,356	-310,840	-1,004	-2,249	-15,870	-1,389	-1,812	-53,495	-36,699	-4,644
2010 (AN)	90,159	223,909	180,927	-303,057	-1,647	-4,035	-43,397	-9,382	-13,472	-49,822	-62,389	-7,793
2011 (W)	1,061,150	229,648	189,374	-305,329	-3,775	-5,091	-49,801	-35,027	-49,190	-54,344	-976,630	-985
2012 (D)	46,214	280,193	64,458	-286,489	-1,410	-2,307	-13,708	-1,376	-2,240	-53,903	-38,001	8,569
2013 (C)	35,261	271,152	108,912	-303,344	-871	-1,891	-22,255	-2,121	-3,672	-57,708	-26,101	2,636
2014 (C)	10,664	269,014	53,197	-265,506	-700	-732	-8,710	-1,223	-1,469	-51,379	-4,790	1,635
Average (1989-2014)	308,226	261,688	152,711	-310,540	-1,988	-3,088	-39,173	-13,811	-18,747	-60,336	-275,457	515
W	845,535	244,150	213,175	-313,135	-3,667	-4,694	-66,622	-31,272	-43,298	-63,462	-773,322	-3,390
AN	150,108	247,086	147,093	-302,896	-1,532	-2,974	-32,811	-11,029	-15,341	-55,199	-121,675	-829
BN	48,537	273,233	112,691	-308,607	-1,029	-2,307	-18,922	-1,752	-2,261	-55,075	-40,474	-4,033
D	56,842	278,278	112,839	-315,271	-1,336	-2,577	-22,293	-3,826	-4,903	-57,984	-45,401	5,631
C	52,759	272,206	127,451	-309,108	-1,150	-2,098	-28,898	-6,336	-7,875	-61,485	-38,637	3,171

3.5 Net Recharge from SWS

Overdraft is defined in DWR Bulletin 118 as “the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions” (DWR 2003). The Madera Subbasin water budget indicates that overdraft conditions occurred during the 1989-2014 historical base period. Per 23 CCR Section 354.18(b)(5), the subbasin overdraft has been quantified for this base period. The evaluation of overdraft conditions includes estimates of recharge from subsurface flows. However, estimates of recharge from subsurface flows are less accurate when estimated for areas less than an entire subbasin. Thus, for estimates of GSA level contribution to overdraft, the term net recharge from the SWS is defined as groundwater recharge minus groundwater extraction. Net recharge from the SWS is useful for understanding and analyzing the combined effects of land surface processes on the underlying GWS.

When calculated from the historical water budget, average net recharge from the SWS represents the average recharge (when positive) or shortage of recharge (when negative) based on historical cropping, land use practices, and average hydrologic conditions. When calculated from the current land use water budget, average net recharge represents the average recharge or shortage (negative net recharge) based on current cropping, land use practices, and average hydrologic conditions.

Average net recharge from the SWS is presented below for the MC GSA portion of the Madera Subbasin. Table A2.F.b-17 shows the average net recharge from the SWS for 1989-2014 based on the historical water budget, and Table A2.F.b-18 shows the same for the current water budget. Historically, average annual net recharge from the SWS in MC GSA was approximately -78 taf between 1989 and 2014. Under current land use conditions, average annual net recharge from the SWS has decreased to approximately -111 taf.

The MC GSA recognizes that groundwater users within its boundaries want to understand potential future limitations on groundwater resources available to meet their beneficial uses. As shown in both Table A2.F.b-17 and Table A2.F.b-18, average values for infiltration of precipitation and infiltration of surface water are provided (columns “b” and “c”). The slight variation between the tables reflects the modified land use conditions. Together, these values represent the sustainable native groundwater for the MC GSA, a value of about 90,000 acre-feet per year.

While the MC GSA has not determined whether an allocation approach, or other methods, will best allow the MC GSA to achieve needed reductions in the consumptive use of groundwater (see GSP Chapter 4). However, the MC GSA recognizes the correlative nature of overlying groundwater rights, which, when coupled with appropriated groundwater use, provides that all the users share in the sustainable quantity of native groundwater. For purposes of analyzing the availability of sustainable quantities of native groundwater for all lands within the GSA, the estimated total quantity of sustainable native groundwater – estimated at 90,000 acre-feet per year – can be calculated to be approximately 0.5 acre-feet per acre within the GSA (based upon estimates of about 90,000 acre-feet of total sustainable native groundwater available for about 185,000 acres within the MC GSA). The achievement of sustainability may or may not involve an equal allocation across the MC GSA, and the MC GSA will use its SGMA-granted authority to manage the basin so as to achieve this end. Furthermore, other GSAs within the Madera Subbasin may choose to manage their proportion of the estimated sustainable native groundwater differently than the MC GSA, but they are also subject to the overall subbasin sustainability requirements.

Table A2.F.b-17. Historical Water Budget: Average Net Recharge from SWS by Water Year Type, 1989-2014 (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water[1] (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	59,323	68,138	69,670	210,557	-13,427
AN	3	51,277	33,499	47,093	214,159	-82,291
BN	2	50,343	19,337	41,868	233,171	-121,622
D	4	57,352	23,131	38,322	251,337	-132,532
C	9	56,045	29,658	45,266	230,142	-99,173
Annual Average (1989-2014)	26	56,266	40,143	51,656	225,765	-77,701

[1] Includes infiltration from the Rivers and Streams System and boundary seepage from San Joaquin River.

Table A2.F.b-18. Current Water Budget: Average Net Recharge from SWS by Water Year Type (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water[1] (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	63,462	66,622	69,394	244,150	-44,672
AN	3	55,199	32,811	47,510	247,086	-111,566
BN	2	55,075	18,922	41,789	273,233	-157,447
D	4	57,984	22,293	38,328	278,278	-159,674
C	9	61,485	28,898	45,012	272,206	-136,810
Annual Average (1989-2014)	26	60,336	39,173	51,526	261,688	-110,652

[1] Includes infiltration from the Rivers and Streams System and boundary seepage from San Joaquin River.

3.6 Uncertainties in Water Budget Components

Uncertainties associated with each water budget component were estimated as a percentage representing approximately a 95% confidence interval following the procedure described by Clemmens and Burt (1997). Uncertainties for all independently measured or estimated water budget components were estimated based on the measurement accuracy, typical values reported in technical literature, typical values calculated in other water budgets, and professional judgement.

Table A2.F.b-19 provides a summary of typical uncertainty values associated with major SWS inflow and outflow components. These uncertainties provide a basis for evaluating confidence in water budget results and help to identify data needs that may be addressed during GSP implementation.

Table A2.F.b-19. Estimated Uncertainty of GSA Water Budget Components.

Flowpath Direction (SWS Boundary)	Water Budget Component	Data Source	Estimated Uncertainty (%)	Source
Inflows	Surface Water Inflows	Calculation	5%	Estimated streamflow measurement accuracy
	Riparian Deliveries	Measurement	10%	Estimated measurement accuracy.
	Precipitation	Calculation	30%	Clemmens, A.J. and C.M. Burt, 1997.
	Groundwater Extraction	Closure	20%	Typical uncertainty calculated for Land Surface System water balance closure.
Outflows	Surface Water Outflows	Closure	20%	Estimated streamflow measurement accuracy and adjustment for losses.
	Evaporation	Calculation	20%	Estimated accuracy of calculation based on CIMIS reference ET and free water surface evaporation coefficient.
	ET of Applied Water	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, estimated crop coefficients from SEBAL energy balance, and annual land use.
	ET of Precipitation	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, precipitation, estimated crop coefficients from SEBAL energy balance, and annual land use.
	Infiltration of Applied Water	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use and NRCS soils characteristics.
	Infiltration of Precipitation	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use, NRCS soils characteristics, and CIMIS precipitation.
	Infiltration of Surface Water	Calculation	15%	Estimated accuracy of daily seepage calculation using NRCS soils characteristics and measured streamflow data.
	Change in SWS Storage	Calculation	50%	Professional Judgment.
Net Recharge from SWS		Calculation	25%	Estimated water budget accuracy; typical value calculated for GSA-level net recharge from SWS.

APPENDIX 2.F. WATER BUDGET INFORMATION

2.F.c. Surface Water System Water Budget: Madera Irrigation District GSA

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

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1 INTRODUCTION

To ensure sustainable groundwater management throughout California's groundwater basins, the Sustainable Groundwater Management Act of 2014 (SGMA) requires Groundwater Sustainability Agencies (GSAs) to prepare and adopt Groundwater Sustainability Plans (GSPs) with strategies to achieve subbasin groundwater sustainability within 20 years of plan adoption. Integral to each GSP is a water budget used to quantify the subbasin's groundwater overdraft (if applicable) and sustainable yield.

In 2017, Madera Irrigation District (MID) GSA formed to manage approximately 134,000 acres of the Madera Subbasin. This document presents results of the surface water system (SWS) water budgets developed for historical and current land use conditions in MID GSA. The MID GSA water budgets were integrated with separate water budgets developed for the other six (6) GSAs in Madera Subbasin to prepare a boundary water budget for the Madera Subbasin SWS. Results of the subbasin boundary water budget are reported in the Madera Subbasin GSP Section 2.2.3 and were integrated with a subbasin groundwater model (GSP Appendix 6.D) to estimate subbasin sustainable yield (GSP Section 2.2.3).

2 WATER BUDGET CONCEPTUAL MODEL

A water budget is defined as a complete accounting of all water flowing into and out of a defined volume (e.g., a subbasin or a GSA) over a specified period of time. The conceptual model (or structure) of the MID GSA water budget developed for this investigation is consistent with the GSP Regulations defined under Title 23 of California Code of Regulations[1] (CCR) and adheres to sound water budget principles and practices defined by California Department of Water Resources (DWR) in the Water Budget Best Management Practice (BMP) guidelines (DWR, 2016).

The lateral extent of MID GSA is defined by the boundaries indicated in Figure A2.F.c-1. The vertical extent of MID GSA is the land surface (top) and the base of fresh water at the bottom of the basin (bottom), as described in the hydrogeologic conceptual model (HCM) developed in GSP Section 2.2.1. The vertical extent of Madera Subbasin and its GSAs is subdivided into a surface water system (SWS) and the underlying groundwater system (GWS), with separate but related water budgets prepared for each that together represent the overall subbasin water budget.

A conceptual representation of the MID GSA water budget is represented in Figure A2.F.c-2. This document details only the SWS portion of the MID GSA water budget. The SWS is divided into three primary accounting centers: the Land Surface System, the Rivers and Streams System, and the Canal System. The Land Surface System is further divided into three accounting centers representing MID GSA's water use sectors: Agricultural Land, Native Vegetation Land, and Urban Land (urban, industrial, and semi-agricultural).

Water budget components, or directional flow of water between accounting centers and across the SWS boundary, are indicated by arrows. Inflows and outflows were calculated using measurements and other historical data or were calculated as the water budget closure term – the difference between all other estimated or measured inflows and outflows from each accounting center or water use sector (bold arrows).

[1] California Code of Regulations Title 23. Waters, Division 2. Department of Water Resources, Chapter 1.5. Groundwater Management, Subchapter 2. Groundwater Sustainability Plans.

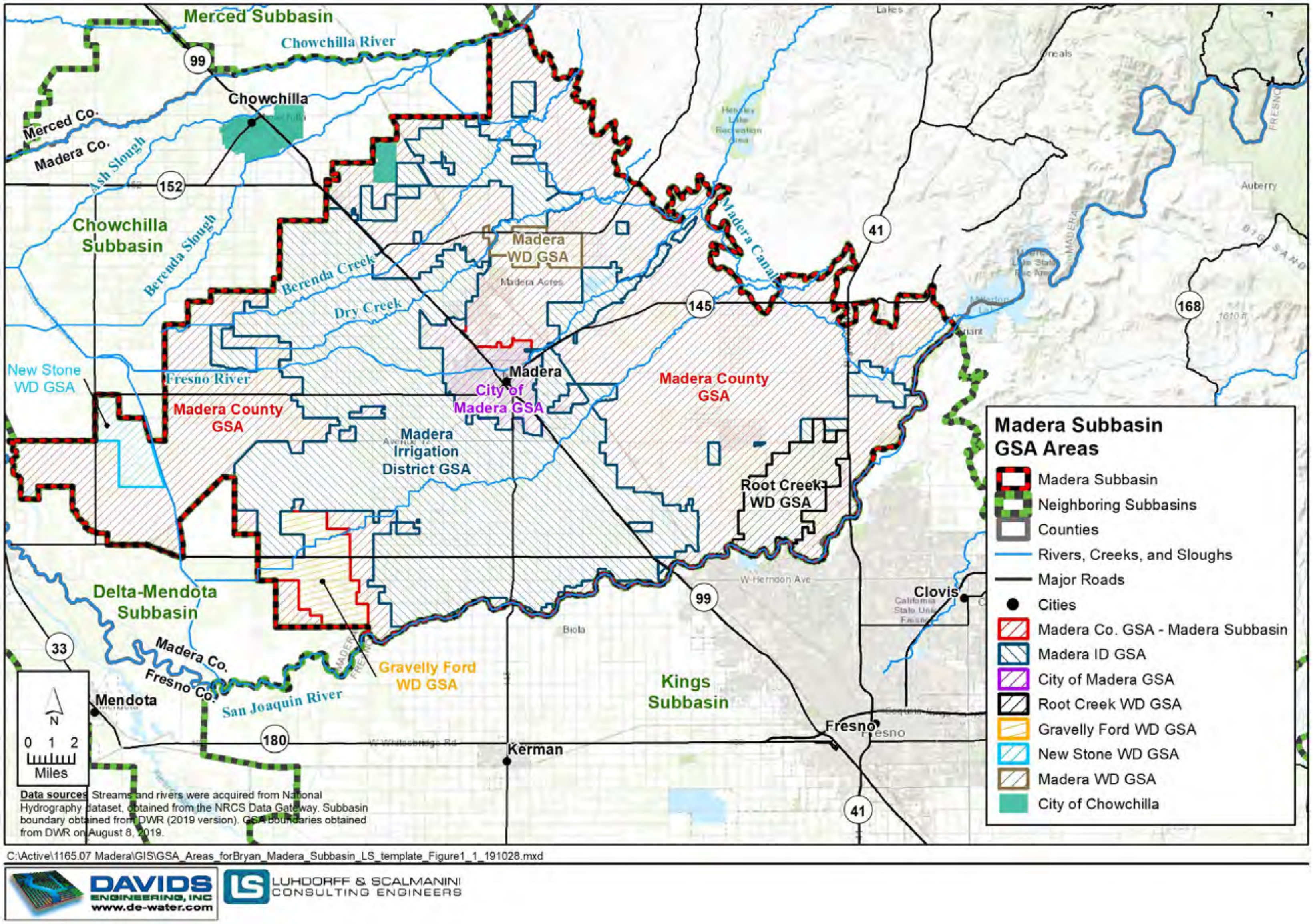

Figure A2.F.c-1. Madera Subbasin GSAs Map

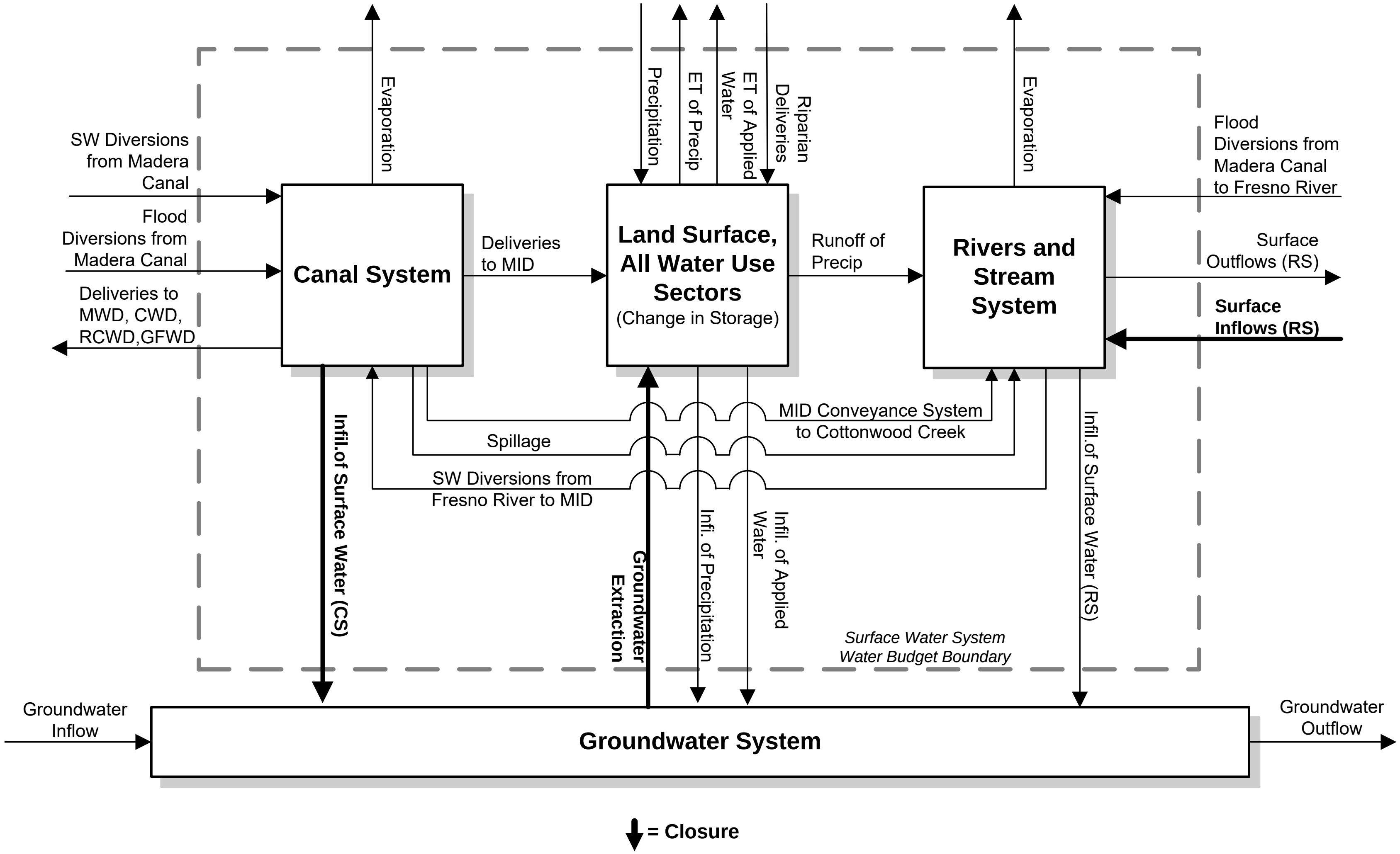

Figure A2.F.c-2. Madera Irrigation District GSA Water Budget Structure

Inflows to the SWS include precipitation, surface water inflows (in various canals and streams), and groundwater extraction. Outflows from the SWS include evapotranspiration (ET), surface water outflows (in various canals and streams), and infiltration to the groundwater system (seepage and deep percolation). Also represented in Figure A2.F.c-2 are inflows and outflows from the GWS, which are discussed and quantified at the subbasin level in the GWS water budget in GSP Section 2.2.3. Subsurface GWS inflows and outflows are not quantified on the water budget subregion scale.

Inflows and outflows were quantified following the process described in GSP Section 2.2.3 on a monthly time step for water years in the historical water budget base period (1989-2014 hydrologic and land use conditions), the current water budget (2015 land use using 1989-2014 average hydrologic conditions), and projected water budget. Four projected water budgets were prepared for the years 2019 through 2090 based on 1965 through 2015 hydrologic conditions, historical water supply data, and 2017 land use adjusted for urban area projected growth from 2017-2070 (areas were held constant from 2071-2090):

1. Historical hydrologic conditions (1965-2015) and water supply data (1989-2015) with adjustment of CVP supply based on projected alteration of available Friant Releases by the San Joaquin River Restoration Program (SJRRP)
    a. Without projects and management actions, and
    b. With projects and management actions
2. Historical hydrologic conditions (1965-2015) and water supply data (1989-2015) with adjustment of CVP supply based on projected alteration of available Friant Releases by the SJRRP and adjustment for anticipated climate change per DWR-provided 2030 climate change factors.
    a. Without projects and management actions, and
    b. With projects and management actions

Note, due to the “current water budget” approach described above, for the MID GSA specifically, this resulted in a conservative “current water budget” estimate of net recharge from SWS (defined as groundwater recharge minus groundwater extraction). MID’s operations for the 1989-2014 time period would have differed due to increased demands as assumed by the 2015 land use. However to be conservative in this GSP, the MID GSA is planning for the conservative number (higher deficit).

3 WATER BUDGET ANALYSIS

The historical water budget and current land use water budget for MID GSA are presented below following a summary of land use data relevant to water budget development. Land use data is provided for the 1989-2014 historical water budget period and for 2015, the current land use water budget period.

3.1 Land Use

Land use estimates for 1989 through 2015 corresponding to water use sectors (as defined by the GSP Regulations) are summarized in Figure A2.F.c-3 and Table A2.F.c-1 for MID GSA. According to GSP Regulations (23 CCR § 351(al)):

> *“Water use sector” refers to 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.*

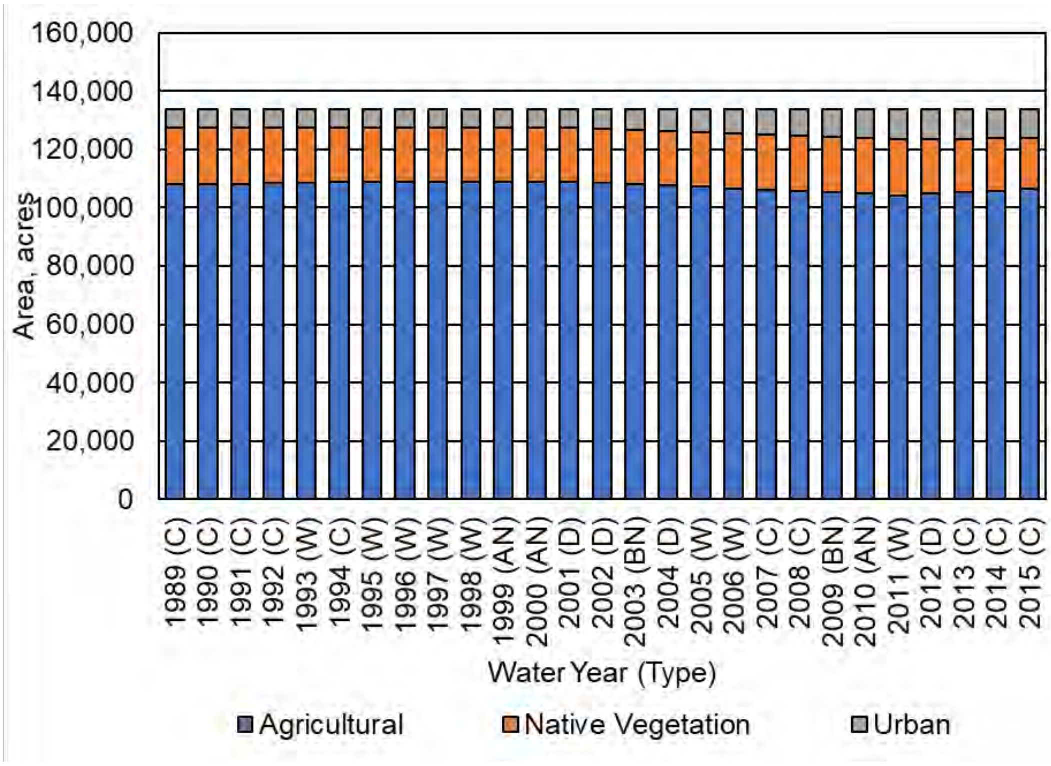

Figure A2.F.c-3. Madera Irrigation District GSA Land Use Areas

Table A2.F.c-1. Madera Irrigation District GSA Land Use Areas, acres

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
1989 (C)	107,910	19,636	6,304	133,850
1990 (C)	108,021	19,500	6,329	133,850
1991 (C)	108,197	19,306	6,347	133,850
1992 (C)	108,491	18,995	6,364	133,850
1993 (W)	108,680	18,785	6,385	133,850
1994 (C)	108,934	18,512	6,404	133,850
1995 (W)	109,076	18,356	6,418	133,850
1996 (W)	109,078	18,379	6,393	133,850
1997 (W)	109,080	18,402	6,368	133,850
1998 (W)	109,082	18,424	6,343	133,850
1999 (AN)	109,085	18,447	6,318	133,850
2000 (AN)	109,087	18,469	6,293	133,850
2001 (D)	109,090	18,492	6,268	133,850
2002 (D)	108,614	18,567	6,668	133,850
2003 (BN)	108,139	18,643	7,068	133,850
2004 (D)	107,664	18,719	7,468	133,850
2005 (W)	107,187	18,794	7,868	133,850
2006 (W)	106,712	18,870	8,268	133,850
2007 (C)	106,237	18,945	8,668	133,850

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
2008 (C)	105,762	19,021	9,068	133,850
2009 (BN)	105,285	19,096	9,468	133,850
2010 (AN)	104,810	19,172	9,868	133,850
2011 (W)	104,334	19,247	10,268	133,850
2012 (D)	104,821	18,817	10,212	133,850
2013 (C)	105,309	18,384	10,157	133,850
2014 (C)	105,796	17,953	10,101	133,850
2015 (C)	106,410	17,424	10,016	133,850
Average (1989-2014)	107,480	18,767	7,603	133,850

[1] Area includes land classified as native vegetation and water surfaces.

[2] Area includes land classified as urban, industrial, and semi-agricultural.

In MID GSA, water use sectors include agricultural, native vegetation, and urban land use. The urban land use category includes urban and semi-agricultural[2] lands as well as industrial land, which covers only a small area in the subbasin.

As indicated, agricultural lands remained relatively steady between 1989 and the early 2000s, after which a slight decrease in agricultural acreage coincided with expansion of urban lands. This is due in part to urban encroachment and changes in DWR's delineation of urban lands in land use surveys over time.

On average, agricultural and urban lands covered an average of approximately 107,000 acres and 8,000 acres, respectively, between 1989 and 2014. Native vegetation has remained fairly constant over time, covering approximately 19,000 acres on average between 1989 and 2014.

Agricultural land uses are further detailed in Figure A2.F.c-4 and Table A2.F.c-2. Historically, a majority of the agricultural area in MID has been comprised of permanent crops, such as grapes and orchard crops. While grape acreage has decreased since the early 2000s, orchard acreage more than doubled between 1989 and 2015.

[2] As defined in the DWR county land use surveys, semi-agricultural land use subclasses include farmsteads, livestock feed lot operations, dairies, poultry farms, and miscellaneous semi-agricultural land use incidental to agriculture (small roads, ditches, non-planted areas of cropped fields (DWR, 2009).

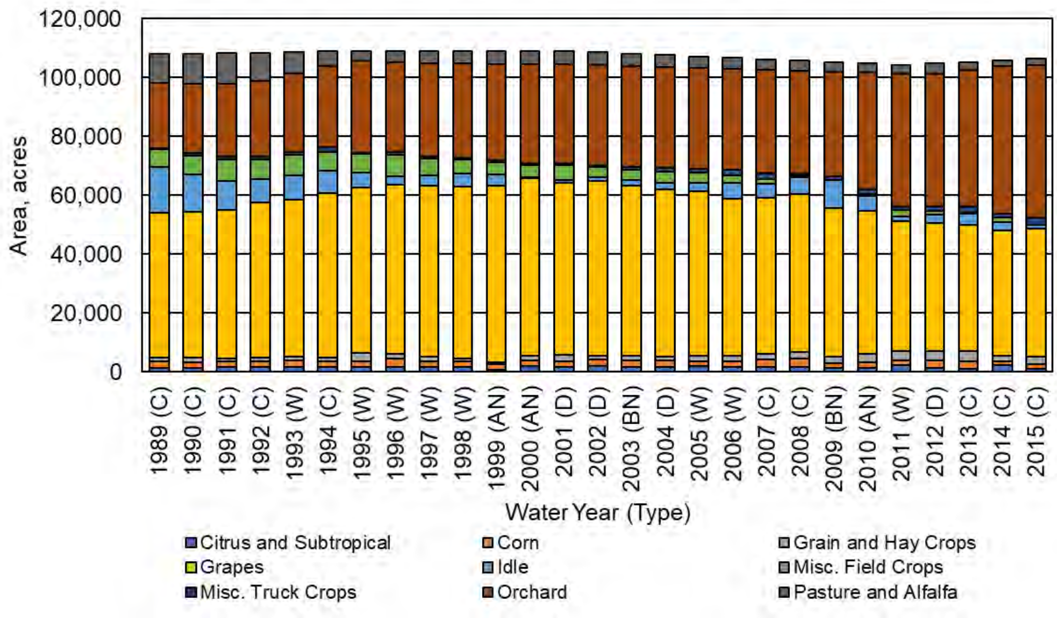

Figure A2.F.c-4. Madera Irrigation District GSA Agricultural Land Use Areas

Table A2.F.c-2. Madera Irrigation District GSA Agricultural Land Use Areas

Water Year (Type)	Citrus and Subtropical	Corn	Grain and Hay Crops	Grapes	Idle	Misc. Field Crops	Misc. Truck Crops	Orchard	Pasture and Alfalfa	Total
1989 (C)	1,483	2,160	1,162	49,111	15,644	6,036	497	22,095	9,723	107,910
1990 (C)	1,531	1,889	1,575	49,434	12,541	6,453	846	23,551	10,202	108,021
1991 (C)	1,718	1,758	1,108	50,577	9,791	7,229	853	24,764	10,397	108,197
1992 (C)	1,715	1,938	1,359	52,626	7,770	6,879	926	25,683	9,595	108,491
1993 (W)	1,746	2,043	1,331	53,441	8,113	6,930	1,058	26,715	7,303	108,680
1994 (C)	1,771	1,947	1,207	55,751	7,647	6,465	1,379	27,897	4,870	108,934
1995 (W)	1,605	2,066	2,755	56,216	5,028	6,289	511	31,436	3,171	109,076
1996 (W)	1,843	2,646	1,547	57,693	2,620	7,321	906	30,624	3,877	109,078
1997 (W)	1,831	1,792	1,585	58,063	3,640	5,537	794	31,688	4,150	109,080
1998 (W)	1,663	2,042	951	58,341	4,447	4,764	739	31,932	4,203	109,082
1999 (AN)	703	2,030	421	60,193	3,755	4,146	698	32,659	4,479	109,085
2000 (AN)	1,901	2,110	1,387	60,485	124	4,349	585	33,540	4,606	109,087
2001 (D)	1,791	1,753	2,245	58,485	864	5,181	609	33,584	4,578	109,090
2002 (D)	1,949	2,131	1,564	59,187	1,327	3,401	752	33,886	4,419	108,614
2003 (BN)	1,838	2,147	1,360	57,963	1,967	3,463	922	34,219	4,259	108,139
2004 (D)	1,686	2,122	1,490	56,843	2,124	3,900	1,293	34,108	4,099	107,664
2005 (W)	1,874	1,805	1,963	55,598	3,117	3,404	1,332	34,155	3,940	107,187
2006 (W)	1,735	1,951	1,957	53,305	5,288	2,510	1,799	34,386	3,780	106,712
2007 (C)	1,797	2,445	1,761	53,158	4,661	1,751	1,811	35,231	3,621	106,237
2008 (C)	1,671	2,990	2,261	53,616	5,616	471	741	34,935	3,461	105,762
2009 (BN)	1,471	1,600	2,099	50,434	9,589	66	1,342	35,383	3,302	105,285
2010 (AN)	1,523	1,678	3,024	48,612	4,822	878	1,454	39,677	3,142	104,810
2011 (W)	2,270	1,517	3,161	44,360	1,451	2,162	1,525	44,906	2,983	104,334
2012 (D)	1,242	2,729	3,016	43,674	2,741	1,233	1,782	45,012	3,392	104,821
2013 (C)	1,097	2,539	3,334	42,985	3,890	373	1,993	46,453	2,645	105,309
2014 (C)	2,206	1,355	2,055	42,298	3,004	1,463	1,333	50,074	2,010	105,796
2015 (C)	1,205	1,421	2,628	43,290	1,481	43	2,565	51,559	2,218	106,410
Average (1989-2014)	1,679	2,046	1,834	53,171	5,061	3,948	1,095	33,792	4,854	107,480

3.2 Surface Water System Water Budget

This section presents surface water system water budget components within MID GSA as per GSP regulations. These are followed by a summary of the water budget results by accounting center.

3.2.1 Inflows

3.2.1.1 Surface Water Inflow by Water Source Type

Surface water inflows include surface water flowing into MID across the subregion boundary. Per the Regulations, surface inflows 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.*

Additionally, runoff of precipitation from upgradient areas adjacent to the subregion represents a potential source of surface water inflow.

Local Supplies

Local supplies in MID GSA include pre-1914 water rights and riparian irrigators in MID GSA along Fresno River and the San Joaquin River. Natural flows along Berenda Creek, Dry Creek, and Cottonwood Creek also pass through the boundaries of MID GSA.

CVP Supplies

MID GSA receives CVP supplies from Hensley Lake via Hidden Dam releases in the Fresno River and from Millerton Lake via the Madera Canal. CVP supplies are diverted directly from Madera Canal or from the Fresno River through Franchi Diversion Dam.

Recycling and Reuse

Recycling and reuse are not a significant source of supply within MID.

Other Surface Inflows

For the water budgets presented herein, precipitation runoff from outside the subregion is considered relatively minimal and is expected to pass through the waterways accounted above following relatively large storm events. Precipitation runoff from lands inside the subregion is internal to the surface water system and is thus not considered as surface inflows to the subregion boundary

Summary of Surface Inflows

The surface water inflows described above are summarized by water source type in Figure A2.F.c-5 and Table A2.F.c-3. During the historical water budget period, total surface inflows average 216 taf per year.

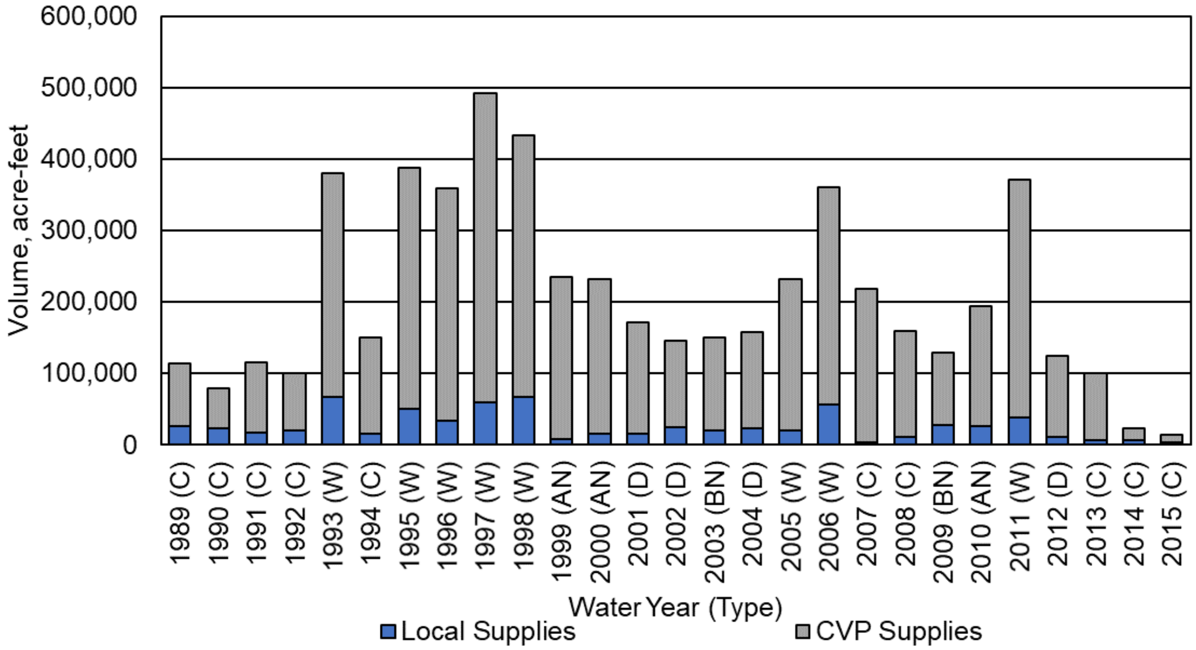

Figure A2.F.c-5. Madera Irrigation District GSA Surface Water Inflows by Water Source Type.

Table A2.F.c-3. Madera Irrigation District GSA Surface Water Inflows by Water Source Type (Acre-Feet).

Water Year (Type)	Local Supply	CVP Supply[1]	Total
1989 (C)	25,810	88,150	113,950
1990 (C)	22,940	55,830	78,760
1991 (C)	17,000	97,710	114,710
1992 (C)	19,370	81,430	100,800
1993 (W)	66,490	313,460	379,950
1994 (C)	15,460	133,960	149,420
1995 (W)	50,910	337,190	388,100
1996 (W)	33,440	324,970	358,410
1997 (W)	59,160	432,210	491,370
1998 (W)	66,900	365,980	432,880
1999 (AN)	7,620	226,870	234,490
2000 (AN)	14,820	216,960	231,780
2001 (D)	15,400	156,420	171,820
2002 (D)	24,350	121,570	145,920
2003 (BN)	20,710	129,250	149,960
2004 (D)	23,540	134,670	158,210
2005 (W)	20,240	211,020	231,270
2006 (W)	55,670	304,240	359,910
2007 (C)	3,300	214,300	217,600
2008 (C)	10,210	149,260	159,470

Water Year (Type)	Local Supply	CVP Supply[1]	Total
2009 (BN)	26,890	102,700	129,590
2010 (AN)	25,350	169,010	194,360
2011 (W)	38,200	333,390	371,590
2012 (D)	10,520	113,280	123,790
2013 (C)	5,770	94,820	100,590
2014 (C)	6,910	16,180	23,090
2015 (C)	3,780	9,600	13,380
Average (1989-2014)	26,420	189,420	215,840
Average (1989-2014) W	48,880	327,810	376,680
Average (1989-2014) AN	15,930	204,280	220,210
Average (1989-2014) BN	23,800	115,980	139,780
Average (1989-2014) D	18,450	131,480	149,940
Average (1989-2014) C	14,080	103,520	117,600

[1]CVP Supply is considered as all water supply released from CVP storage facilities. The volume of CVP Supply includes CVP deliveries to CVP contractors/water users, and flood releases from CVP facilities that largely pass through the subbasin.

3.2.1.2 Precipitation

Precipitation estimates for MID GSA are provided in Figure A2.F.c-6 and Table A2.F.c-4. Precipitation estimates are reported by water use sector.

Total precipitation is highly variable between years in the study area, ranging from approximately 84 taf (7.6 inches) during average dry years to 158 taf (14.4 inches) during average wet years.

3.2.1.3 Groundwater Extraction by Water Use Sector

Estimates of groundwater extraction by water use sector are provided in Figure 7 and Table 5. For agricultural and urban (urban, semi-agricultural, industrial) lands, groundwater extraction represents pumping, while for native lands, groundwater extraction by riparian vegetation was considered to be minimal. Groundwater extraction is dominated by irrigated agriculture, varying substantially from year to year based on variability in surface water supplies.

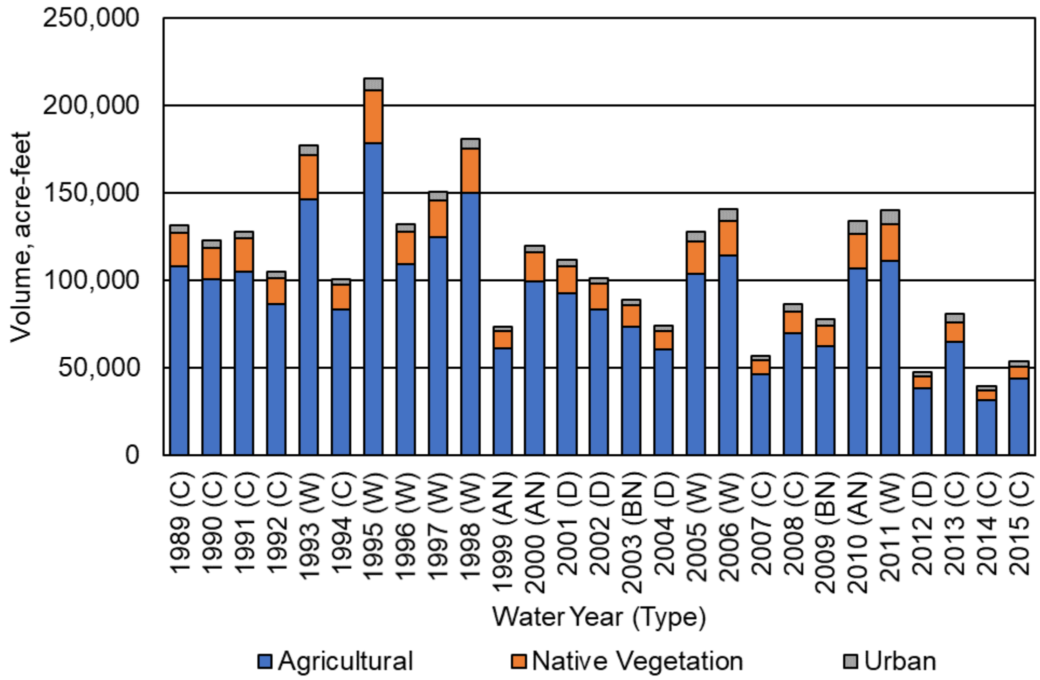

Figure A2.F.c-6. Madera Irrigation District GSA Precipitation by Water Use Sector.

Table A2.F.c-4. Madera Irrigation District GSA Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	107,550	19,570	4,110	131,240
1990 (C)	100,370	18,120	3,860	122,350
1991 (C)	105,040	18,740	4,060	127,850
1992 (C)	86,070	15,070	3,340	104,480
1993 (W)	146,080	25,250	5,710	177,040
1994 (C)	82,970	14,100	3,260	100,340
1995 (W)	178,340	30,020	7,060	215,420
1996 (W)	108,990	18,370	4,310	131,660
1997 (W)	124,530	21,010	4,930	150,470
1998 (W)	149,720	25,290	5,920	180,920
1999 (AN)	60,720	10,270	2,400	73,390
2000 (AN)	99,000	16,760	3,910	119,670
2001 (D)	92,360	15,660	3,640	111,660
2002 (D)	83,450	14,270	3,570	101,290
2003 (BN)	72,990	12,580	3,360	88,940
2004 (D)	60,380	10,500	2,990	73,870
2005 (W)	103,700	18,180	5,480	127,370
2006 (W)	113,740	20,110	6,400	140,250
2007 (C)	45,860	8,180	2,740	56,780
2008 (C)	69,360	12,470	4,380	86,220
2009 (BN)	62,380	11,320	4,160	77,860
2010 (AN)	106,640	19,510	7,490	133,640
2011 (W)	111,120	20,500	8,200	139,820

2012 (D)	38,000	6,820	2,770	47,590
2013 (C)	64,500	11,260	4,650	80,410
2014 (C)	31,650	5,370	2,260	39,280
2015 (C)	43,450	7,120	3,040	53,610
Average (1989-2014)	92,520	16,130	4,420	113,070
Average (1989-2014) W	129,530	22,340	6,000	157,870
Average (1989-2014) AN	88,790	15,510	4,600	108,900
Average (1989-2014) BN	67,690	11,950	3,760	83,400
Average (1989-2014) D	68,550	11,810	3,240	83,600
Average (1989-2014) C	77,040	13,650	3,630	94,330

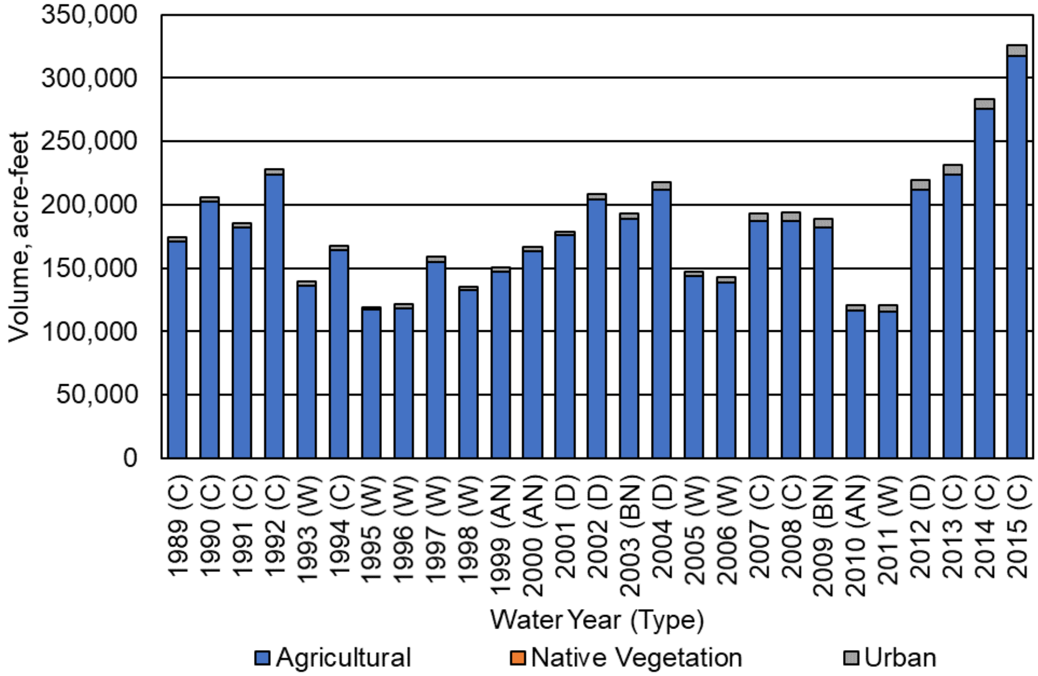

Figure A2.F.c-7. Madera Irrigation District GSA Groundwater Extraction by Water Use Sector.

Table A2.F.c-5. Madera Irrigation District GSA Groundwater Extraction by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	171,160	0	3,110	174,270
1990 (C)	202,280	0	3,280	205,560
1991 (C)	182,270	0	3,080	185,350
1992 (C)	223,910	0	4,060	227,970
1993 (W)	135,780	0	3,190	138,960
1994 (C)	163,980	0	3,650	167,630
1995 (W)	116,830	0	2,080	118,910
1996 (W)	118,340	0	2,950	121,290
1997 (W)	154,550	0	4,740	159,280
1998 (W)	132,970	0	2,550	135,520

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1999 (AN)	147,210	0	3,600	150,810
2000 (AN)	162,990	0	3,430	166,420
2001 (D)	175,780	0	3,170	178,940
2002 (D)	203,660	0	4,290	207,940
2003 (BN)	188,650	0	4,420	193,070
2004 (D)	211,770	0	5,980	217,750
2005 (W)	143,230	0	3,940	147,170
2006 (W)	138,800	0	3,980	142,780
2007 (C)	186,740	0	6,520	193,260
2008 (C)	187,360	0	6,680	194,040
2009 (BN)	182,250	0	6,770	189,030
2010 (AN)	116,160	0	4,140	120,300
2011 (W)	115,700	0	4,800	120,490
2012 (D)	211,890	0	7,450	219,330
2013 (C)	223,250	0	7,740	230,990
2014 (C)	275,930	0	7,490	283,420
2015 (C)	317,140	0	8,220	325,360
Average (1989-2014)	172,060	0	4,500	176,560
Average (1989-2014) W	132,020	0	3,530	135,550
Average (1989-2014) AN	142,120	0	3,720	145,840
Average (1989-2014) BN	185,450	0	5,600	191,050
Average (1989-2014) D	200,770	0	5,220	205,990
Average (1989-2014) C	201,880	0	5,070	206,940

3.2.1.4 Groundwater Discharge to Surface Water Sources

The depth to groundwater is greater than 100-200 ft across much of the Madera Subbasin. Given the depth to the water table in the Madera Subbasin, groundwater discharge to surface water sources is negligible.

3.2.2 Outflows

3.2.2.1 Evapotranspiration by Water Use Sector

Evapotranspiration (ET) by water use sector is reported in Figures A2.F.c-8 to A2.F.c-10 and Tables A2.F.c-6 to A2.F.c-8. First, total ET is reported, followed by ET from applied water and ET from precipitation.

Total ET varies between years, with the lowest observed in 1989, at approximately 259 taf, and greatest in 2004, at approximately 322 taf. Agricultural ET tends to increase in drier years, while native ET decreases.

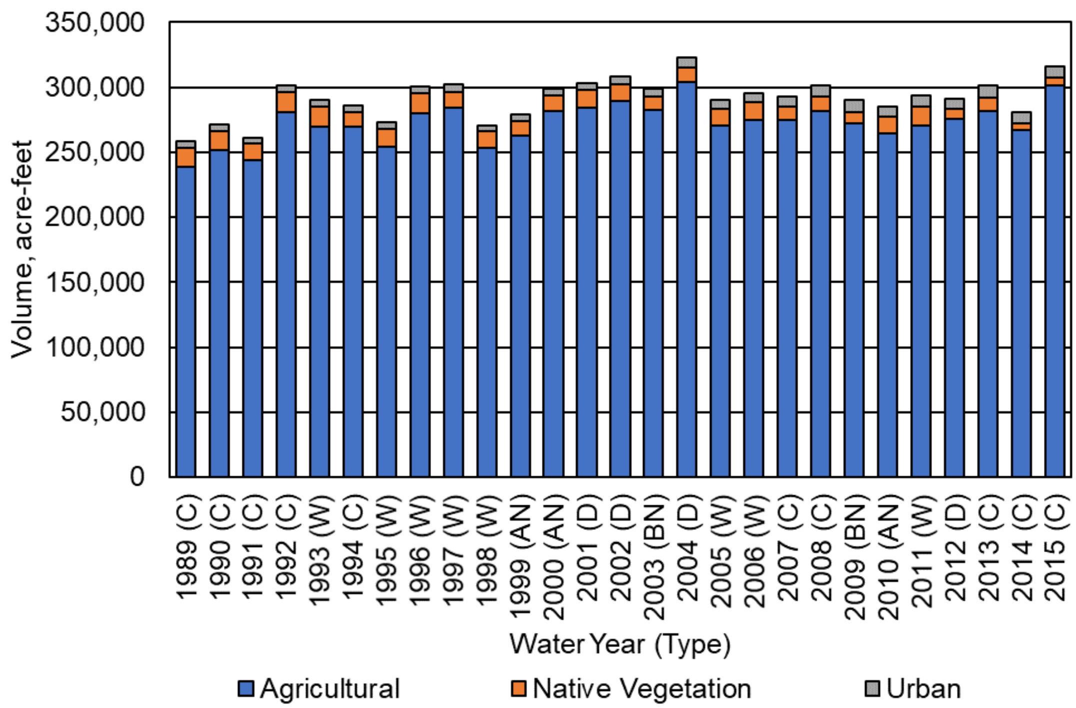

Figure A2.F.c-8. Madera Irrigation District GSA Evapotranspiration by Water Use Sector.

Table A2.F.c-6. Madera Irrigation District GSA Evapotranspiration by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	239,030	14,710	4,830	258,570
1990 (C)	251,650	14,260	5,080	270,990
1991 (C)	244,250	12,680	4,440	261,370
1992 (C)	281,100	14,960	5,460	301,520
1993 (W)	269,970	14,810	5,270	290,050
1994 (C)	269,450	11,540	5,180	286,170
1995 (W)	253,800	14,310	4,820	272,930
1996 (W)	280,280	14,710	5,160	300,150
1997 (W)	283,830	12,850	5,480	302,160
1998 (W)	253,250	12,630	4,760	270,640
1999 (AN)	263,170	10,790	4,740	278,700
2000 (AN)	281,420	12,410	5,120	298,950
2001 (D)	284,480	13,440	4,990	302,910
2002 (D)	289,520	12,730	5,810	308,060
2003 (BN)	282,610	10,340	6,000	298,950
2004 (D)	304,020	11,280	7,160	322,460
2005 (W)	270,760	12,930	6,600	290,290
2006 (W)	274,470	14,000	7,080	295,550
2007 (C)	274,910	10,220	7,450	292,580
2008 (C)	281,680	10,970	8,510	301,160
2009 (BN)	272,000	9,170	8,700	289,870
2010 (AN)	264,290	13,080	8,140	285,510

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2011 (W)	270,720	14,150	8,610	293,480
2012 (D)	275,360	7,910	7,910	291,180
2013 (C)	281,680	9,980	9,330	300,990
2014 (C)	267,330	5,230	7,820	280,380
2015 (C)	301,660	5,830	8,770	316,260
Average (1989-2014)	271,730	12,160	6,320	290,210
Average (1989-2014) W	269,640	13,800	5,970	289,410
Average (1989-2014) AN	269,630	12,100	6,000	287,730
Average (1989-2014) BN	277,300	9,750	7,350	294,400
Average (1989-2014) D	288,340	11,340	6,460	306,140
Average (1989-2014) C	265,680	11,620	6,460	283,760

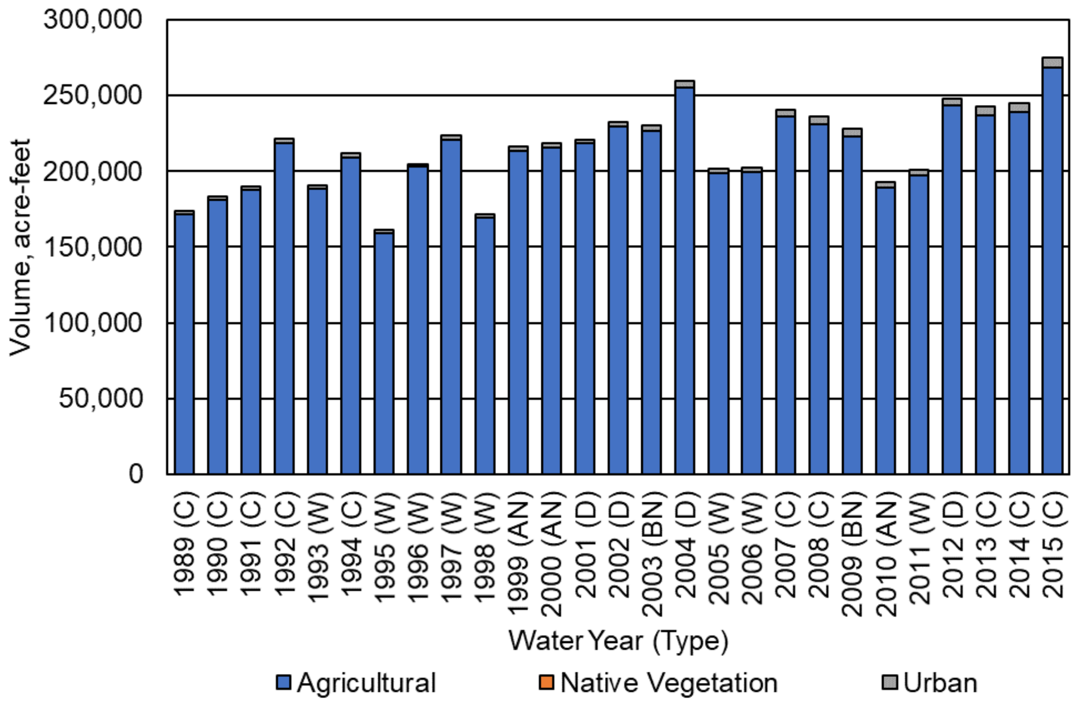

Figure A2.F.c-9. Madera Irrigation District GSA Evapotranspiration of Applied Water by Water Use Sector.

Table A2.F.c-7. Madera Irrigation District GSA Evapotranspiration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	171,480	0	2,220	173,700
1990 (C)	181,160	0	2,340	183,500
1991 (C)	188,080	0	2,150	190,230
1992 (C)	218,790	0	2,710	221,500
1993 (W)	188,730	0	2,290	191,020
1994 (C)	208,910	0	2,740	211,650
1995 (W)	159,440	0	1,650	161,090
1996 (W)	202,800	0	1,900	204,700
1997 (W)	220,690	0	2,690	223,380

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1998 (W)	169,220	0	2,030	171,250
1999 (AN)	213,560	0	2,410	215,970
2000 (AN)	215,720	0	2,630	218,350
2001 (D)	218,570	0	2,290	220,860
2002 (D)	229,690	0	3,070	232,760
2003 (BN)	226,690	0	3,460	230,150
2004 (D)	255,450	0	4,370	259,820
2005 (W)	198,500	0	3,210	201,710
2006 (W)	199,380	0	3,190	202,570
2007 (C)	235,840	0	4,340	240,180
2008 (C)	230,700	0	5,120	235,820
2009 (BN)	222,880	0	5,500	228,380
2010 (AN)	189,460	0	3,680	193,140
2011 (W)	197,540	0	3,500	201,040
2012 (D)	243,180	0	4,840	248,020
2013 (C)	237,060	0	5,850	242,910
2014 (C)	238,950	0	5,700	244,650
2015 (C)	268,660	0	6,500	275,160
Average (1989-2014)	210,090	0	3,300	213,390
Average (1989-2014) W	192,040	0	2,560	194,600
Average (1989-2014) AN	206,250	0	2,910	209,160
Average (1989-2014) BN	224,780	0	4,480	229,260
Average (1989-2014) D	236,720	0	3,640	240,360
Average (1989-2014) C	212,330	0	3,690	216,020

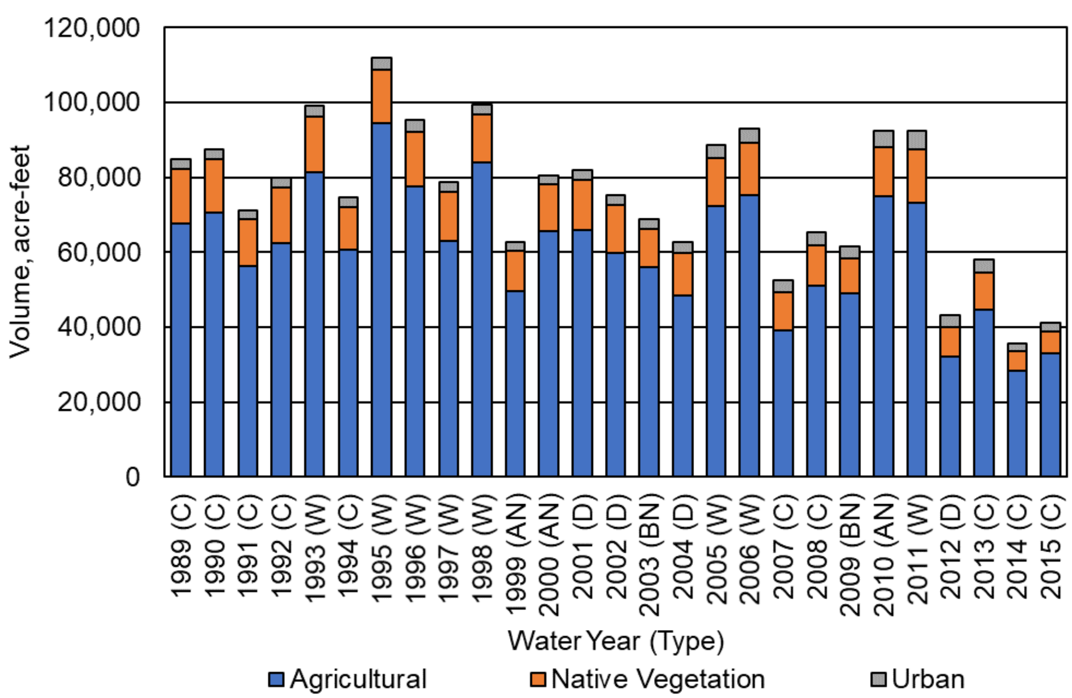

Figure A2.F.c-10. Madera Irrigation District GSA Evapotranspiration of Precipitation by Water Use Sector.

Table A2.F.c-8. Madera Irrigation District GSA Evapotranspiration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	67,550	14,710	2,610	84,870
1990 (C)	70,490	14,260	2,740	87,490
1991 (C)	56,170	12,680	2,290	71,140
1992 (C)	62,310	14,960	2,750	80,020
1993 (W)	81,240	14,810	2,980	99,030
1994 (C)	60,540	11,540	2,440	74,520
1995 (W)	94,360	14,310	3,170	111,840
1996 (W)	77,480	14,710	3,260	95,450
1997 (W)	63,140	12,850	2,790	78,780
1998 (W)	84,030	12,630	2,730	99,390
1999 (AN)	49,610	10,790	2,330	62,730
2000 (AN)	65,700	12,410	2,490	80,600
2001 (D)	65,910	13,440	2,700	82,050
2002 (D)	59,830	12,730	2,740	75,300
2003 (BN)	55,920	10,340	2,540	68,800
2004 (D)	48,570	11,280	2,790	62,640
2005 (W)	72,260	12,930	3,390	88,580
2006 (W)	75,090	14,000	3,890	92,980
2007 (C)	39,070	10,220	3,110	52,400
2008 (C)	50,980	10,970	3,390	65,340
2009 (BN)	49,120	9,170	3,200	61,490
2010 (AN)	74,830	13,080	4,460	92,370
2011 (W)	73,180	14,150	5,110	92,440
2012 (D)	32,180	7,910	3,070	43,160
2013 (C)	44,620	9,980	3,480	58,080
2014 (C)	28,380	5,230	2,120	35,730
2015 (C)	33,000	5,830	2,270	41,100
Average (1989-2014)	61,640	12,160	3,020	76,820
Average (1989-2014) W	77,600	13,800	3,410	94,810
Average (1989-2014) AN	63,380	12,100	3,090	78,570
Average (1989-2014) BN	52,520	9,750	2,870	65,140
Average (1989-2014) D	51,620	11,340	2,820	65,780
Average (1989-2014) C	53,350	11,620	2,770	67,740

In addition to ET from land surfaces, estimates of evaporation from MID canals and rivers and streams are reported in Figure A2.F.c-11 and Table A2.F.c-9. Evaporation from the Rivers and Streams System includes evaporation of both surface inflows and of precipitation runoff within local sloughs and depressions. Evaporation from the canals is relatively constant between years, averaging approximately 1 taf annually. Evaporation from the rivers and streams is higher during wet years (3.8 taf) and lower during critical years (2.2 taf), following the pattern of typical surface water inflows.

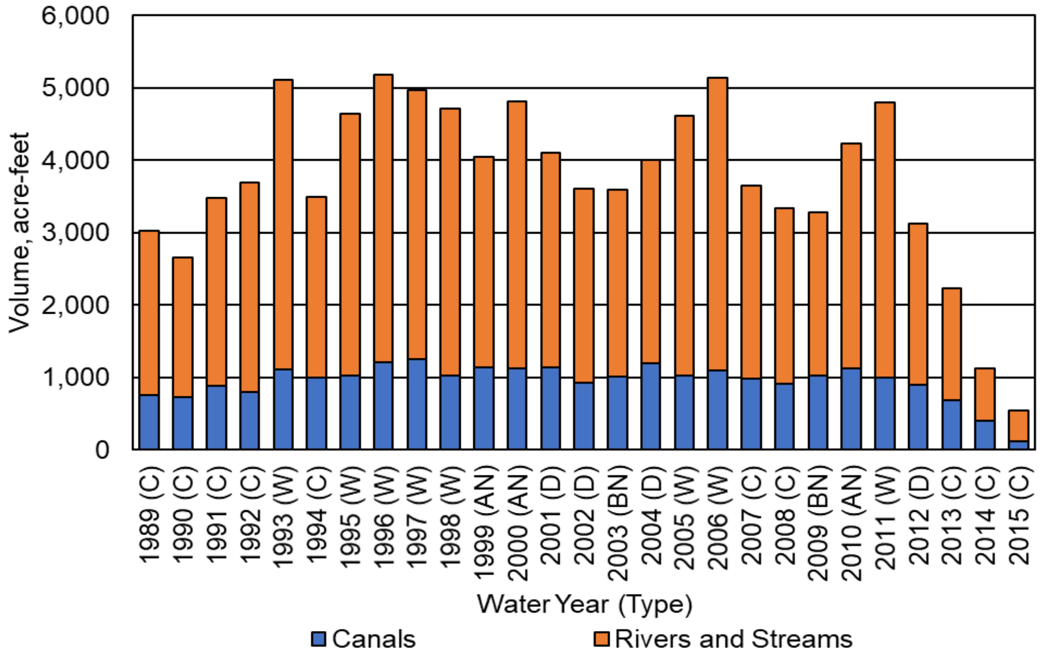

Figure A2.F.c-11. Madera Irrigation District GSA Evaporation from the Surface Water System.

Table A2.F.c-9. Madera Irrigation District GSA Evaporation from the Surface Water System (Acre-Feet).

Water Year (Type)	Canals	Rivers and Streams[1]	Total
1989 (C)	750	2,280	3,030
1990 (C)	730	1,930	2,660
1991 (C)	880	2,610	3,490
1992 (C)	800	2,890	3,690
1993 (W)	1,110	4,000	5,110
1994 (C)	1,000	2,490	3,490
1995 (W)	1,020	3,630	4,650
1996 (W)	1,210	3,970	5,180
1997 (W)	1,250	3,720	4,970
1998 (W)	1,020	3,690	4,710
1999 (AN)	1,140	2,920	4,060
2000 (AN)	1,130	3,690	4,820
2001 (D)	1,140	2,960	4,100
2002 (D)	920	2,680	3,600
2003 (BN)	1,010	2,590	3,600
2004 (D)	1,200	2,810	4,010
2005 (W)	1,020	3,600	4,620
2006 (W)	1,100	4,040	5,140
2007 (C)	990	2,660	3,650
2008 (C)	910	2,430	3,340
2009 (BN)	1,030	2,250	3,280
2010 (AN)	1,120	3,110	4,230
2011 (W)	1,000	3,800	4,800

Water Year (Type)	Canals	Rivers and Streams[1]	Total
2012 (D)	890	2,230	3,120
2013 (C)	690	1,550	2,240
2014 (C)	400	730	1,130
2015 (C)	120	420	540
Average (1989-2014)	980	2,890	3,870
Average (1989-2014) W	1,090	3,810	4,900
Average (1989-2014) AN	1,130	3,240	4,370
Average (1989-2014) BN	1,020	2,420	3,440
Average (1989-2014) D	1,040	2,670	3,710
Average (1989-2014) C	790	2,170	2,960

[1] Includes evaporation of surface inflows and of precipitation runoff.

3.2.2.2 Surface Water Outflow by Water Source Type

Surface water outflows by water source type are summarized in Figure A2.F.c-12 and Table A2.F.c-10. In MID GSA, runoff of applied water is assumed negligible and runoff of precipitation is collected in waterways within MID GSA, with most infiltrating to the groundwater system except following the largest storm events. Thus, surface outflows primarily from local supplies and CVP supplies are expected to leave the subregion. Surface outflows of local supplies are comprised of natural flows along waterways that cross the subregion. Surface outflows of CVP supplies are comprised, in part, of direct deliveries made by MID to customers or water distributors outside MID, including Gravelly Ford WD, Madera WD, Root Creek WD, and Chowchilla WD. Other surface outflows of CVP supplies include Hidden Dam and Millerton Reservoir releases along Fresno River and releases from the MID conveyance system to Cottonwood Creek for delivery to Gravelly Ford WD. Total surface outflows average approximately 53 taf per year.

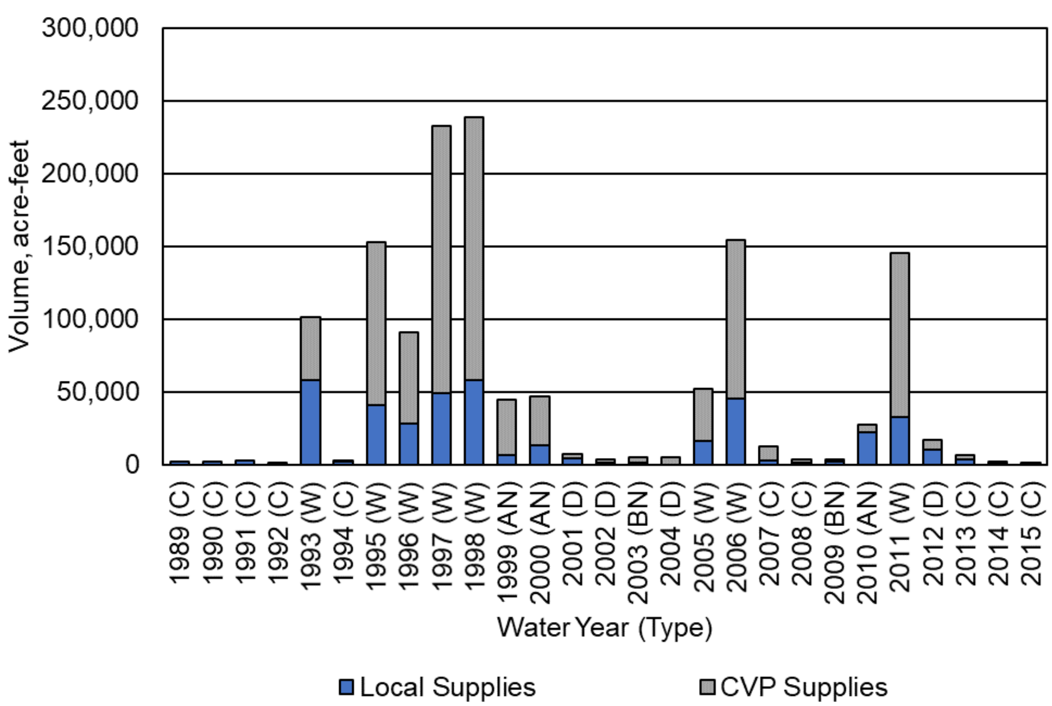

Figure A2.F.c-12. Madera Irrigation District GSA Surface Outflows by Water Source Type.

Table A2.F.c-10. Madera Irrigation District GSA Surface Outflows by Water Source Type (Acre-Feet).

Water Year (Type)	Local Supplies	CVP Supplies	Total
1989 (C)	2,540	0	2,540
1990 (C)	2,270	0	2,270
1991 (C)	3,170	0	3,170
1992 (C)	1,270	0	1,270
1993 (W)	58,020	43,630	101,650
1994 (C)	2,290	1,020	3,310
1995 (W)	41,480	111,610	153,090
1996 (W)	28,470	62,870	91,340
1997 (W)	49,600	183,040	232,640
1998 (W)	58,540	179,840	238,380
1999 (AN)	7,080	38,070	45,150
2000 (AN)	13,410	33,560	46,970
2001 (D)	4,460	2,750	7,210
2002 (D)	1,480	2,680	4,160
2003 (BN)	1,680	3,900	5,580
2004 (D)	440	4,590	5,030
2005 (W)	16,840	35,110	51,950
2006 (W)	45,340	109,110	154,450
2007 (C)	3,300	9,790	13,090
2008 (C)	1,430	2,520	3,950
2009 (BN)	2,020	2,110	4,130
2010 (AN)	22,410	5,560	27,970
2011 (W)	32,880	112,880	145,760
2012 (D)	10,280	6,840	17,120
2013 (C)	3,650	3,010	6,660
2014 (C)	570	1,680	2,250
2015 (C)	660	1,240	1,900
Average (1989-2014)	15,960	36,780	52,730
Average (1989-2014) W	41,400	104,760	146,160
Average (1989-2014) AN	14,300	25,730	40,030
Average (1989-2014) BN	1,850	3,010	4,860
Average (1989-2014) D	4,170	4,220	8,380
Average (1989-2014) C	2,280	2,000	4,280

3.2.2.3 Infiltration of Precipitation

Estimated infiltration of precipitation (deep percolation of precipitation) by water use sector is provided in Figure A2.F.c-13 and Table A2.F.c-11. Infiltration of precipitation to the groundwater system is highly variable from year to year due to variation in the timing and amount of precipitation, ranging from less than 15 taf annually during some critical and dry years to more than 80 taf during 1995.

3.2.2.4 Infiltration of Surface Water

Estimated infiltration of surface water (seepage) by source is provided in Figure A2.F.c-14 and Table A2.F.c-12. Seepage from the Rivers and Streams System includes seepage of both surface inflows and of precipitation runoff into local sloughs and depressions. The canal system predominantly contributes to seepage in MID, with seepage averaging 47 taf per year between 1989 and 2014. Seepage from rivers and streams is comparatively lower, averaging 14 taf per year. While flows in the San Joaquin River were not accounted directly as water budget components[3], boundary seepage from the San Joaquin River contributes an additional 20 taf per year on average to net recharge in MID GSA.

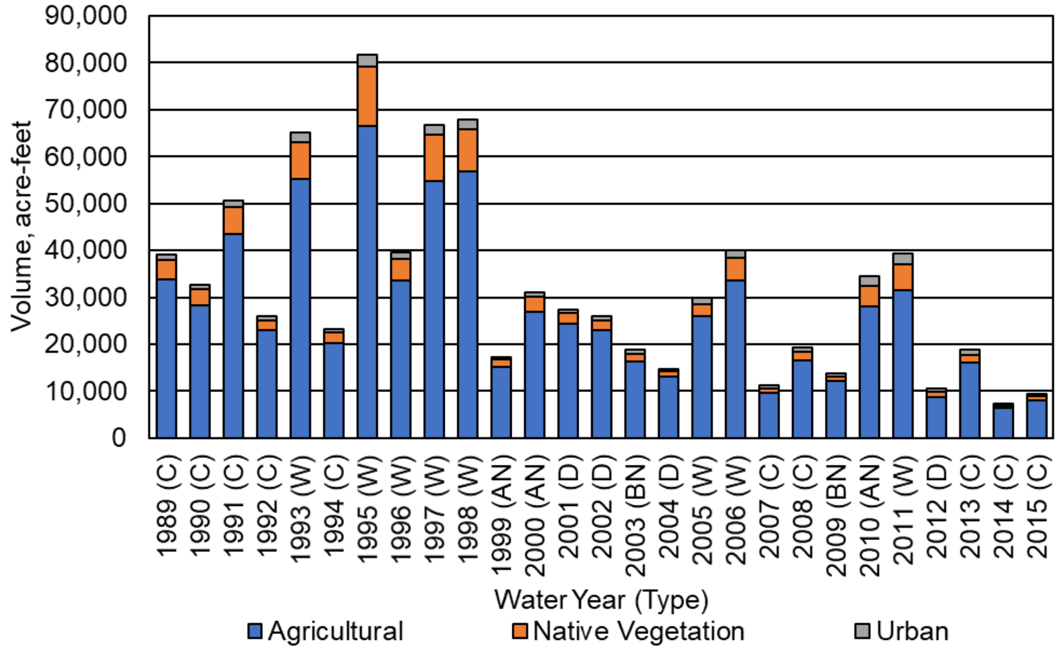

Figure A2.F.c-13. Madera Irrigation District GSA Infiltration of Precipitation by Water Use Sector.

Table A2.F.c-11. Madera Irrigation District GSA Infiltration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	33,890	4,040	1,160	39,090
1990 (C)	28,210	3,540	980	32,730
1991 (C)	43,490	5,650	1,440	50,580
1992 (C)	22,990	2,180	780	25,950
1993 (W)	55,190	7,920	1,970	65,080
1994 (C)	20,270	2,220	790	23,280
1995 (W)	66,440	12,650	2,580	81,670
1996 (W)	33,540	4,730	1,320	39,590
1997 (W)	54,770	9,830	2,180	66,780
1998 (W)	56,770	9,010	2,180	67,960
1999 (AN)	15,200	1,470	620	17,290
2000 (AN)	26,970	3,060	1,000	31,030

[3] The San Joaquin River does not cross the lateral boundaries of the Madera Subbasin, as defined above. Thus, San Joaquin River flows are not considered surface water inflows within this water budget. A portion of infiltration of surface water from the San Joaquin River is considered to cross the subbasin boundaries into the groundwater system and is included in the calculation of the subbasin estimates of overdraft and net recharge from SWS.

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2001 (D)	24,320	2,290	850	27,460
2002 (D)	23,020	2,100	890	26,010
2003 (BN)	16,350	1,630	750	18,730
2004 (D)	13,100	1,080	590	14,770
2005 (W)	25,910	2,680	1,300	29,890
2006 (W)	33,680	4,630	1,810	40,120
2007 (C)	9,580	960	630	11,170
2008 (C)	16,630	1,640	920	19,190
2009 (BN)	12,050	1,010	760	13,820
2010 (AN)	28,090	4,330	2,040	34,460
2011 (W)	31,610	5,310	2,420	39,340
2012 (D)	8,720	1,120	800	10,640
2013 (C)	16,100	1,700	1,140	18,940
2014 (C)	6,310	450	480	7,240
2015 (C)	8,080	800	570	9,450
Average (1989-2014)	27,820	3,740	1,250	32,810
Average (1989-2014) W	44,740	7,100	1,970	53,810
Average (1989-2014) AN	23,420	2,950	1,220	27,590
Average (1989-2014) BN	14,200	1,320	760	16,280
Average (1989-2014) D	17,290	1,650	780	19,720
Average (1989-2014) C	21,940	2,490	920	25,350

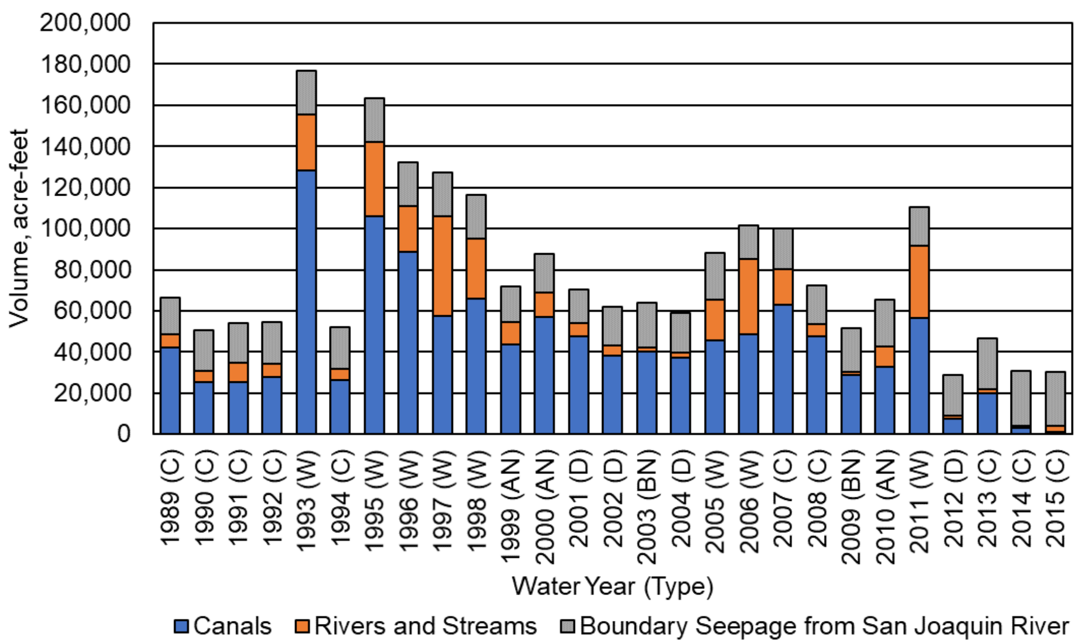

Figure A2.F.c-14. Madera Irrigation District GSA Infiltration of Surface Water.

Table A2.F.c-12. Madera Irrigation District GSA Infiltration of Surface Water (Acre-Feet).

Water Year (Type)	Canals	Rivers and Streams[1]	Boundary Seepage from San Joaquin River	Total
1989 (C)	42,010	6,700	17,760	66,470
1990 (C)	25,400	5,310	19,870	50,580
1991 (C)	25,550	8,980	19,380	53,910
1992 (C)	27,640	6,700	20,310	54,650
1993 (W)	128,260	27,340	21,250	176,850
1994 (C)	26,470	5,410	20,280	52,160
1995 (W)	106,140	36,100	21,250	163,490
1996 (W)	88,530	22,470	21,060	132,060
1997 (W)	57,550	48,310	21,250	127,110
1998 (W)	66,130	28,840	21,250	116,220
1999 (AN)	43,700	11,040	17,220	71,960
2000 (AN)	57,240	11,460	18,770	87,470
2001 (D)	47,350	6,690	16,290	70,330
2002 (D)	38,170	4,900	18,880	61,950
2003 (BN)	40,230	2,130	21,400	63,760
2004 (D)	36,970	2,480	19,410	58,860
2005 (W)	45,680	19,510	23,210	88,400
2006 (W)	48,420	37,000	16,110	101,530
2007 (C)	63,090	17,030	19,700	99,820
2008 (C)	47,430	6,310	18,660	72,400
2009 (BN)	28,580	1,570	21,650	51,800
2010 (AN)	32,900	9,640	22,850	65,390
2011 (W)	56,520	35,240	18,600	110,360
2012 (D)	7,710	1,370	19,620	28,700
2013 (C)	19,820	2,200	24,580	46,600
2014 (C)	2,980	1,240	26,600	30,820
2015 (C)	910	3,110	26,190	30,210
Average (1989-2014)	46,560	14,080	20,280	80,910
Average (1989-2014) W	74,650	31,850	20,500	127,000
Average (1989-2014) AN	44,610	10,710	19,610	74,940
Average (1989-2014) BN	34,410	1,850	21,530	57,780
Average (1989-2014) D	32,550	3,860	18,550	54,960
Average (1989-2014) C	31,150	6,650	20,790	58,600

[1] Includes infiltration of surface inflows and of precipitation runoff.

3.2.2.5 Infiltration of Applied Water

Estimated infiltration of applied water (deep percolation of applied water) by water use sector is provided in Figure A2.F.c-15 and Table A2.F.c-13. Infiltration of applied water is dominated by agricultural irrigation and has slowly decreased over time, likely due to increase use of drip and micro-irrigation systems in place of flood irrigation.

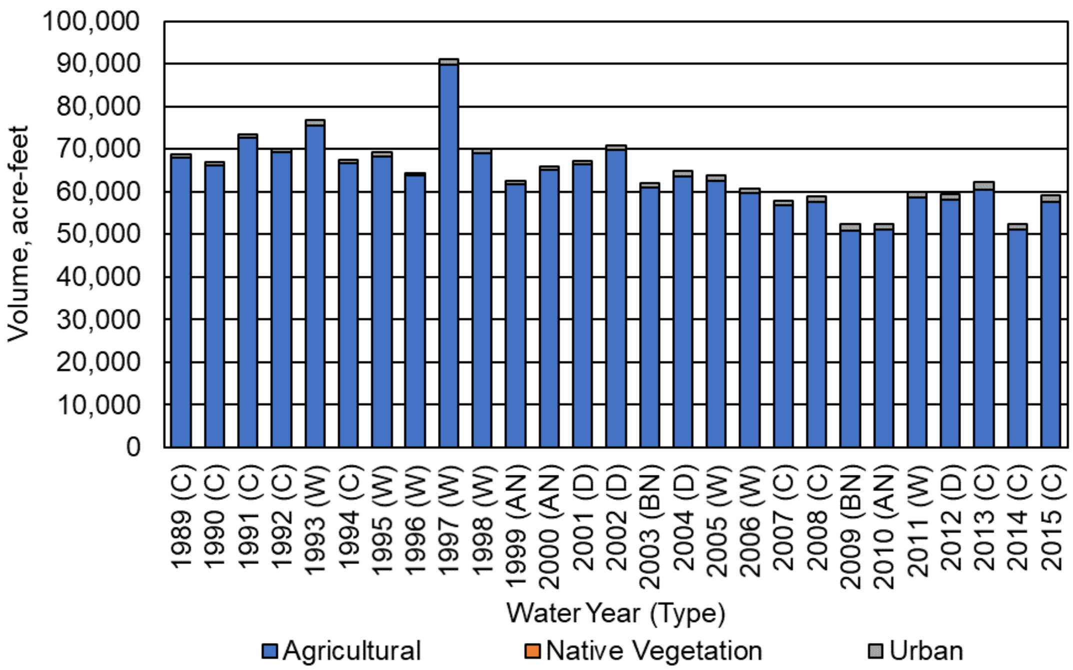

Figure A2.F.c-15. Madera Irrigation District GSA Infiltration of Applied Water by Water Use Sector.

Table A2.F.c-13. Madera Irrigation District GSA Infiltration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	67,900	0	930	68,830
1990 (C)	66,090	0	850	66,940
1991 (C)	72,660	0	870	73,530
1992 (C)	69,190	0	830	70,020
1993 (W)	75,490	0	1,180	76,670
1994 (C)	66,690	0	850	67,540
1995 (W)	68,250	0	930	69,180
1996 (W)	63,690	0	650	64,340
1997 (W)	89,740	0	1,400	91,140
1998 (W)	68,940	0	1,110	70,050
1999 (AN)	61,820	0	710	62,530
2000 (AN)	65,060	0	860	65,920
2001 (D)	66,430	0	780	67,210
2002 (D)	69,890	0	1,010	70,900
2003 (BN)	60,980	0	990	61,970
2004 (D)	63,640	0	1,110	64,750
2005 (W)	62,520	0	1,320	63,840
2006 (W)	59,600	0	1,060	60,660
2007 (C)	56,780	0	1,130	57,910
2008 (C)	57,530	0	1,440	58,970
2009 (BN)	50,930	0	1,380	52,310
2010 (AN)	51,030	0	1,320	52,350
2011 (W)	58,560	0	1,390	59,950

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2012 (D)	58,010	0	1,390	59,400
2013 (C)	60,310	0	1,840	62,150
2014 (C)	51,060	0	1,400	52,460
2015 (C)	57,470	0	1,640	59,110
Average (1989-2014)	63,950	0	1,110	65,060
Average (1989-2014) W	68,350	0	1,130	69,480
Average (1989-2014) AN	59,300	0	960	60,260
Average (1989-2014) BN	55,960	0	1,190	57,150
Average (1989-2014) D	64,490	0	1,070	65,560
Average (1989-2014) C	63,130	0	1,130	64,260

3.2.3 Change in Surface Water System Storage

Estimates of change in SWS storage are provided in Figure A2.F.c-16 and Table A2.F.c-14. Inter-annual changes in storage within the surface water system consist primarily of root zone soil moisture storage changes, are relatively small, and tend to average near zero over many years.

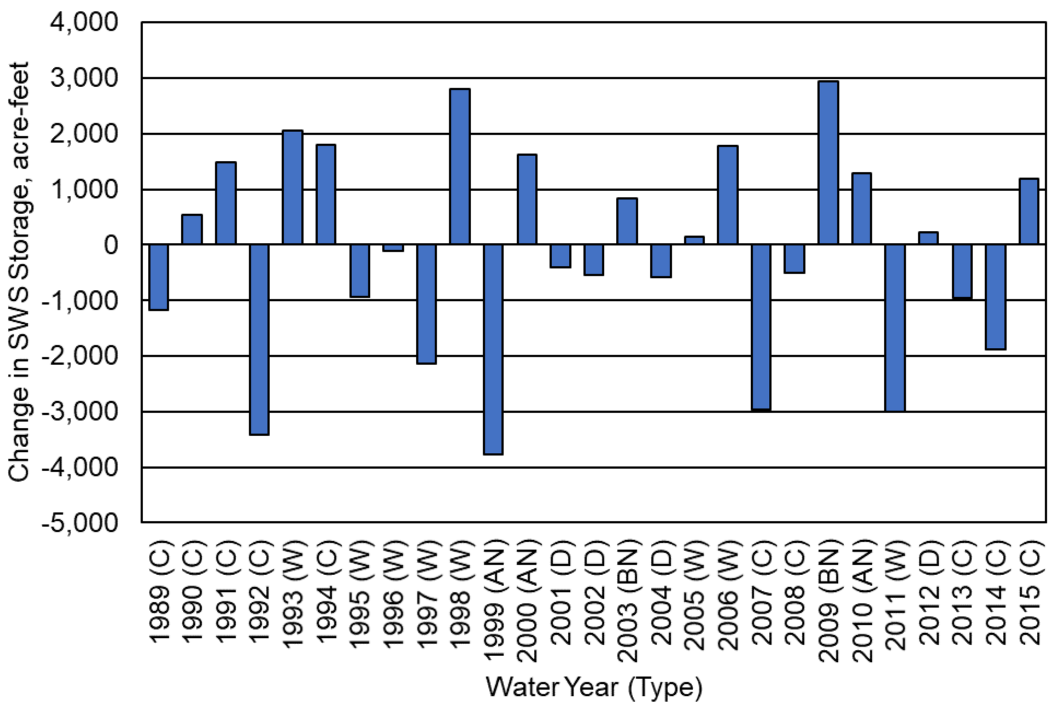

Figure A2.F.c-16. Madera Irrigation District GSA Change in Surface Water System Storage.

Table A2.F.c-14. Madera Irrigation District GSA Change in Surface Water System Storage (Acre-Feet).

Water Year (Type)	Change in SWS Storage
1989 (C)	-1,180
1990 (C)	540
1991 (C)	1,480
1992 (C)	-3,420
1993 (W)	2,060
1994 (C)	1,790
1995 (W)	-940
1996 (W)	-120
1997 (W)	-2,140
1998 (W)	2,800
1999 (AN)	-3,770
2000 (AN)	1,630
2001 (D)	-410
2002 (D)	-550
2003 (BN)	840
2004 (D)	-590
2005 (W)	140
2006 (W)	1,780
2007 (C)	-2,970
2008 (C)	-500
2009 (BN)	2,930
2010 (AN)	1,290
2011 (W)	-3,000
2012 (D)	230
2013 (C)	-950
2014 (C)	-1,890
2015 (C)	1,180
Average (1989-2014)	-190
Average (1989-2014) W	70
Average (1989-2014) AN	-280
Average (1989-2014) BN	1,890
Average (1989-2014) D	-330
Average (1989-2014) C	-790

3.3 Historical Water Budget Summary

Annual inflows, outflows, and change in SWS storage during the historical water budget period (1989-2014) are summarized in Figure A2.F.c-17 and Table A2.F.c-15. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values. Review of the variability in component volumes across years provides insight into the impacts of hydrology on the surface water system water budget.

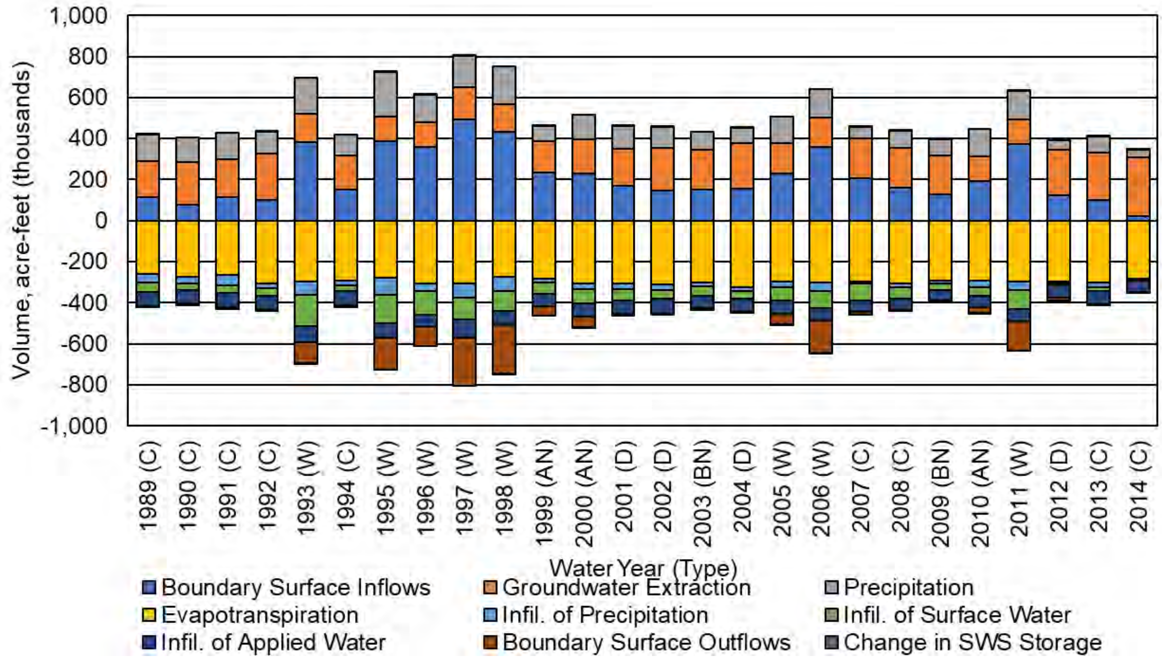

Figure A2.F.c-17. Madera Irrigation District GSA Surface Water System Historical Water Budget, 1989-2014.

Table A2.F.c-15. Madera Irrigation District GSA Surface Water System Historical Water Budget, 1989-2014 (Acre-Feet).

Water Year	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Evapo-transpiration[1]	Infil. of Precipitation	Infil. of Surface Water[2]	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	114,080	174,260	131,240	-261,600	-39,080	-48,710	-68,830	-2,540	1,180
1990 (C)	78,930	205,560	122,350	-273,650	-32,730	-30,710	-66,940	-2,270	-540
1991 (C)	114,940	185,350	127,850	-264,860	-50,580	-34,520	-73,530	-3,170	-1,480
1992 (C)	100,930	227,960	104,480	-305,210	-25,950	-34,330	-70,020	-1,270	3,420
1993 (W)	380,210	138,960	177,040	-295,160	-65,080	-155,600	-76,670	-101,650	-2,060
1994 (C)	149,480	167,630	100,340	-289,650	-23,280	-31,880	-67,540	-3,310	-1,790
1995 (W)	388,490	118,900	215,420	-277,580	-81,670	-142,240	-69,180	-153,090	940
1996 (W)	358,540	121,290	131,660	-305,340	-39,590	-111,000	-64,340	-91,340	120
1997 (W)	491,660	159,280	150,470	-307,120	-66,780	-105,860	-91,140	-232,640	2,140
1998 (W)	433,070	135,520	180,920	-275,340	-67,960	-94,970	-70,050	-238,380	-2,800
1999 (AN)	234,500	150,810	73,390	-282,770	-17,280	-54,740	-62,530	-45,150	3,770
2000 (AN)	231,940	166,420	119,670	-303,770	-31,030	-68,700	-65,920	-46,970	-1,630
2001 (D)	171,910	178,940	111,660	-307,000	-27,450	-54,030	-67,210	-7,220	410
2002 (D)	146,010	207,940	101,290	-311,660	-26,010	-43,070	-70,890	-4,160	550
2003 (BN)	150,000	193,070	88,940	-302,540	-18,730	-42,360	-61,970	-5,580	-840
2004 (D)	158,230	217,750	73,870	-326,450	-14,760	-39,450	-64,750	-5,030	590
2005 (W)	231,360	147,170	127,370	-294,900	-29,880	-65,190	-63,850	-51,950	-140
2006 (W)	360,080	142,780	140,250	-300,680	-40,110	-85,420	-60,660	-154,450	-1,780
2007 (C)	205,500	193,260	56,780	-296,230	-11,160	-80,120	-57,910	-13,090	2,970
2008 (C)	159,570	194,050	86,220	-304,490	-19,180	-53,740	-58,980	-3,950	500
2009 (BN)	129,620	189,020	77,860	-293,150	-13,820	-30,160	-52,320	-4,130	-2,930
2010 (AN)	194,420	120,310	133,640	-289,750	-34,470	-42,550	-52,350	-27,970	-1,290
2011 (W)	371,790	120,490	139,820	-298,290	-39,330	-91,760	-59,960	-145,760	3,000
2012 (D)	123,820	219,330	47,590	-294,290	-10,650	-9,080	-59,390	-17,110	-230
2013 (C)	100,640	230,990	80,410	-303,220	-18,940	-22,020	-62,150	-6,660	950
2014 (C)	23,090	283,420	39,280	-281,510	-7,230	-4,220	-52,460	-2,250	1,890
Average (1989-2014)	215,490	176,560	113,070	-294,080	-32,800	-60,630	-65,060	-52,730	190
W	376,900	135,550	157,870	-294,300	-53,800	-106,500	-69,480	-146,160	-70
AN	220,290	145,850	108,900	-292,090	-27,590	-55,330	-60,270	-40,030	280
BN	139,810	191,050	83,400	-297,850	-16,270	-36,260	-57,140	-4,850	-1,880
D	149,990	205,990	83,600	-309,850	-19,720	-36,410	-65,560	-8,380	330
C	116,350	206,940	94,330	-286,710	-25,350	-37,810	-64,260	-4,280	790

[1] Includes ET of applied water, ET of precipitation, and evaporation from rivers and streams.
[2] Includes infiltration from the Rivers and Streams System and Canal System.

3.4 Current Water Budget Summary

The current water budget was developed following a similar process to the historical water budget using the 2015 land use in Table A2.F.c-1 and the same 1989-2014 average hydrologic conditions of the historical base period, including surface water flows, precipitation, and weather parameters. This allowed quantification of groundwater inflows and outflows for current consumptive use in the context of average water supply conditions.

Annual inflows, outflows, and change in SWS storage from the current water budget are summarized in Figure A2.F.c-18 and Table A2.F.c-16. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values.

Note, due to the "current water budget" approach described above, for the MID GSA specifically, this resulted in a conservative "current water budget" estimate of net recharge from SWS (defined as groundwater recharge minus groundwater extraction). MID's operations for the 1989-2014 time period would have differed due to increased demands as assumed by the 2015 land use. Thus, while MID GSA is planning for the conservative number (higher deficit) in this GSP, it is acknowledged that MID GSA's actual deficit, if any, is less and that MID GSA has been, and is, operating close to sustainability.

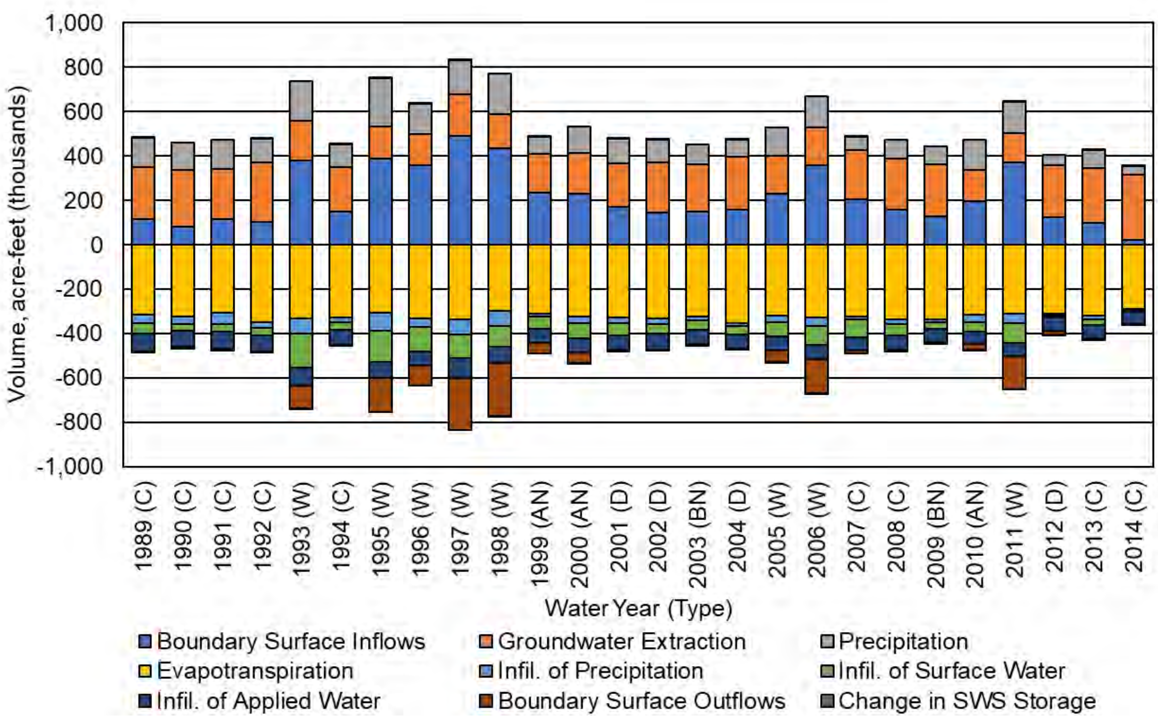

Figure A2.F.c-18. Madera Irrigation District GSA Surface Water System Current Water Budget.

Table A2.F.c-16. Madera Irrigation District GSA Surface Water System Current Water Budget (Acre-Feet).

Water Year	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Evapo-transpiration[1]	Infil. of Precipitation	Infil. of Surface Water[2]	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	115,530	232,490	133,400	-315,770	-37,510	-48,140	-78,510	-2,540	1,040
1990 (C)	80,120	258,080	124,370	-324,460	-31,240	-30,170	-73,870	-2,270	-560
1991 (C)	116,080	225,970	129,950	-307,870	-48,460	-33,980	-77,750	-3,170	-770
1992 (C)	101,660	269,770	106,190	-348,310	-24,630	-34,150	-71,530	-1,270	2,280
1993 (W)	381,040	177,840	179,920	-333,430	-64,470	-154,820	-81,440	-101,650	-3,010
1994 (C)	149,800	201,630	101,950	-327,240	-21,810	-31,520	-69,570	-3,310	70
1995 (W)	388,800	143,810	218,840	-305,180	-80,110	-141,570	-72,160	-153,090	670
1996 (W)	358,820	141,410	133,740	-330,810	-37,750	-110,970	-63,220	-91,340	130
1997 (W)	491,680	187,070	152,810	-336,130	-66,460	-105,580	-92,170	-232,640	1,400
1998 (W)	433,440	155,890	183,710	-298,970	-66,270	-94,950	-72,040	-238,380	-2,430
1999 (AN)	234,720	175,440	74,510	-308,000	-16,420	-54,920	-63,500	-45,150	3,320
2000 (AN)	232,730	180,000	121,470	-322,000	-29,760	-69,960	-64,230	-46,970	-1,290
2001 (D)	171,690	194,270	113,330	-327,330	-25,940	-53,950	-65,190	-7,220	340
2002 (D)	146,030	225,280	102,840	-332,660	-25,060	-43,210	-69,550	-4,160	490
2003 (BN)	150,020	212,680	90,350	-323,950	-18,060	-42,370	-62,050	-5,580	-1,050
2004 (D)	158,210	238,980	75,070	-351,620	-14,020	-39,400	-63,740	-5,030	1,540
2005 (W)	231,350	168,880	129,500	-318,940	-29,060	-64,990	-64,380	-51,950	-420
2006 (W)	360,250	166,570	142,660	-327,580	-38,580	-85,040	-61,990	-154,450	-1,840
2007 (C)	205,540	221,600	57,780	-324,680	-10,700	-80,060	-59,310	-13,090	2,910
2008 (C)	159,900	226,760	87,780	-336,110	-18,860	-53,750	-61,580	-3,950	-190
2009 (BN)	129,790	233,260	79,310	-333,850	-13,760	-29,990	-58,410	-4,130	-2,220
2010 (AN)	194,610	143,290	136,190	-313,240	-34,320	-42,370	-55,310	-27,970	-870
2011 (W)	371,870	131,130	142,550	-311,510	-39,380	-91,890	-60,400	-145,760	3,400
2012 (D)	123,900	232,970	48,520	-308,930	-10,460	-9,100	-59,210	-17,110	-580
2013 (C)	100,750	245,860	81,980	-318,240	-18,980	-21,970	-63,580	-6,660	840
2014 (C)	23,120	292,300	40,040	-289,500	-7,410	-4,220	-54,020	-2,250	1,940
Average (1989-2014)	215,820	203,200	114,950	-322,170	-31,900	-60,500	-66,870	-52,730	200
W	377,160	159,080	160,470	-320,320	-52,760	-106,230	-70,970	-146,160	-260
AN	220,690	166,240	110,720	-314,410	-26,830	-55,750	-61,010	-40,030	390
BN	139,910	222,970	84,830	-328,900	-15,910	-36,180	-60,230	-4,850	-1,640
D	149,960	222,880	84,940	-330,130	-18,870	-36,410	-64,420	-8,380	450
C	116,940	241,610	95,940	-321,350	-24,400	-37,550	-67,750	-4,280	840

[1] Includes ET of applied water, ET of precipitation, and evaporation from rivers and streams.
[2] Includes infiltration from the Rivers and Streams System and Canal System.

3.5 Net Recharge from SWS

Overdraft is defined in DWR Bulletin 118 as "the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions" (DWR 2003). The Madera Subbasin water budget indicates that overdraft conditions occurred during the 1989-2014 historical base period. Per 23 CCR Section 354.18(b)(5), the subbasin overdraft has been quantified for this base period. The evaluation of overdraft conditions includes estimates of recharge from subsurface flows. However, estimates of recharge from subsurface flows are less accurate when estimated for areas less than an entire subbasin. Thus, for GSA level contribution to overdraft, the term net recharge from the SWS is defined as groundwater recharge minus groundwater extraction. Net Recharge from the SWS is useful for understanding and analyzing the combined effects of land surface processes on the underlying GWS.

When calculated from the historical water budget, average net recharge from the SWS represents the average recharge (when positive) or shortage of recharge (when negative) based on historical cropping, land use practices, and average hydrologic conditions. When calculated from the current land use water budget, average net recharge represents the average recharge or shortage (negative net recharge) based on current cropping, land use practices, and average hydrologic conditions.

Average net recharge from the SWS is presented below for the MID GSA portion of the Madera Subbasin. Table A2.F.c-17 shows the average net recharge from the SWS for 1989-2014 based on the historical water budget, and Table A2.F.c-18 shows the same for the current water budget. Historically, the average net recharge in MID GSA was approximately 2 taf per year between 1989 and 2014. Under current land use conditions, the average net recharge in MID GSA is approximately -24 taf, indicating shortage conditions.

Table A2.F.c-17. Historical Water Budget: Average Net Recharge from SWS by Water Year Type, 1989-2014 (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water[1] (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	69,480	53,800	127,000	135,550	114,730
AN	3	60,270	27,590	74,940	145,850	16,950
BN	2	57,140	16,270	57,780	191,050	-59,860
D	4	65,560	19,720	54,960	205,990	-65,750
C	9	64,260	25,350	58,600	206,940	-58,730
Annual Average (1989-2014)	26	65,060	32,800	80,910	176,560	2,210

[1] Includes infiltration from the Rivers and Streams System, Canal System, and boundary seepage from San Joaquin River.

Table A2.F.c-18. Current Water Budget: Average Net Recharge from SWS by Water Year Type (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water[1] (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	70,970	52,760	126,730	159,080	91,380
AN	3	61,010	26,830	75,360	166,240	-3,040
BN	2	60,230	15,910	57,700	222,970	-89,130
D	4	64,420	18,870	54,960	222,880	-84,630
C	9	67,750	24,400	58,340	241,610	-91,120
Annual Average (1989-2014)	26	66,870	31,900	80,780	203,200	-23,650

[1] Includes infiltration from the Rivers and Streams System, Canal System, and boundary seepage from San Joaquin River.

3.6 Uncertainties in Water Budget Components

Uncertainties associated with each water budget component were estimated as a percentage representing approximately a 95% confidence interval following the procedure described by Clemmens and Burt (1997). Uncertainties for all independently measured or estimated water budget components were estimated based on the measurement accuracy, typical values reported in technical literature, typical values calculated in other water budgets, and professional judgement.

Table A2.F.c-19 provides a summary of typical uncertainty values associated with major SWS inflow and outflow components. These uncertainties provide a basis for evaluating confidence in water budget results and help to identify data needs that may be addressed during GSP implementation.

Table A2.F.c-19. Estimated Uncertainty of GSA Water Budget Components.

Flowpath Direction (SWS Boundary)	Water Budget Component	Data Source	Estimated Uncertainty (%)	Source
Inflows	Surface Water Inflows	Calculation	5%	Estimated streamflow measurement accuracy
	Deliveries	Measurement	6%	Estimated delivery measurement accuracy (accuracy required for Reclamation contractors)
	Riparian Deliveries	Measurement	10%	Estimated measurement accuracy.
	Precipitation	Calculation	30%	Clemmens, A.J. and C.M. Burt, 1997.
	Groundwater Extraction	Closure	20%	Typical uncertainty calculated for Land Surface System water balance closure.
Outflows	Surface Water Outflows	Closure	20%	Estimated streamflow measurement accuracy and adjustment for losses.
	Evaporation	Calculation	20%	Estimated accuracy of calculation based on CIMIS reference ET and free water surface evaporation coefficient.
	ET of Applied Water	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, estimated crop coefficients from SEBAL energy balance, and annual land use.
	ET of Precipitation	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, precipitation, estimated crop coefficients from SEBAL energy balance, and annual land use.
	Infiltration of Applied Water	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use and NRCS soils characteristics.
	Infiltration of Precipitation	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use, NRCS soils characteristics, and CIMIS precipitation.
	Infiltration of Surface Water	Calculation	15%	Estimated accuracy of daily seepage calculation using NRCS soils characteristics and measured streamflow data.
	Change in SWS Storage	Calculation	50%	Professional Judgment.
Net Recharge from SWS		Calculation	25%	Estimated water budget accuracy; typical value calculated for GSA-level net recharge from SWS.

APPENDIX 2.F. WATER BUDGET INFORMATION

2.F.d. Surface Water System Water Budget: Madera Water District GSA

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

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Stillwater Sciences and
California State University, Sacramento

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1 INTRODUCTION

To ensure sustainable groundwater management throughout California's groundwater basins, the Sustainable Groundwater Management Act of 2014 (SGMA) requires Groundwater Sustainability Agencies (GSAs) to prepare and adopt Groundwater Sustainability Plans (GSPs) with strategies to achieve subbasin groundwater sustainability within 20 years of plan adoption. Integral to each GSP is a water budget used to quantify the subbasin's groundwater overdraft (if applicable) and sustainable yield.

In 2017, Madera Water District (MWD) GSA formed to manage approximately 3,700 acres of the Madera Subbasin. This document presents results of the surface water system (SWS) water budgets developed for historical and current land use conditions in MWD GSA. The MWD GSA water budgets were integrated with separate water budgets developed for the other six (6) GSAs in Madera Subbasin to prepare a boundary water budget for the Madera Subbasin SWS. Results of the subbasin boundary water budget are reported in the Madera Subbasin GSP Section 2.2.3 and were integrated with a subbasin groundwater model (GSP Appendix 6.D) to estimate subbasin sustainable yield (GSP Section 2.2.3).

2 WATER BUDGET CONCEPTUAL MODEL

A water budget is defined as a complete accounting of all water flowing into and out of a defined volume (e.g., a subbasin or a GSA) over a specified period of time. The conceptual model (or structure) of the MWD GSA water budget developed for this investigation is consistent with the GSP Regulations defined under Title 23 of California Code of Regulations[1] (CCR) and adheres to sound water budget principles and practices defined by California Department of Water Resources (DWR) in the Water Budget Best Management Practice (BMP) guidelines (DWR, 2016).

The lateral extent of MWD GSA is defined by the boundaries indicated in Figure A2.F.d-1. The vertical extent of MWD GSA is the land surface (top) and the base of fresh water at the bottom of the basin (bottom), as described in the hydrogeologic conceptual model (HCM) developed in GSP Section 2.2.1. The vertical extent of Madera Subbasin and its GSAs is subdivided into a surface water system (SWS) and the underlying groundwater system (GWS), with separate but related water budgets prepared for each that together represent the overall subbasin water budget.

A conceptual representation of the MWD GSA water budget is represented in Figure A2.F.d-2. This document details only the SWS portion of the MWD GSA water budget. The SWS is divided into three primary accounting centers: the Land Surface System, the Rivers and Streams System, and the Conveyance System. The Land Surface System is further divided into three accounting centers representing MWD GSA's water use sectors: Agricultural Land, Native Vegetation Land, and Urban Land (urban, industrial, and semi-agricultural).

Water budget components, or directional flow of water between accounting centers and across the SWS boundary, are indicated by arrows. Inflows and outflows were calculated using measurements and other historical data or were calculated as the water budget closure term – the difference between all other estimated or measured inflows and outflows from each accounting center or water use sector (bold arrows).

[1] California Code of Regulations Title 23. Waters, Division 2. Department of Water Resources, Chapter 1.5. Groundwater Management, Subchapter 2. Groundwater Sustainability Plans.

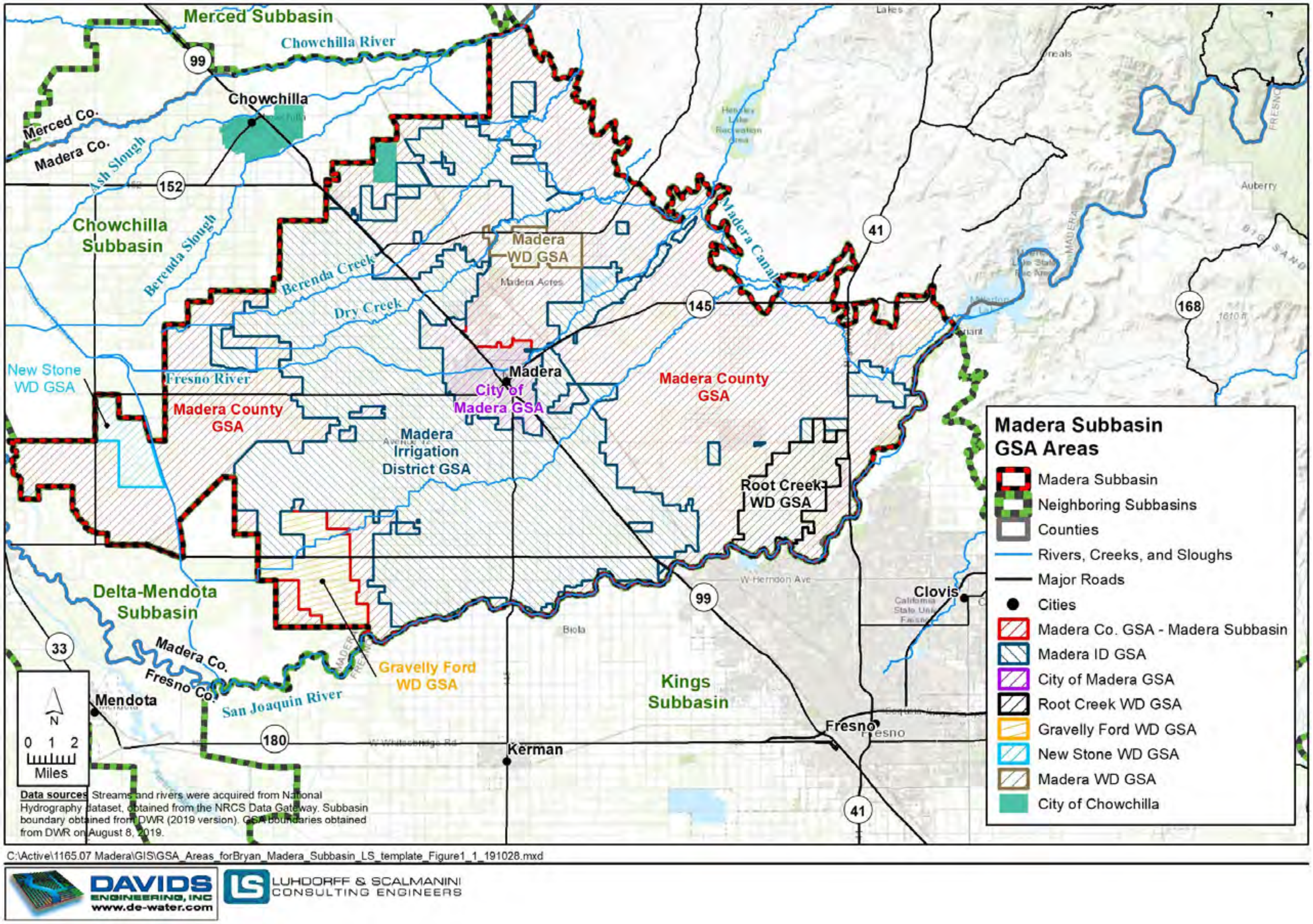

Figure A2.F.d-1. Madera Subbasin GSAs Map

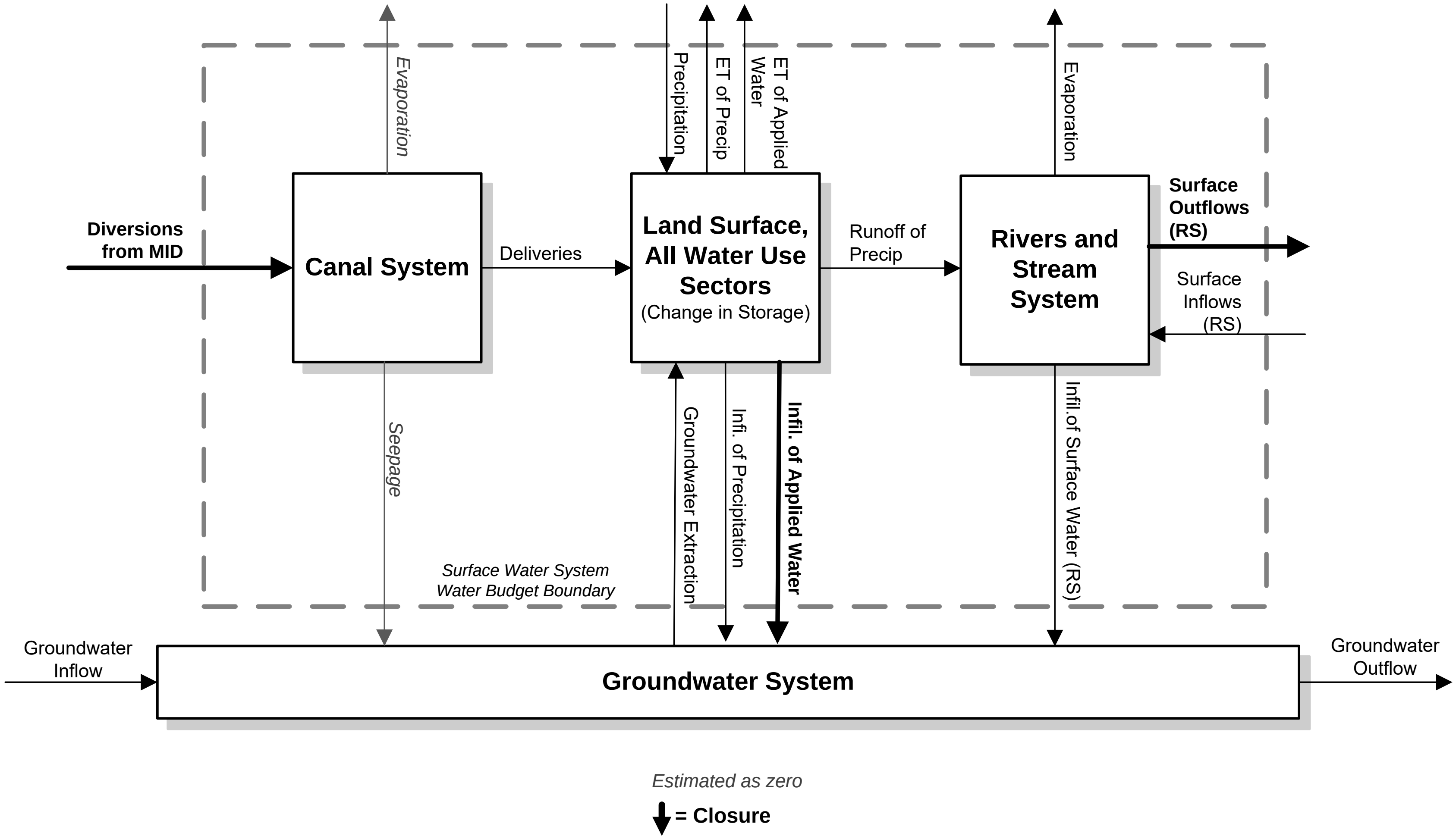

Figure A2.F.d-2. Madera Water District GSA Water Budget Structure

Inflows to the SWS include precipitation, surface water inflows (in various rivers and streams), and groundwater extraction. Outflows from the SWS include evapotranspiration (ET), surface water outflows (in various rivers and streams), and infiltration to the groundwater system (seepage and deep percolation). Also represented in Figure A2.F.d-2 are inflows and outflows from the GWS, which are discussed and quantified at the subbasin level in the GWS water budget in GSP Section 2.2.3. Subsurface GWS inflows and outflows are not quantified on the water budget subregion scale.

Inflows and outflows were quantified following the process described in GSP Section 2.2.3 on a monthly time step for water years in the historical water budget base period (1989-2014 hydrologic and land use conditions), the current water budget (2015 land use using 1989-2014 average hydrologic conditions), and projected water budget. Four projected water budgets were prepared for the years 2019 through 2090 based on 1965 through 2015 hydrologic conditions:

1. Historical hydrologic conditions
    a. Without projects and management actions, and
    b. With projects and management actions
2. Historical hydrologic conditions adjusted for anticipated climate change per DWR-provided 2030 climate change factors
    a. Without projects and management actions, and
    b. With projects and management actions.

3 WATER BUDGET ANALYSIS

The historical water budget and current land use water budget for MWD GSA are presented below following a summary of land use data relevant to water budget development. Land use data is provided for the 1989-2014 historical water budget period and for 2015, the current land use water budget period.

3.1 Land Use

Land use estimates for 1989 through 2015 corresponding to water use sectors (as defined by the GSP Regulations) are summarized in Figure A2.F.d-3 and Table A2.F.d-1 for the MWD GSA. According to GSP Regulations (23 CCR § 351(al)):

> *"Water use sector" refers to 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.*

In MWD GSA, water use sectors include agricultural, native vegetation, and urban land use. The urban land use category includes urban and semi-agricultural[2] lands as well as industrial land, which covers only a small area in the subbasin.

As shown, land in MWD is largely agricultural, accounting for over 3,400 acres, or 92 percent, of the total subregion area. Agricultural lands increased between 1989 and the early 2000s, after which a slight decrease in agricultural acreage coincided with expansion of urban lands. This is due in part to urban encroachment and changes in DWR's delineation of urban lands in land use surveys over time. However, since 2011 agricultural acreage has begun to increase as native vegetation has decreased.

[2] As defined in the DWR county land use surveys, semi-agricultural land use subclasses include farmsteads, livestock feed lot operations, dairies, poultry farms, and miscellaneous semi-agricultural land use incidental to agriculture (small roads, ditches, non-planted areas of cropped fields (DWR, 2009).

On average, agricultural lands covered an average of approximately 3,400 acres, between 1989 and 2014. During this same period, urban lands and native vegetation averaged approximately 200 acres and 80 acres, respectively.

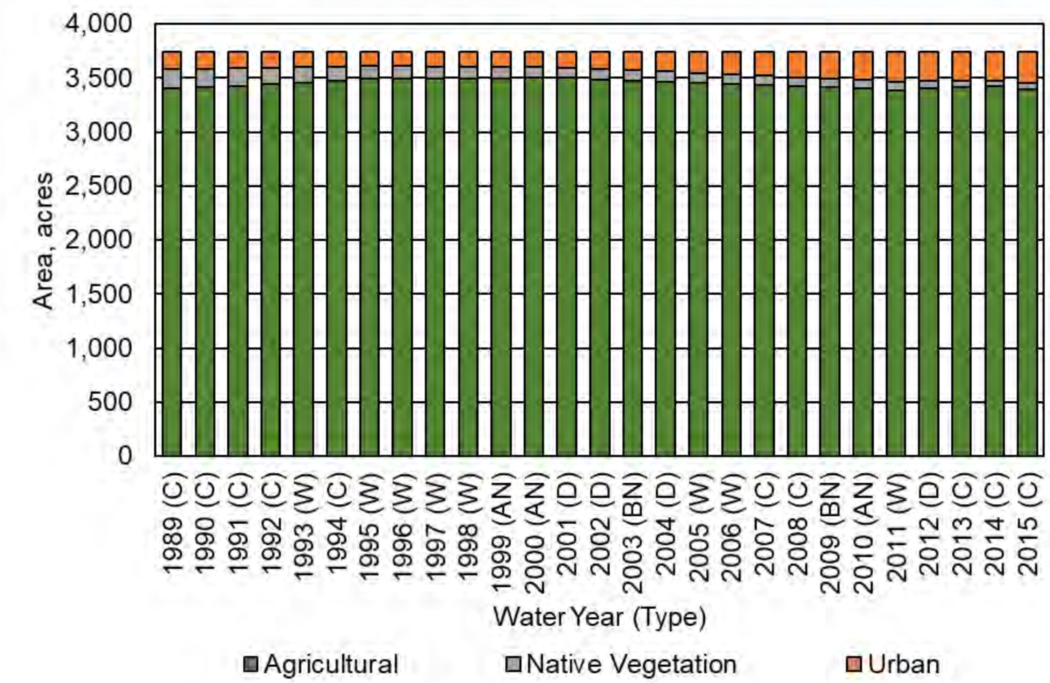

Figure A2.F.d-3. Madera Water District GSA Land Use Areas

Table A2.F.d-1. Madera Water District GSA Land Use Areas, acres

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
1989 (C)	3,402	180	163	3,744
1990 (C)	3,414	172	159	3,744
1991 (C)	3,422	168	155	3,744
1992 (C)	3,441	153	150	3,744
1993 (W)	3,455	144	145	3,744
1994 (C)	3,474	132	139	3,744
1995 (W)	3,497	115	133	3,744
1996 (W)	3,497	112	135	3,744
1997 (W)	3,497	109	138	3,744
1998 (W)	3,498	107	140	3,744
1999 (AN)	3,498	104	143	3,744
2000 (AN)	3,498	101	145	3,744
2001 (D)	3,499	98	148	3,744
2002 (D)	3,488	96	161	3,744
2003 (BN)	3,476	94	174	3,744

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
2004 (D)	3,465	93	186	3,744
2005 (W)	3,454	91	199	3,744
2006 (W)	3,443	89	212	3,744
2007 (C)	3,432	87	225	3,744
2008 (C)	3,421	85	238	3,744
2009 (BN)	3,410	84	251	3,744
2010 (AN)	3,399	82	264	3,744
2011 (W)	3,388	80	277	3,744
2012 (D)	3,399	71	274	3,744
2013 (C)	3,411	61	272	3,744
2014 (C)	3,423	52	270	3,744
2015 (C)	3,399	51	295	3,744
Average (1989-2014)	3,450	106	188	3,744

[1] Area includes land classified as native vegetation and water surfaces.

[2] Area includes land classified as urban, industrial, and semi-agricultural.

Agricultural land uses are further detailed in Figure A2.F.d-4 and Table A2.F.d-2. Based on historical records, agricultural land in MWD has been comprised entirely of pistachios since the 1960s. However, annual land use areas in MWD GSA were determined using the same procedure and data sources used throughout the Madera Subbasin. This procedure, described in Appendix 2.A., generally estimates annual land use using DWR Land Use surveys in 1995, 2001 and 2011; Land IQ remote sensing-based land use identification in 2014; and the DWR Land Use interpolation tool in other years. Slight divergence from 100 percent pistachio acreage, particularly in the 1990s, may be attributed to interpolation with agricultural land adjacent to the District.

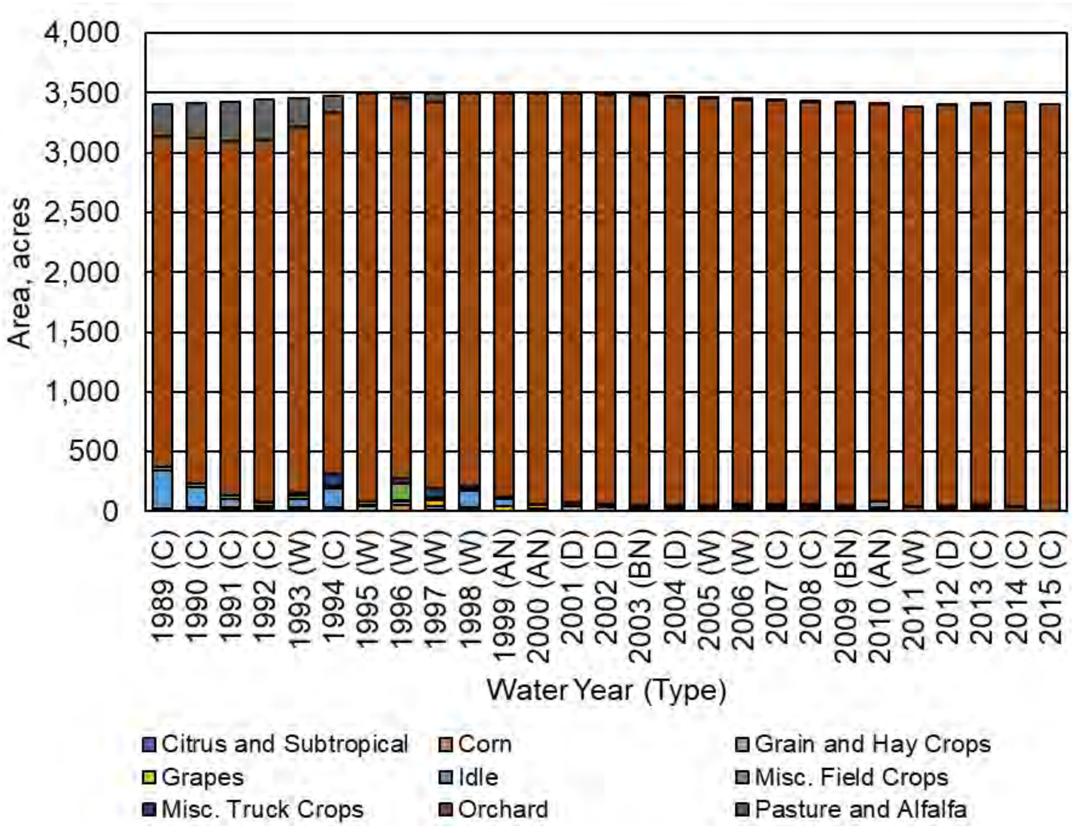

Figure A2.F.d-4. Madera Water District GSA Agricultural Land Use Areas[3]

[3] Based on historical records, agricultural land in MWD has been comprised entirely of pistachios since the 1960s. Slight divergence from 100 percent pistachio acreage, particularly in the 1990s, may be attributed to interpolation with agricultural land adjacent to the District.

Table A2.F.d-2. Madera Water District GSA Agricultural Land Use Areas

Water Year (Type)	Citrus and Subtropical	Corn	Grain and Hay Crops	Grapes	Idle	Misc. Field Crops	Misc. Truck Crops	Orchard[1]	Pasture and Alfalfa	Total
1989 (C)	6	0	12	11	312	30	0	2,763	269	3,402
1990 (C)	6	0	17	11	169	31	0	2,897	284	3,414
1991 (C)	7	0	12	11	71	34	1	2,955	331	3,422
1992 (C)	6	0	16	12	8	31	10	3,020	338	3,441
1993 (W)	6	0	17	12	68	30	24	3,058	239	3,455
1994 (C)	6	0	16	13	154	26	96	3,018	144	3,474
1995 (W)	3	0	41	14	0	24	0	3,415	0	3,497
1996 (W)	7	50	24	17	0	134	37	3,182	46	3,497
1997 (W)	16	0	26	51	1	18	79	3,238	70	3,497
1998 (W)	2	0	16	20	138	14	23	3,284	1	3,498
1999 (AN)	0	0	8	36	57	10	10	3,375	2	3,498
2000 (AN)	1	0	26	25	0	9	1	3,434	2	3,498
2001 (D)	0	0	45	22	2	9	1	3,418	3	3,499
2002 (D)	4	0	27	20	2	5	1	3,426	2	3,488
2003 (BN)	7	0	21	18	2	5	1	3,421	2	3,476
2004 (D)	9	0	20	16	2	6	1	3,410	2	3,465
2005 (W)	13	0	22	14	3	4	1	3,395	2	3,454
2006 (W)	15	0	19	12	13	3	3	3,376	1	3,443
2007 (C)	18	1	14	11	16	2	4	3,365	1	3,432
2008 (C)	20	1	14	9	14	0	0	3,361	1	3,421
2009 (BN)	19	0	10	5	22	0	0	3,352	1	3,410
2010 (AN)	22	0	11	5	44	0	0	3,317	0	3,399
2011 (W)	35	0	7	0	0	0	0	3,345	0	3,388
2012 (D)	20	15	5	0	7	0	1	3,345	7	3,399
2013 (C)	17	16	9	0	18	0	3	3,345	3	3,411
2014 (C)	36	0	1	0	6	0	0	3,380	0	3,423
2015 (C)	0	0	0	0	0	0	0	3,399	0	3,399
Average (1989-2014)	12	3	17	14	43	16	11	3,265	67	3,450

[1] Based on historical records, agricultural land in MWD has been comprised entirely of pistachios since the 1960s. Slight divergence from 100 percent pistachio acreage, particularly in the 1990s, may be attributed to interpolation with agricultural land adjacent to the District.

3.2 Surface Water System Water Budget

This section presents surface water system water budget components within MWD GSA as per GSP regulations. These are followed by a summary of the water budget results by accounting center.

3.2.1 Inflows

3.2.1.1 Surface Water Inflow by Water Source Type

Surface water inflows include surface water flowing into MWD across the subregion boundary. Per the Regulations, surface inflows 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.*

Additionally, runoff of precipitation from upgradient areas adjacent to the subregion represents a potential source of surface water inflow.

Local Supplies

Surface water inflows to MWD GSA include local supplies along Dry Creek.

CVP Supplies

MWD GSA receives surface water supplies from MID for irrigation purposes. All surface water delivered to MWD is initially diverted into the MID conveyance system and then routed to Dry Creek, where it is released and then received by MWD through a metered pipeline. The source type of this water is unknown, although the majority of water received by MID during deliveries to MWD is CVP supply.

Recycling and Reuse

Recycling and reuse are not a significant source of supply within MWD.

Other Surface Inflows

For the water budgets presented herein, precipitation runoff from outside the subregion is considered relatively minimal and is expected to pass through the waterways accounted above following relatively large storm events. Precipitation runoff from lands inside the subregion is internal to the surface water system and is thus not considered as surface inflows to the subregion boundary.

Summary of Surface Inflows

The surface water inflows described above are summarized by water source type in Figure A2.F.d-5 and Table A2.F.d-3. During the study period, local supplies vary by water year type, averaging 6 taf during wet years and less than 1 taf during all other year types. CVP supplies are steadier between years, averaging 2 taf per year between 1989 and 2014.

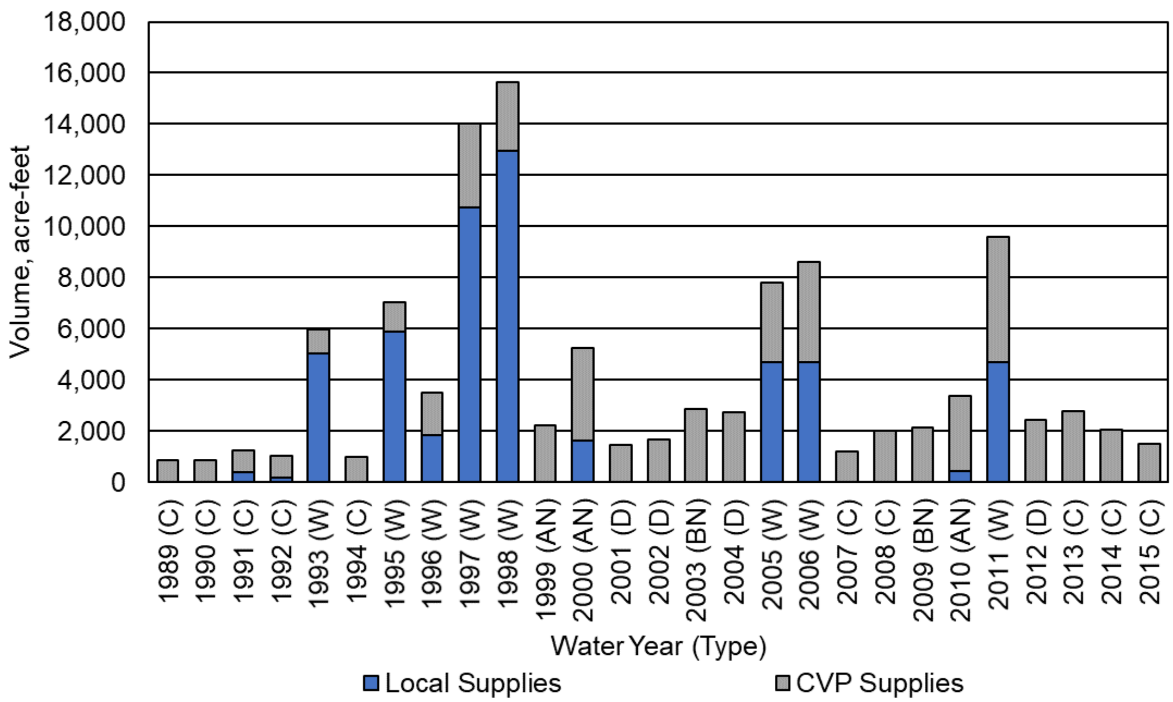

Figure A2.F.d-5. Madera Water District GSA Surface Water Inflows by Water Source Type.

Table A2.F.d-3. Madera Water District GSA Surface Water Inflows by Water Source Type (Acre-Feet).

Water Year (Type)	Local Supply	CVP Supply[1]	Total
1989 (C)	0	850	850
1990 (C)	0	850	850
1991 (C)	408	850	1,258
1992 (C)	196	850	1,046
1993 (W)	5,038	950	5,988
1994 (C)	0	995	995
1995 (W)	5,868	1,175	7,043
1996 (W)	1,852	1,665	3,517
1997 (W)	10,755	3,267	14,022
1998 (W)	12,958	2,658	15,617
1999 (AN)	0	2,244	2,244
2000 (AN)	1,637	3,599	5,236
2001 (D)	0	1,459	1,459
2002 (D)	0	1,652	1,652
2003 (BN)	0	2,881	2,881
2004 (D)	0	2,715	2,715
2005 (W)	4,692	3,104	7,796
2006 (W)	4,692	3,903	8,595
2007 (C)	0	1,187	1,187

Water Year (Type)	Local Supply	CVP Supply[1]	Total
2008 (C)	0	2,006	2,006
2009 (BN)	0	2,152	2,152
2010 (AN)	437	2,954	3,391
2011 (W)	4,692	4,918	9,610
2012 (D)	0	2,436	2,436
2013 (C)	0	2,760	2,760
2014 (C)	0	2,064	2,064
2015 (C)	0	1,481	1,481
Average (1989-2014)	2,047	2,159	4,207
Average (1989-2014) W	6,319	2,705	9,024
Average (1989-2014) AN	691	2,932	3,624
Average (1989-2014) BN	0	2,516	2,516
Average (1989-2014) D	0	2,065	2,065
Average (1989-2014) C	67	1,379	1,446

[1]CVP Supply is considered as all water supply released from CVP storage facilities. The volume of CVP Supply includes CVP deliveries to CVP contractors/water users, and flood releases from CVP facilities that largely pass through the subbasin.

3.2.1.2 Precipitation

Precipitation estimates for MWD GSA are provided in Figure A2.F.d-6 and Table A2.F.d-4. Precipitation estimates are reported by water use sector.

Total precipitation is variable between years in the study area, ranging from approximately 2.7 taf (7.6 inches) during average dry years to 4.5 taf (14.4 inches) during average wet years.

3.2.1.3 Groundwater Extraction by Water Use Sector

Groundwater extraction by water use sector is provided in Figure A2.F.d-7 and Table A2.F.d-5. For agricultural and urban (urban, semi-agricultural, industrial) lands, groundwater extraction represents pumping, while for native lands, groundwater extraction by riparian vegetation was considered to be negligible. In the agricultural water use sector, groundwater extraction is equal to groundwater pump meter records available between 1993-2015. Groundwater extraction in all other years and in the urban water use sector was estimated as the water use sector water budget closure term.

As indicated in Figure 6, groundwater extraction is dominated by irrigated agriculture, varying from year to year based on variability in metered surface water supplies.

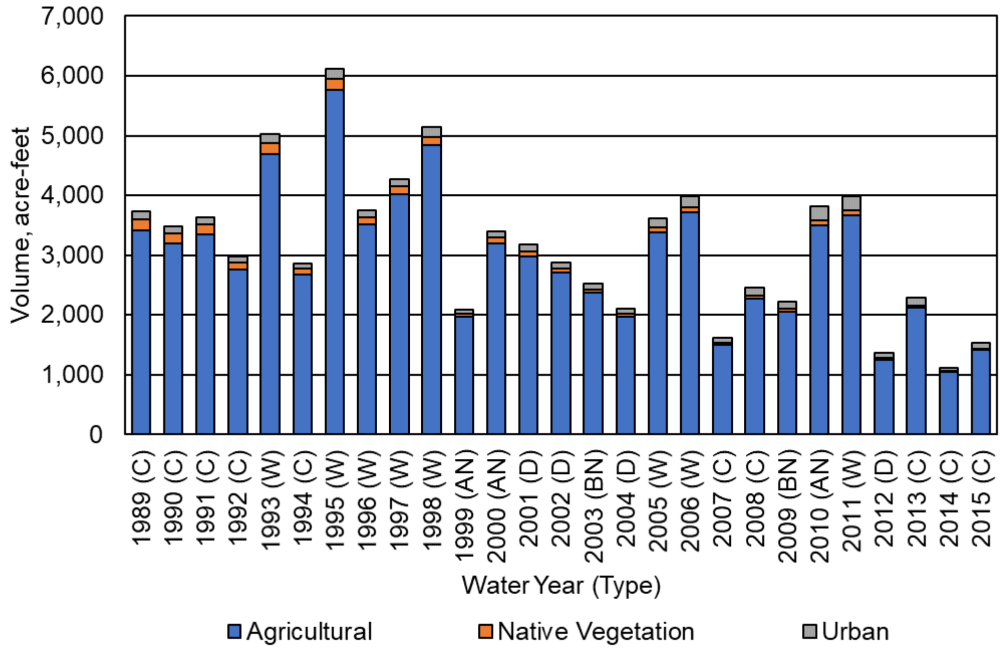

Figure A2.F.d-6. Madera Water District GSA Precipitation by Water Use Sector.

Table- A2.F.d-4. Madera Water District GSA Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	3,421	180	133	3,734
1990 (C)	3,200	158	120	3,478
1991 (C)	3,352	164	121	3,637
1992 (C)	2,754	123	95	2,972
1993 (W)	4,683	194	157	5,034
1994 (C)	2,668	102	83	2,853
1995 (W)	5,762	187	174	6,123
1996 (W)	3,521	112	108	3,741
1997 (W)	4,022	125	126	4,273
1998 (W)	4,838	144	156	5,138
1999 (AN)	1,963	58	64	2,085
2000 (AN)	3,199	91	107	3,397
2001 (D)	2,983	85	104	3,172
2002 (D)	2,702	73	102	2,877
2003 (BN)	2,367	64	97	2,528
2004 (D)	1,962	51	87	2,100
2005 (W)	3,375	89	158	3,622
2006 (W)	3,710	94	187	3,991
2007 (C)	1,498	38	80	1,616
2008 (C)	2,272	56	129	2,457
2009 (BN)	2,047	49	122	2,218
2010 (AN)	3,505	84	221	3,810
2011 (W)	3,662	86	242	3,990
2012 (D)	1,250	26	81	1,357

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2013 (C)	2,119	38	137	2,294
2014 (C)	1,039	16	66	1,121
2015 (C)	1,411	21	98	1,530
Average (1989-2014)	2,995	96	125	3,216
Average (1989-2014) W	4,197	129	164	4,489
Average (1989-2014) AN	2,889	78	131	3,097
Average (1989-2014) BN	2,207	57	110	2,373
Average (1989-2014) D	2,224	59	94	2,377
Average (1989-2014) C	2,480	97	107	2,685

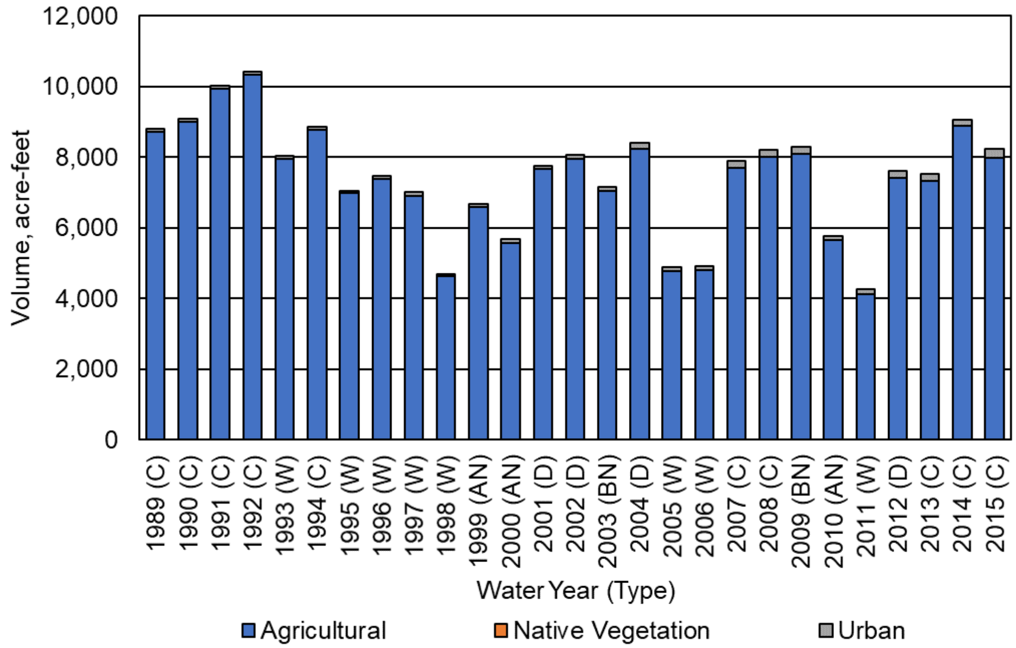

Figure A2.F.d-7. Madera Water District GSA Groundwater Extraction by Water Use Sector.

Table A2.F.d-5. Madera Water District GSA Groundwater Extraction by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban[1]	Total
1989 (C)	8,712	0	97	8,809
1990 (C)	8,994	0	98	9,092
1991 (C)	9,944	0	90	10,034
1992 (C)	10,325	0	111	10,436
1993 (W)	7,951	0	82	8,033
1994 (C)	8,773	0	91	8,864
1995 (W)	6,999	0	41	7,040
1996 (W)	7,391	0	69	7,460
1997 (W)	6,916	0	116	7,032
1998 (W)	4,639	0	62	4,701
1999 (AN)	6,581	0	92	6,673
2000 (AN)	5,585	0	92	5,677

Water Year (Type)	Agricultural	Native Vegetation	Urban[1]	Total
2001 (D)	7,676	0	82	7,758
2002 (D)	7,956	0	119	8,075
2003 (BN)	7,040	0	118	7,158
2004 (D)	8,239	0	163	8,402
2005 (W)	4,786	0	105	4,891
2006 (W)	4,817	0	106	4,923
2007 (C)	7,713	0	175	7,888
2008 (C)	8,021	0	184	8,205
2009 (BN)	8,102	0	181	8,283
2010 (AN)	5,665	0	111	5,776
2011 (W)	4,132	0	126	4,258
2012 (D)	7,421	0	197	7,618
2013 (C)	7,336	0	206	7,542
2014 (C)	8,879	0	193	9,072
2015 (C)	7,997	0	232	8,229
Average (1989-2014)	7,330	0	120	7,450
Average (1989-2014) W	5,954	0	88	6,042
Average (1989-2014) AN	5,944	0	98	6,042
Average (1989-2014) BN	7,571	0	150	7,720
Average (1989-2014) D	7,823	0	140	7,963
Average (1989-2014) C	8,744	0	138	8,882

[1]Although urban groundwater pumping records are not available, there is only one known domestic well within MWD. Thus, urban groundwater extraction estimates resulting from the water budget closure may be high.

3.2.1.4 Groundwater Discharge to Surface Water Sources

The depth to groundwater is greater than 100-200 ft across much of the Madera Subbasin. Given the depth to the water table in the Madera Subbasin, groundwater discharge to surface water sources is negligible.

3.2.2 Outflows

3.2.2.1 Evapotranspiration by Water Use Sector

Evapotranspiration (ET) by water use sector is reported in Figures A2.F.d-8 to A2.F.d-10 and Tables A2.F.d-6 to A2.F.d-8. First, total ET is reported, followed by ET from applied water and ET from precipitation.

Total ET varies between years, with the lowest observed in 1989, at approximately 10 taf, and the greatest observed in 2004, at approximately 12 taf.

In addition to ET from land surfaces, estimates of evaporation from rivers and streams are reported in Figure A2.F.d-11 and Table A2.F.d-9. Evaporation from the Rivers and Streams System includes evaporation of both surface inflows and of precipitation runoff within local sloughs and depressions. Evaporation from the rivers and streams follows the pattern of typical surface water inflows, but is estimated to be less than 1 taf during all years. Because the MWD conveyance system is a pipeline, evaporation from the Conveyance System is considered negligible.

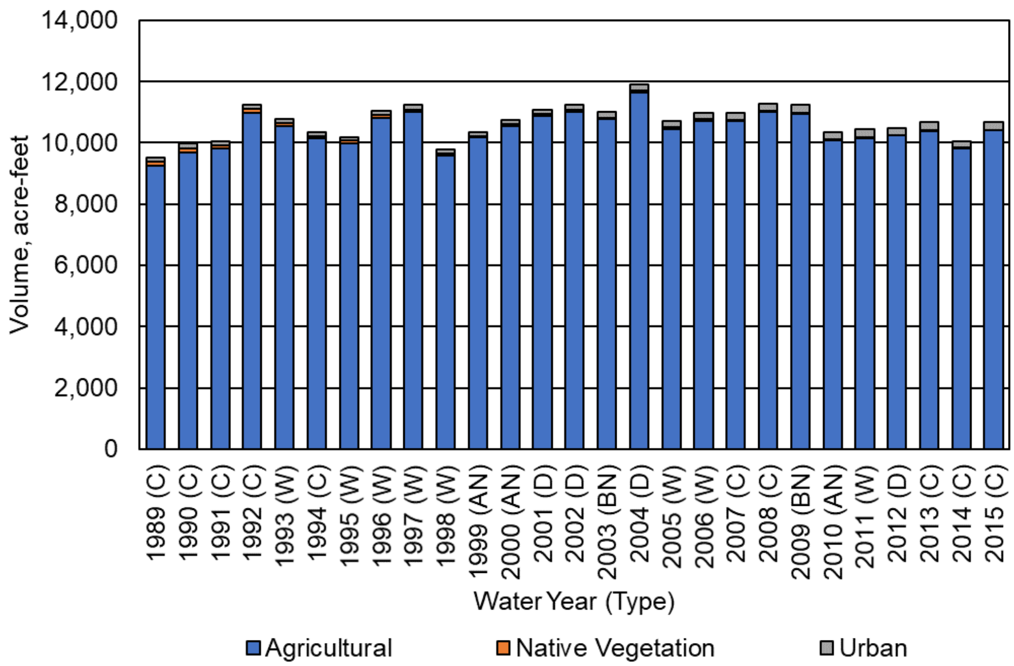

Figure A2.F.d-8. Madera Water District GSA Evapotranspiration by Water Use Sector.

Table A2.F.d-6. Madera Water District GSA Evapotranspiration by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	9,243	130	155	9,528
1990 (C)	9,690	123	156	9,969
1991 (C)	9,811	108	131	10,050
1992 (C)	10,982	112	153	11,247
1993 (W)	10,534	113	145	10,792
1994 (C)	10,133	78	132	10,343
1995 (W)	9,985	94	115	10,194
1996 (W)	10,826	87	128	11,041
1997 (W)	11,016	71	140	11,227
1998 (W)	9,578	76	124	9,778
1999 (AN)	10,167	57	128	10,352
2000 (AN)	10,558	64	139	10,761
2001 (D)	10,878	67	139	11,084
2002 (D)	11,017	62	164	11,243
2003 (BN)	10,775	52	169	10,996
2004 (D)	11,655	52	203	11,910
2005 (W)	10,451	63	186	10,700
2006 (W)	10,701	67	202	10,970
2007 (C)	10,717	41	209	10,967
2008 (C)	10,997	47	243	11,287
2009 (BN)	10,949	40	246	11,235
2010 (AN)	10,069	58	233	10,360
2011 (W)	10,132	58	245	10,435

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2012 (D)	10,232	25	218	10,475
2013 (C)	10,390	30	261	10,681
2014 (C)	9,832	15	213	10,060
2015 (C)	10,414	15	264	10,693
Average (1989-2014)	10,435	69	176	10,680
Average (1989-2014) W	10,403	79	161	10,642
Average (1989-2014) AN	10,265	60	167	10,491
Average (1989-2014) BN	10,862	46	208	11,116
Average (1989-2014) D	10,946	52	181	11,178
Average (1989-2014) C	10,199	76	184	10,459

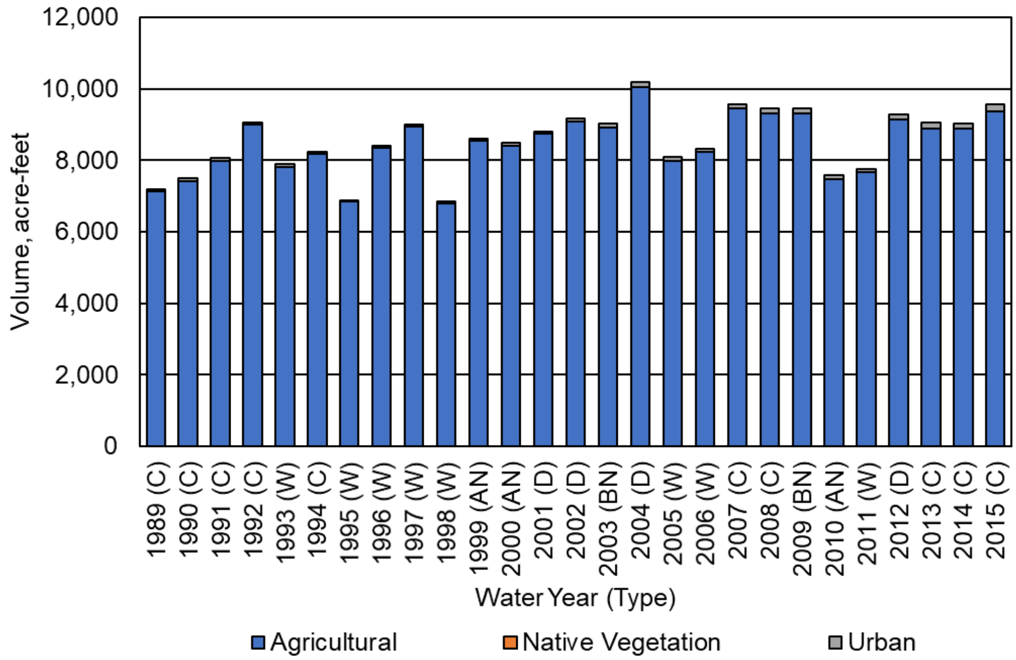

Figure A2.F.d-9. Madera Water District GSA Evapotranspiration of Applied Water by Water Use Sector.

Table A2.F.d-7. Madera Water District GSA Evapotranspiration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	7,135	0	71	7,206
1990 (C)	7,428	0	73	7,501
1991 (C)	7,997	0	63	8,060
1992 (C)	8,995	0	77	9,072
1993 (W)	7,824	0	64	7,888
1994 (C)	8,169	0	70	8,239
1995 (W)	6,851	0	40	6,891
1996 (W)	8,356	0	46	8,402
1997 (W)	8,946	0	68	9,014
1998 (W)	6,787	0	54	6,841

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1999 (AN)	8,550	0	64	8,614
2000 (AN)	8,409	0	72	8,481
2001 (D)	8,745	0	65	8,810
2002 (D)	9,087	0	88	9,175
2003 (BN)	8,931	0	96	9,027
2004 (D)	10,064	0	123	10,187
2005 (W)	7,997	0	91	8,088
2006 (W)	8,240	0	91	8,331
2007 (C)	9,457	0	117	9,574
2008 (C)	9,303	0	143	9,446
2009 (BN)	9,306	0	155	9,461
2010 (AN)	7,476	0	105	7,581
2011 (W)	7,671	0	95	7,766
2012 (D)	9,153	0	127	9,280
2013 (C)	8,894	0	159	9,053
2014 (C)	8,890	0	151	9,041
2015 (C)	9,372	0	192	9,564
Average (1989-2014)	8,410	0	91	8,501
Average (1989-2014) W	7,834	0	69	7,903
Average (1989-2014) AN	8,145	0	80	8,225
Average (1989-2014) BN	9,119	0	126	9,244
Average (1989-2014) D	9,262	0	101	9,363
Average (1989-2014) C	8,474	0	103	8,577

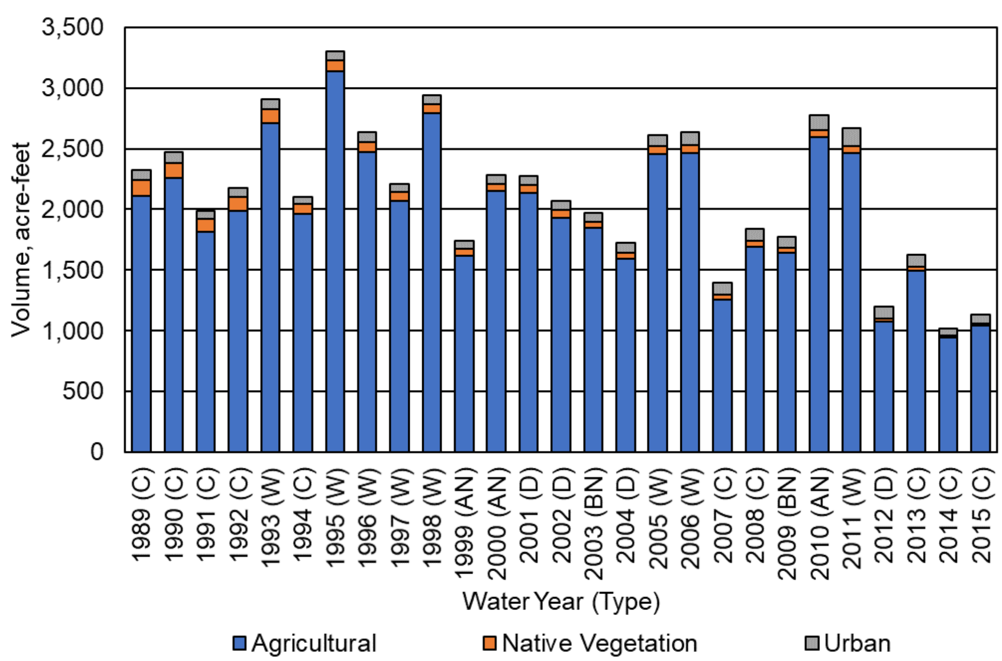

Figure A2.F.d-10. Madera Water District GSA Evapotranspiration of Precipitation by Water Use Sector.

Table A2.F.d-8. Madera Water District GSA Evapotranspiration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	2,108	130	84	2,322
1990 (C)	2,262	123	83	2,468
1991 (C)	1,814	108	68	1,990
1992 (C)	1,987	112	76	2,175
1993 (W)	2,710	113	81	2,904
1994 (C)	1,964	78	62	2,104
1995 (W)	3,134	94	75	3,303
1996 (W)	2,470	87	82	2,639
1997 (W)	2,070	71	72	2,213
1998 (W)	2,791	76	70	2,937
1999 (AN)	1,617	57	64	1,738
2000 (AN)	2,149	64	67	2,280
2001 (D)	2,133	67	74	2,274
2002 (D)	1,930	62	76	2,068
2003 (BN)	1,844	52	73	1,969
2004 (D)	1,591	52	80	1,723
2005 (W)	2,454	63	95	2,612
2006 (W)	2,461	67	111	2,639
2007 (C)	1,260	41	92	1,393
2008 (C)	1,694	47	100	1,841
2009 (BN)	1,643	40	91	1,774
2010 (AN)	2,593	58	128	2,779
2011 (W)	2,461	58	150	2,669
2012 (D)	1,079	25	91	1,195
2013 (C)	1,496	30	102	1,628
2014 (C)	942	15	62	1,019
2015 (C)	1,042	15	72	1,129
Average (1989-2014)	2,025	69	85	2,179
Average (1989-2014) W	2,569	79	92	2,740
Average (1989-2014) AN	2,120	60	86	2,266
Average (1989-2014) BN	1,744	46	82	1,872
Average (1989-2014) D	1,683	52	80	1,815
Average (1989-2014) C	1,725	76	81	1,882

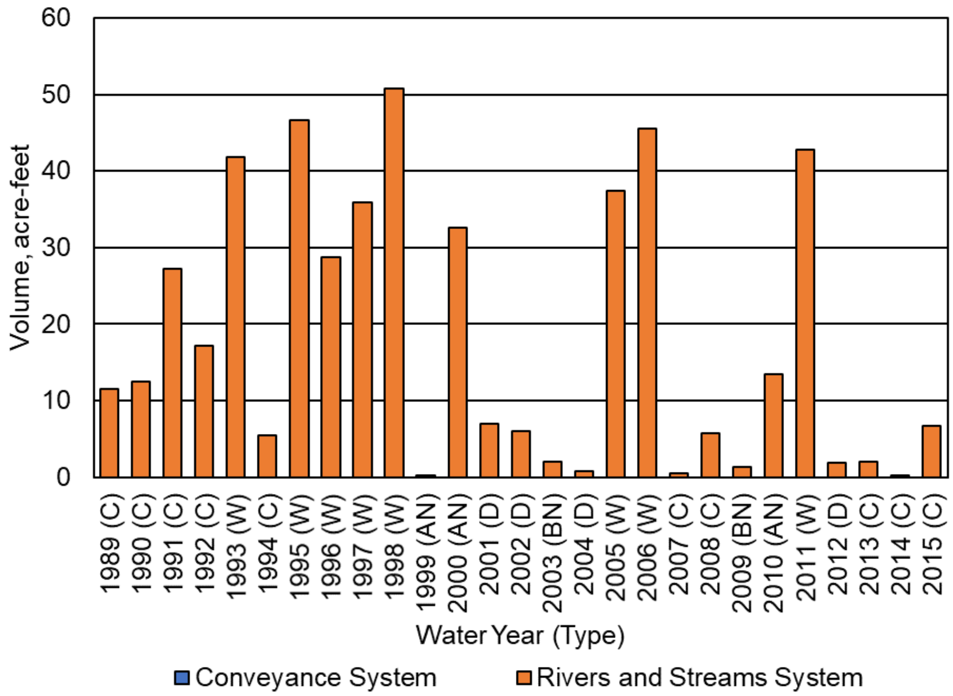

Figure A2.F.d-11. Madera Water District GSA Evaporation from the Surface Water System.

Table A2.F.d-9. Madera Water District GSA Evaporation from the Surface Water System (Acre-Feet).

Water Year (Type)	Conveyance System	Rivers and Streams System[1]	Total
1989 (C)	0	12	12
1990 (C)	0	13	13
1991 (C)	0	27	27
1992 (C)	0	17	17
1993 (W)	0	42	42
1994 (C)	0	5	5
1995 (W)	0	47	47
1996 (W)	0	29	29
1997 (W)	0	36	36
1998 (W)	0	51	51
1999 (AN)	0	0	0
2000 (AN)	0	33	33
2001 (D)	0	7	7
2002 (D)	0	6	6
2003 (BN)	0	2	2
2004 (D)	0	1	1
2005 (W)	0	37	37
2006 (W)	0	46	46
2007 (C)	0	0	0
2008 (C)	0	6	6
2009 (BN)	0	1	1

Water Year (Type)	Conveyance System	Rivers and Streams System[1]	Total
2010 (AN)	0	14	14
2011 (W)	0	43	43
2012 (D)	0	2	2
2013 (C)	0	2	2
2014 (C)	0	0	0
2015 (C)	0	7	7
Average (1989-2014)	0	18	18
Average (1989-2014) W	0	41	41
Average (1989-2014) AN	0	15	15
Average (1989-2014) BN	0	2	2
Average (1989-2014) D	0	4	4
Average (1989-2014) C	0	9	9

[1] Includes evaporation of surface inflows and of precipitation runoff.

3.2.2.2 Surface Water Outflow by Water Source Type

Surface water outflows by water source type are summarized in Figure A2.F.d-12 and Table A2.F.d-10. In MWD GSA, all CVP supplies are delivered to MWD agricultural lands to meet consumptive use requirements. Additionally, runoff of applied water is assumed negligible and runoff of precipitation is collected in waterways, completely reentering the groundwater system through infiltration except during the largest storm events. Thus, surface outflows primarily from local supplies, or natural flows, along Dry Creek are expected to leave the subregion. These outflows are significantly higher in wet years, averaging approximately 5.7 taf during wet years and less than 1 taf during below all other year types.

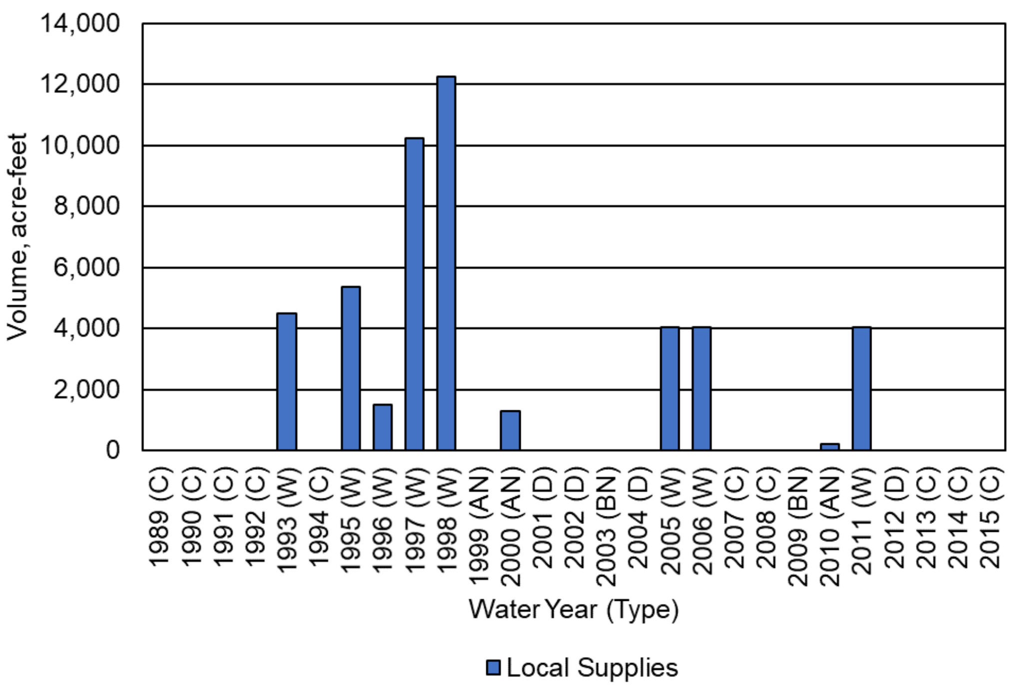

Figure A2.F.d-12. Madera Water District GSA Surface Outflows by Water Source Type.

Table A2.F.d-10. Madera Water District GSA Surface Outflows by Water Source Type (Acre-Feet).

Water Year (Type)	Local Supplies	CVP Supplies	Total
1989 (C)	0	0	0
1990 (C)	0	0	0
1991 (C)	0	0	0
1992 (C)	0	0	0
1993 (W)	4,497	0	4,497
1994 (C)	0	0	0
1995 (W)	5,377	0	5,377
1996 (W)	1,493	0	1,493
1997 (W)	10,224	0	10,224
1998 (W)	12,234	0	12,234
1999 (AN)	0	0	0
2000 (AN)	1,276	0	1,276
2001 (D)	0	0	0
2002 (D)	0	0	0
2003 (BN)	0	0	0
2004 (D)	0	0	0
2005 (W)	4,050	0	4,050
2006 (W)	4,048	0	4,048
2007 (C)	0	0	0
2008 (C)	0	0	0
2009 (BN)	0	0	0
2010 (AN)	197	0	197
2011 (W)	4,052	0	4,052
2012 (D)	0	0	0
2013 (C)	0	0	0
2014 (C)	0	0	0
2015 (C)	0	0	0
Average (1989-2014)	1,825	0	1,825
Average (1989-2014) W	5,747	0	5,747
Average (1989-2014) AN	491	0	491
Average (1989-2014) BN	0	0	0
Average (1989-2014) D	0	0	0
Average (1989-2014) C	0	0	0

3.2.2.3 Infiltration of Precipitation

Estimated infiltration of precipitation (deep percolation of precipitation) by water use sector is provided in Figure A2.F.d-13 and Table A2.F.d-11. Infiltration of precipitation to the groundwater system is variable from year to year due to variation in the timing and amount of precipitation, ranging from less than 0.3 taf during some critical and dry years to more than 2.1 taf during 1995.

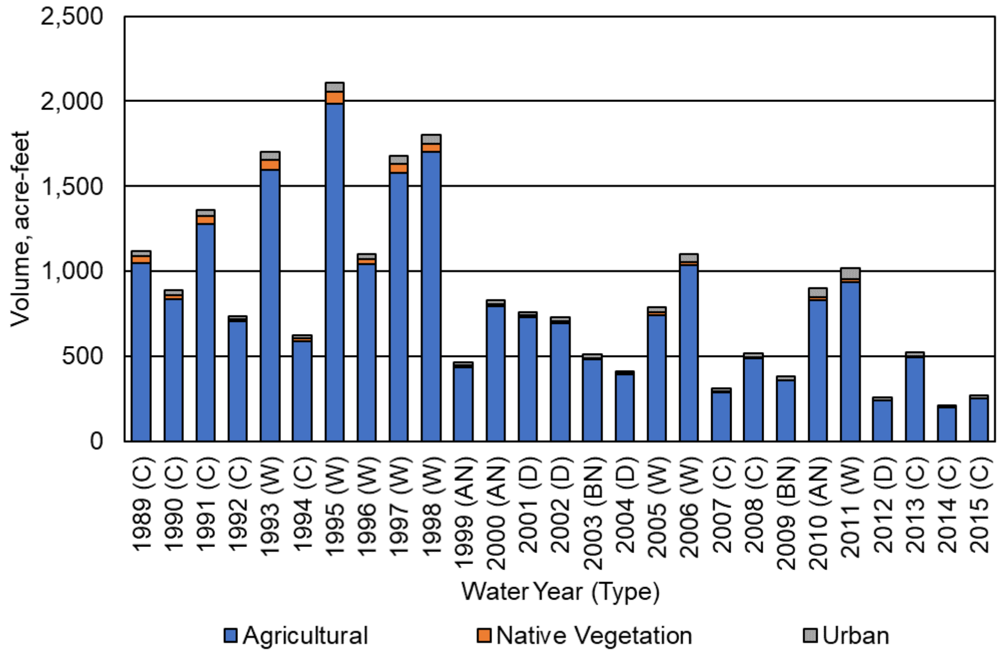

Figure A2.F.d-13. Madera Water District GSA Infiltration of Precipitation by Water Use Sector.

Table A2.F.d-11. Madera Water District GSA Infiltration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	1,050	38	31	1,119
1990 (C)	833	28	27	888
1991 (C)	1,276	48	35	1,359
1992 (C)	703	15	19	737
1993 (W)	1,598	58	47	1,703
1994 (C)	589	16	18	623
1995 (W)	1,984	73	53	2,110
1996 (W)	1,043	28	30	1,101
1997 (W)	1,580	51	48	1,679
1998 (W)	1,700	49	51	1,800
1999 (AN)	435	9	17	461
2000 (AN)	791	17	23	831
2001 (D)	728	12	20	760
2002 (D)	695	9	23	727
2003 (BN)	481	8	20	509
2004 (D)	394	4	15	413
2005 (W)	742	14	33	789
2006 (W)	1,038	17	47	1,102
2007 (C)	289	3	18	310
2008 (C)	489	6	23	518
2009 (BN)	357	3	21	381
2010 (AN)	827	18	54	899
2011 (W)	935	19	63	1,017

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2012 (D)	238	1	21	260
2013 (C)	491	5	29	525
2014 (C)	199	0	11	210
2015 (C)	249	1	16	266
Average (1989-2014)	826	21	31	878
Average (1989-2014) W	1,328	39	47	1,413
Average (1989-2014) AN	684	15	31	730
Average (1989-2014) BN	419	6	21	445
Average (1989-2014) D	514	7	20	540
Average (1989-2014) C	658	18	23	699

3.2.2.4 Infiltration of Surface Water

Estimated infiltration of surface water (seepage) by source is provided in Figure A2.F.d-14 and Table A2.F.d-12. Seepage from the Rivers and Streams System includes seepage of both surface inflows and of precipitation runoff into local sloughs and depressions. Seepage from rivers and streams is provides an average of 0.4 taf per year to the groundwater system. Because the MWD conveyance system is a pipeline, seepage from the Conveyance System is considered negligible.

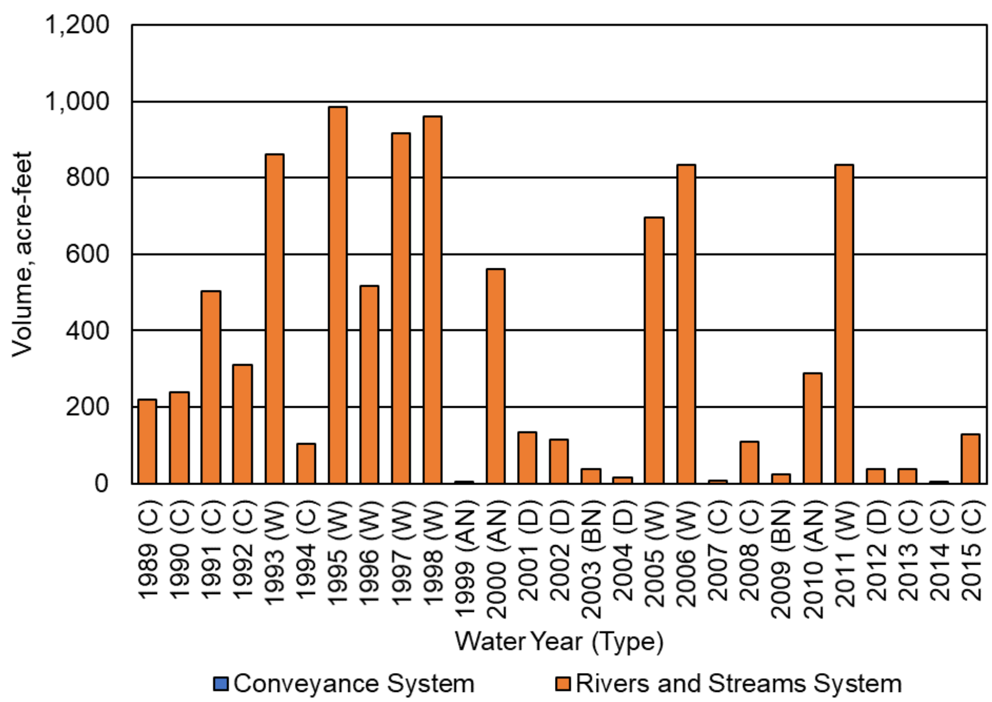

Figure A2.F.d-14. Madera Water District GSA Infiltration of Surface Water.

Table A2.F.d-12. Madera Water District GSA Infiltration of Surface Water (Acre-Feet).

Water Year (Type)	Conveyance System	Rivers and Streams System[1]	Total
1989 (C)	0	219	219
1990 (C)	0	238	238
1991 (C)	0	503	503
1992 (C)	0	310	310
1993 (W)	0	860	860
1994 (C)	0	103	103
1995 (W)	0	985	985
1996 (W)	0	517	517
1997 (W)	0	917	917
1998 (W)	0	961	961
1999 (AN)	0	5	5
2000 (AN)	0	561	561
2001 (D)	0	134	134
2002 (D)	0	114	114
2003 (BN)	0	39	39
2004 (D)	0	16	16
2005 (W)	0	697	697
2006 (W)	0	835	835
2007 (C)	0	9	9
2008 (C)	0	109	109
2009 (BN)	0	25	25
2010 (AN)	0	288	288
2011 (W)	0	834	834
2012 (D)	0	37	37
2013 (C)	0	39	39
2014 (C)	0	4	4
2015 (C)	0	127	127
Average (1989-2014)	0	360	360
Average (1989-2014) W	0	826	826
Average (1989-2014) AN	0	284	284
Average (1989-2014) BN	0	32	32
Average (1989-2014) D	0	75	75
Average (1989-2014) C	0	170	170

[1] Includes infiltration of surface inflows and of precipitation runoff.

3.2.2.5 Infiltration of Applied Water

Estimated infiltration of applied water (deep percolation of applied water) by water use sector is provided in Figure A2.F.d-15 and Table A2.F.d-13. Infiltration of applied water is dominated by agricultural irrigation. The annual fluctuations are primarily a result calculating deep percolation of applied water as the closure term of the agricultural lands water budget between 1993 and 2015, when annual groundwater pumping data was available from the MWD Groundwater Management Plan. As the closure term, all errors in the other water budget terms are manifested in the infiltration of applied water. For example, the very low volumes in 1999 and 2007 could be the result of problems with one or two of the groundwater pumping meters under reporting.

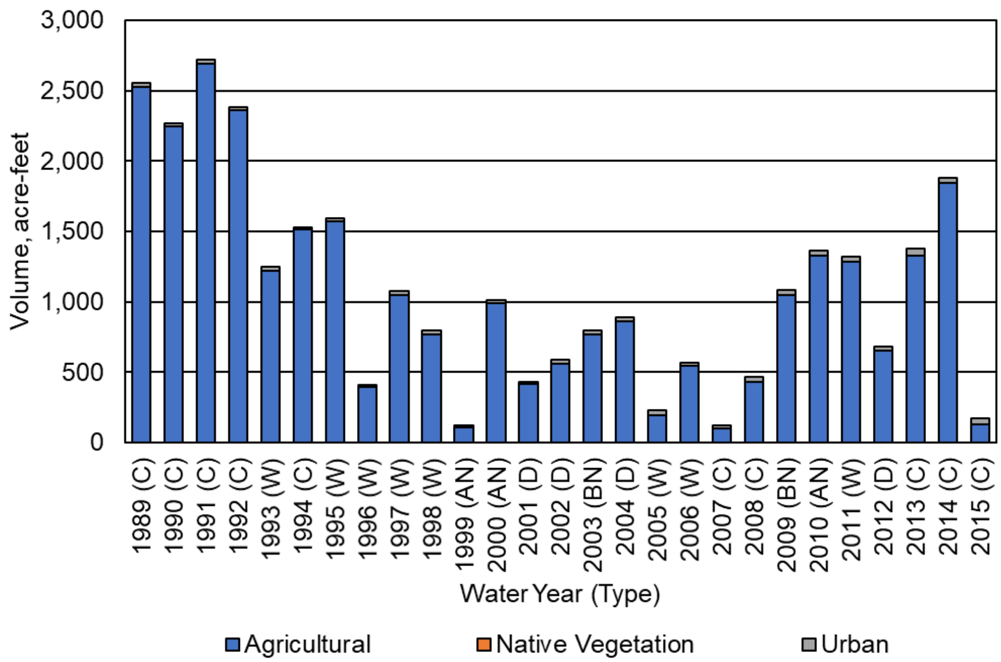

Figure A2.F.d-15. Madera Water District GSA Infiltration of Applied Water by Water Use Sector.

Table A2.F.d-13. Madera Water District GSA Infiltration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	2,524	0	28	2,552
1990 (C)	2,244	0	23	2,267
1991 (C)	2,691	0	27	2,718
1992 (C)	2,361	0	23	2,384
1993 (W)	1,222	0	29	1,251
1994 (C)	1,515	0	17	1,532
1995 (W)	1,571	0	22	1,593
1996 (W)	395	0	13	408
1997 (W)	1,048	0	32	1,080
1998 (W)	768	0	28	796
1999 (AN)	110	0	13	123
2000 (AN)	993	0	22	1,015
2001 (D)	413	0	19	432
2002 (D)	561	0	25	586
2003 (BN)	769	0	24	793
2004 (D)	860	0	27	887
2005 (W)	193	0	34	227
2006 (W)	544	0	25	569
2007 (C)	97	0	26	123
2008 (C)	433	0	37	470
2009 (BN)	1,050	0	33	1,083
2010 (AN)	1,328	0	35	1,363
2011 (W)	1,284	0	33	1,317

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2012 (D)	651	0	32	683
2013 (C)	1,331	0	46	1,377
2014 (C)	1,844	0	33	1,877
2015 (C)	132	0	39	171
Average (1989-2014)	1,108	0	27	1,135
Average (1989-2014) W	878	0	27	905
Average (1989-2014) AN	810	0	23	834
Average (1989-2014) BN	910	0	29	938
Average (1989-2014) D	621	0	26	647
Average (1989-2014) C	1,671	0	29	1,700

3.2.3 Change in Surface Water System Storage

Estimates of change in SWS storage are provided in Figure A2.F.d-16 and Table A2.F.d-14. Inter-annual changes in storage within the surface water system consist primarily of root zone soil moisture storage changes, are relatively small, and tend to average near zero over many years. The large estimated change in SWS storage in 2007 is the result of uncertainty in the deep percolation of applied water closure term, when change in SWS storage was adjusted to improve deep percolation estimates.

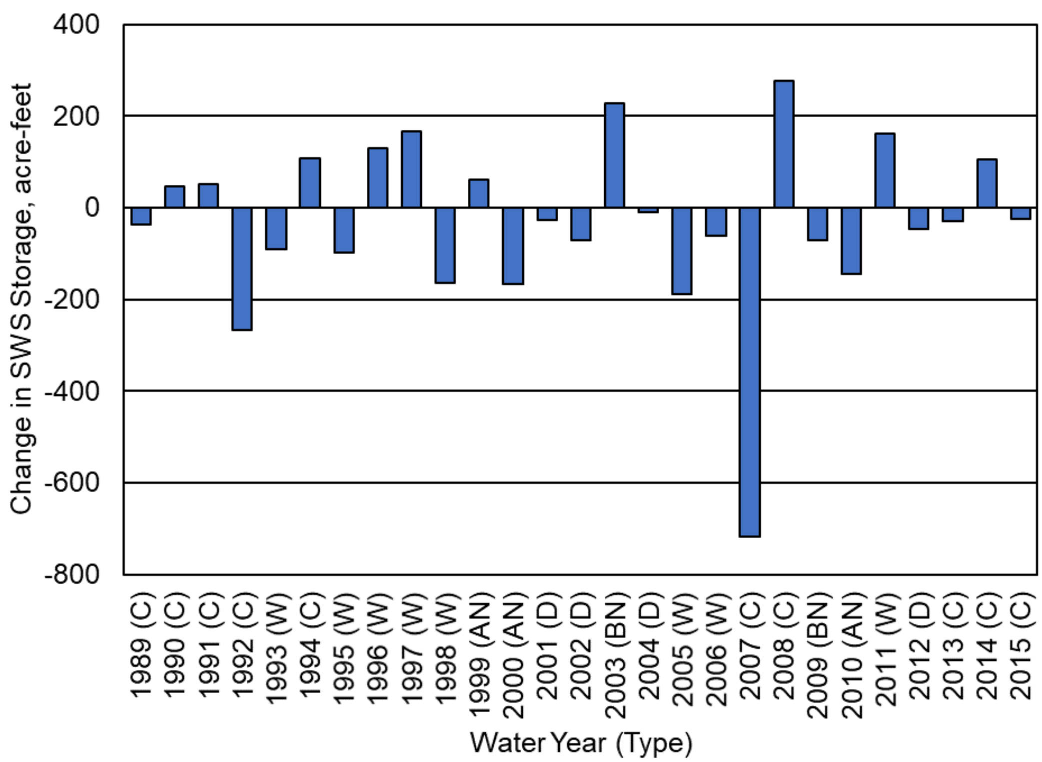

Figure A2.F.d-16. Madera Water District GSA Change in Surface Water System Storage.

Table A2.F.d-14. Madera Water District GSA Change in Surface Water System Storage (Acre-Feet).

Water Year (Type)	Change in SWS Storage
1989 (C)	-36
1990 (C)	46
1991 (C)	52
1992 (C)	-266
1993 (W)	-90
1994 (C)	107
1995 (W)	-98
1996 (W)	130
1997 (W)	167
1998 (W)	-164
1999 (AN)	61
2000 (AN)	-167
2001 (D)	-27
2002 (D)	-71
2003 (BN)	229
2004 (D)	-10
2005 (W)	-189
2006 (W)	-60
2007 (C)	-718
2008 (C)	278
2009 (BN)	-72
2010 (AN)	-144
2011 (W)	161
2012 (D)	-47
2013 (C)	-28
2014 (C)	106
2015 (C)	-24
Average (1989-2014)	-33
Average (1989-2014) W	-18
Average (1989-2014) AN	-83
Average (1989-2014) BN	79
Average (1989-2014) D	-39
Average (1989-2014) C	-51

3.3 Historical Water Budget Summary

Annual inflows, outflows, and change in SWS storage during the historical water budget period (1989-2014) are summarized in Figure A2.F.d-17 and Table A2.F.d-15. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values. Review of the variability in component volumes across years provides insight into the impacts of hydrology on the surface water system water budget.

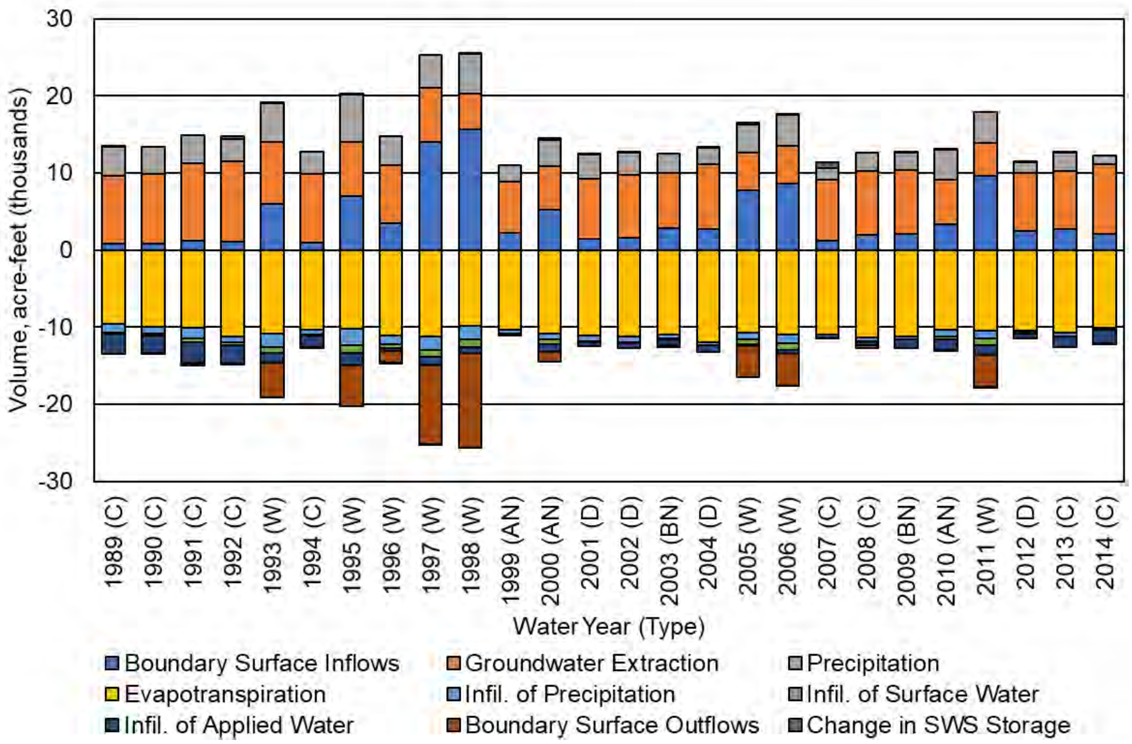

Figure A2.F.d-17. Madera Water District GSA Surface Water System Historical Water Budget, 1989-2014.

Table A2.F.d-15. Madera Water District GSA Surface Water System Historical Water Budget, 1989-2014 (Acre-Feet).

Water Year (Type)	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Evapo-transpiration[1]	Infil. of Precipitation	Infil. of Surface Water	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	850	8,809	3,734	-9,540	-1,119	-219	-2,552	0	36
1990 (C)	850	9,092	3,478	-9,982	-888	-238	-2,267	0	-46
1991 (C)	1,258	10,034	3,637	-10,077	-1,359	-503	-2,718	-220	-52
1992 (C)	1,046	10,436	2,972	-11,264	-737	-310	-2,384	-25	266
1993 (W)	5,988	8,033	5,034	-10,834	-1,703	-860	-1,251	-4,497	90
1994 (C)	995	8,864	2,853	-10,348	-623	-103	-1,532	0	-107
1995 (W)	7,043	7,040	6,123	-10,241	-2,110	-985	-1,593	-5,377	98
1996 (W)	3,517	7,460	3,741	-11,070	-1,101	-517	-408	-1,493	-130
1997 (W)	14,022	7,032	4,273	-11,263	-1,679	-917	-1,080	-10,224	-167
1998 (W)	15,617	4,701	5,138	-9,829	-1,800	-961	-796	-12,234	164
1999 (AN)	2,244	6,673	2,085	-10,352	-461	-5	-123	0	-61
2000 (AN)	5,236	5,677	3,397	-10,794	-831	-561	-1,015	-1,276	167
2001 (D)	1,459	7,758	3,172	-11,091	-760	-134	-432	0	27
2002 (D)	1,652	8,075	2,877	-11,249	-727	-114	-586	0	71
2003 (BN)	2,881	7,158	2,528	-10,998	-509	-39	-793	0	-229
2004 (D)	2,715	8,402	2,100	-11,911	-413	-16	-887	0	10
2005 (W)	7,796	4,891	3,622	-10,737	-789	-697	-227	-4,050	189
2006 (W)	8,595	4,923	3,991	-11,016	-1,102	-835	-569	-4,048	60
2007 (C)	1,187	7,888	1,616	-10,967	-310	-9	-48	0	643
2008 (C)	2,006	8,205	2,457	-11,293	-518	-109	-470	0	-278
2009 (BN)	2,152	8,283	2,218	-11,236	-381	-25	-1,083	0	72
2010 (AN)	3,391	5,776	3,810	-10,374	-899	-288	-1,363	-197	144
2011 (W)	9,610	4,258	3,990	-10,478	-1,017	-834	-1,317	-4,052	-161
2012 (D)	2,436	7,618	1,357	-10,477	-260	-37	-683	0	47
2013 (C)	2,760	7,542	2,294	-10,683	-525	-39	-1,377	0	28
2014 (C)	2,064	9,072	1,121	-10,060	-210	-4	-1,877	0	-106
Average (1989-2014)	4,207	7,450	3,216	-10,699	-878	-360	-1,135	-1,834	33
W	9,024	6,042	4,489	-10,683	-1,413	-826	-905	-5,747	18
AN	3,624	6,042	3,097	-10,506	-730	-284	-834	-491	83
BN	2,516	7,720	2,373	-11,117	-445	-32	-938	0	-79
D	2,065	7,963	2,377	-11,182	-540	-75	-647	0	39
C	1,446	8,882	2,685	-10,468	-699	-170	-1,700	-27	51

[1]Includes ET of applied water, ET of precipitation, and evaporation from rivers and streams.

3.4 Current Water Budget Summary

The current water budget was developed following a similar process to the historical water budget using the 2015 land use in Table A2.F.d-1 and the same 1989-2014 average hydrologic conditions of the historical base period, including surface water flows, precipitation, and weather parameters. This allowed quantification of groundwater inflows and outflows for current consumptive use in the context of average water supply conditions.

Annual inflows, outflows, and change in SWS storage from the current water budget are summarized in Figure A2.F.d-18 and Table A2.F.d-16. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values.

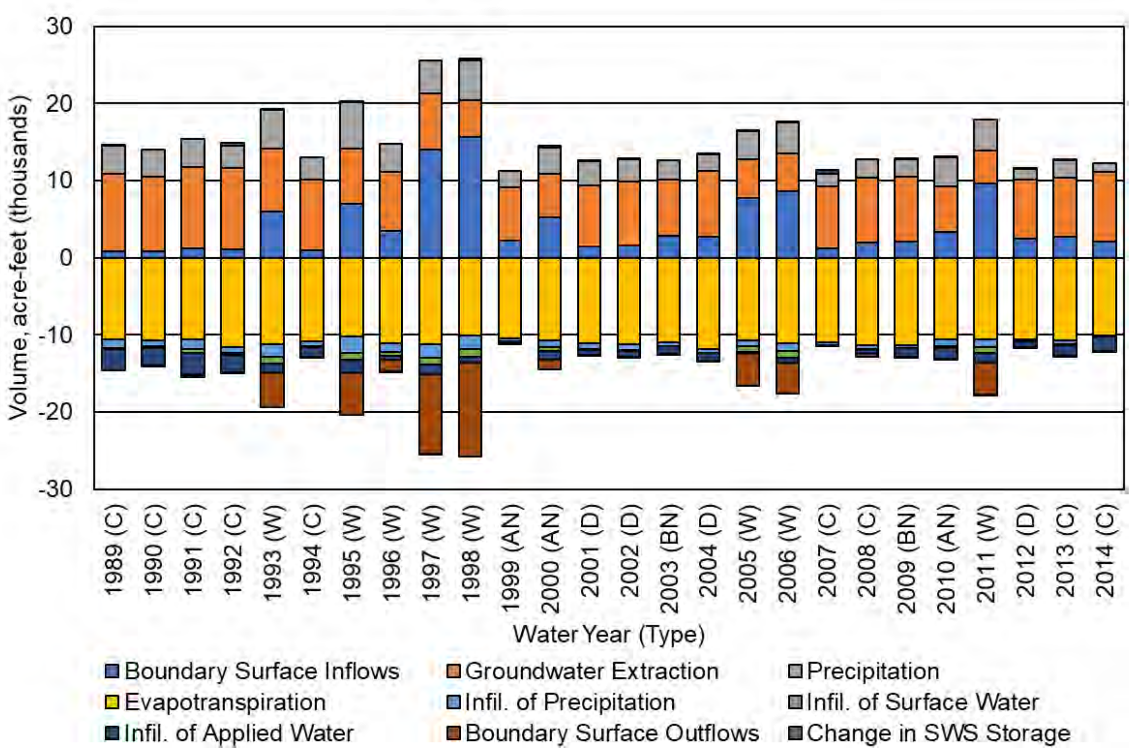

Figure A2.F.d-18. Madera Water District GSA Surface Water System Current Water Budget.

Table A2.F.d-16. Madera Water District GSA Surface Water System Current Water Budget (Acre-Feet).

Water Year (Type)	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Evapo-transpiration[1]	Infil. of Precipitation	Infil. of Surface Water	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	850	9,998	3,732	-10,568	-1,094	-164	-2,795	0	42
1990 (C)	850	9,718	3,479	-10,650	-869	-208	-2,285	0	-35
1991 (C)	1,258	10,515	3,635	-10,563	-1,305	-503	-2,737	-212	-89
1992 (C)	1,046	10,539	2,971	-11,578	-712	-335	-2,234	-3	305
1993 (W)	5,988	8,167	5,033	-11,192	-1,661	-900	-1,127	-4,441	133
1994 (C)	995	9,116	2,852	-10,860	-603	-76	-1,282	0	-142
1995 (W)	7,043	7,068	6,122	-10,194	-2,094	-984	-1,673	-5,386	98
1996 (W)	3,517	7,573	3,741	-11,075	-1,078	-507	-541	-1,487	-143
1997 (W)	14,022	7,225	4,275	-11,258	-1,670	-916	-1,269	-10,223	-186
1998 (W)	15,617	4,851	5,139	-10,057	-1,790	-989	-783	-12,173	184
1999 (AN)	2,244	6,888	2,084	-10,410	-458	-4	-274	0	-70
2000 (AN)	5,236	5,671	3,398	-10,720	-827	-561	-1,088	-1,283	175
2001 (D)	1,459	7,920	3,170	-11,036	-752	-133	-653	-2	26
2002 (D)	1,652	8,221	2,877	-11,194	-724	-114	-788	-4	75
2003 (BN)	2,881	7,228	2,528	-10,952	-509	-39	-905	-3	-230
2004 (D)	2,715	8,580	2,100	-11,877	-413	-15	-1,097	-2	10
2005 (W)	7,796	4,945	3,623	-10,727	-785	-696	-303	-4,053	201
2006 (W)	8,595	4,966	3,991	-11,032	-1,101	-834	-601	-4,049	65
2007 (C)	1,187	8,042	1,616	-11,014	-310	-7	496	-1	-10
2008 (C)	2,006	8,331	2,456	-11,346	-520	-109	-536	-1	-281
2009 (BN)	2,152	8,355	2,219	-11,329	-383	-23	-1,066	0	75
2010 (AN)	3,391	5,841	3,810	-10,522	-899	-347	-1,296	-131	153
2011 (W)	9,610	4,272	3,988	-10,540	-1,016	-833	-1,264	-4,053	-163
2012 (D)	2,436	7,680	1,357	-10,533	-260	-36	-697	-1	53
2013 (C)	2,760	7,603	2,293	-10,730	-524	-37	-1,396	-1	31
2014 (C)	2,064	9,064	1,120	-10,030	-213	-4	-1,896	-1	-105
Average (1989-2014)	4,207	7,630	3,216	-10,846	-868	-360	-1,157	-1,827	7
W	9,024	6,133	4,489	-10,760	-1,399	-832	-945	-5,733	23
AN	3,624	6,133	3,098	-10,551	-728	-304	-886	-471	86
BN	2,516	7,792	2,373	-11,141	-446	-31	-985	-1	-77
D	2,065	8,100	2,376	-11,160	-537	-74	-809	-2	41
C	1,446	9,214	2,684	-10,816	-683	-160	-1,629	-24	-32

[1]Includes ET of applied water, ET of precipitation, and evaporation from rivers and streams.

3.5 Net Recharge from SWS

Overdraft is defined in DWR Bulletin 118 as "the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions" (DWR 2003). The Madera Subbasin water budget indicates that overdraft conditions occurred during the 1989-2014 historical base period. Per 23 CCR Section 354.18(b)(5), the subbasin overdraft has been quantified for this base period. The evaluation of overdraft conditions includes estimates of recharge from subsurface flows. However, estimates of recharge from subsurface flows are less accurate when estimated for areas less than an entire subbasin. Thus, for estimates of GSA level contribution to overdraft, the term net recharge from the SWS, is defined as groundwater recharge minus groundwater extraction. Net recharge from the SWS is useful for understanding and analyzing the combined effects of land surface processes on the underlying GWS.

When calculated from the historical water budget, average net recharge from the SWS represents the average recharge (when positive) or shortage of recharge (when negative) based on historical cropping, land use practices, and average hydrologic conditions. When calculated from the current land use water budget, average net recharge represents the average recharge or shortage (negative net recharge) based on current cropping, land use practices, and average hydrologic conditions.

Average net recharge from the SWS is presented below for the MWD GSA portion of the Madera Subbasin. Table A2.F.d-17 shows the average net recharge from the SWS for 1989-2014 based on the historical water budget, and Table A2.F.d-18 shows the same for the current water budget. Historically, the average net recharge in MWD GSA was approximately -5.1 taf per year between 1989 and 2014. Under current land use conditions, the average net recharge in MWD GSA is approximately -5.2 taf, indicating that groundwater extraction exceeds recharge from the surface water system.

Table A2.F.d-17. Historical Water Budget: Average Net Recharge from SWS by Water Year Type, 1989-2014 (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	905	1,413	826	6,042	-2,899
AN	3	834	730	284	6,042	-4,193
BN	2	938	445	32	7,720	-6,305
D	4	647	540	75	7,963	-6,701
C	9	1,700	699	170	8,882	-6,313
Annual Average (1989-2014)	26	1,135	878	360	7,450	-5,077

Table A2.F.d-18. Current Water Budget: Average Net Recharge from SWS by Water Year Type (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	945	1,399	832	6,133	-2,957
AN	3	886	728	304	6,133	-4,215
BN	2	985	446	31	7,792	-6,330
D	4	809	537	74	8,100	-6,679
C	9	1,629	683	160	9,214	-6,741
Annual Average (1989-2014)	26	1,157	868	360	7,630	-5,244

3.6 Uncertainties in Water Budget Components

Uncertainties associated with each water budget component were estimated as a percentage representing approximately a 95% confidence interval following the procedure described by Clemmens and Burt (1997). Uncertainties for all independently measured or estimated water budget components were estimated based on the measurement accuracy, typical values reported in technical literature, typical values calculated in other water budgets, and professional judgement.

Table A2.F.d-19 provides a summary of typical uncertainty values associated with major SWS inflow and outflow components. These uncertainties provide a basis for evaluating confidence in water budget results and help to identify data needs that may be addressed during GSP implementation.

Table A2.F.d-19. Estimated Uncertainty of GSA Water Budget Components.

Flowpath Direction (SWS Boundary)	Water Budget Component	Data Source	Estimated Uncertainty (%)	Source
Inflows	Surface Water Inflows	Calculation	20%	Estimated streamflow measurement accuracy and adjustment for losses.
	Deliveries	Measurement	6%	Estimated delivery measurement accuracy (accuracy required for Reclamation contractors)
	Precipitation	Calculation	30%	Clemmens, A.J. and C.M. Burt, 1997.
	Groundwater Extraction	Closure	20%	Typical uncertainty calculated for Land Surface System water balance closure; Estimated accuracy of groundwater pumping measurements.
Outflows	Surface Water Outflows	Closure	20%	Estimated streamflow measurement accuracy and adjustment for losses.
	Evaporation	Calculation	20%	Estimated accuracy of calculation based on CIMIS reference ET and free water surface evaporation coefficient.
	ET of Applied Water	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, estimated crop coefficients from SEBAL energy balance, and annual land use.
	ET of Precipitation	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, precipitation, estimated crop coefficients from SEBAL energy balance, and annual land use.
	Infiltration of Applied Water	Calculation	20%	Typical uncertainty calculated for Land Surface System water balance closure; Estimated accuracy of daily IDC root zone water budget component based on annual land use and NRCS soils characteristics.
	Infiltration of Precipitation	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use, NRCS soils characteristics, and CIMIS precipitation.
	Infiltration of Surface Water	Calculation	15%	Estimated accuracy of daily seepage calculation using NRCS soils characteristics and measured streamflow data.
	Change in SWS Storage	Calculation	50%	Professional Judgment.
Net Recharge from SWS		Calculation	25%	Estimated water budget accuracy; typical value calculated for GSA-level net recharge from SWS.

APPENDIX 2.F. WATER BUDGET INFORMATION

2.F.e. Surface Water System Water Budget: Gravelly Ford Water District GSA

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

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1 INTRODUCTION

To ensure sustainable groundwater management throughout California's groundwater basins, the Sustainable Groundwater Management Act of 2014 (SGMA) requires Groundwater Sustainability Agencies (GSAs) to prepare and adopt Groundwater Sustainability Plans (GSPs) with strategies to achieve subbasin groundwater sustainability within 20 years of plan adoption. Integral to each GSP is a water budget used to quantify the subbasin's groundwater overdraft (if applicable) and sustainable yield.

In 2017, Gravelly Ford Water District (GFWD) GSA formed to manage approximately 8,400 acres of the Madera Subbasin. This document presents results of the surface water system (SWS) water budgets developed for historical and current land use conditions in GFWD GSA. The GFWD GSA water budgets were integrated with separate water budgets developed for the other six (6) GSAs in Madera Subbasin to prepare a boundary water budget for the Madera Subbasin SWS. Results of the subbasin boundary water budget are reported in the Madera Subbasin GSP Section 2.2.3 and were integrated with a subbasin groundwater model (GSP Appendix 6.D) to estimate subbasin sustainable yield (GSP Section 2.2.3).

2 WATER BUDGET CONCEPTUAL MODEL

A water budget is defined as a complete accounting of all water flowing into and out of a defined volume (e.g., a subbasin or a GSA) over a specified period of time. The conceptual model (or structure) of the GFWD GSA water budget developed for this investigation is consistent with the GSP Regulations defined under Title 23 of California Code of Regulations[1] (CCR) and adheres to sound water budget principles and practices defined by California Department of Water Resources (DWR) in the Water Budget Best Management Practice (BMP) guidelines (DWR, 2016).

The lateral extent of GFWD GSA is defined by the boundaries indicated in Figure A2.F.e-1. The vertical extent of GFWD GSA is the land surface (top) and the base of fresh water at the bottom of the basin (bottom), as described in the hydrogeologic conceptual model (HCM) developed in GSP Section 2.2.1. The vertical extent of Madera Subbasin and its GSAs is subdivided into a surface water system (SWS) and the underlying groundwater system (GWS), with separate but related water budgets prepared for each that together represent the overall subbasin water budget.

A conceptual representation of the GFWD GSA water budget is represented in Figure A2.F.e-2. This document details only the SWS portion of the GFWD GSA water budget. The SWS is divided into three primary accounting centers: the Land Surface System, the Rivers and Streams System, and the Canal System. The Land Surface System is further divided into three accounting centers representing GFWD GSA's water use sectors: Agricultural Land, Native Vegetation Land, and Urban Land (urban, industrial, and semi-agricultural).

Water budget components, or directional flow of water between accounting centers and across the SWS boundary, are indicated by arrows. Inflows and outflows were calculated using measurements and other historical data or were calculated as the water budget closure term – the difference between all other estimated or measured inflows and outflows from each accounting center or water use sector (bold arrows).

[1] California Code of Regulations Title 23. Waters, Division 2. Department of Water Resources, Chapter 1.5. Groundwater Management, Subchapter 2. Groundwater Sustainability Plans.

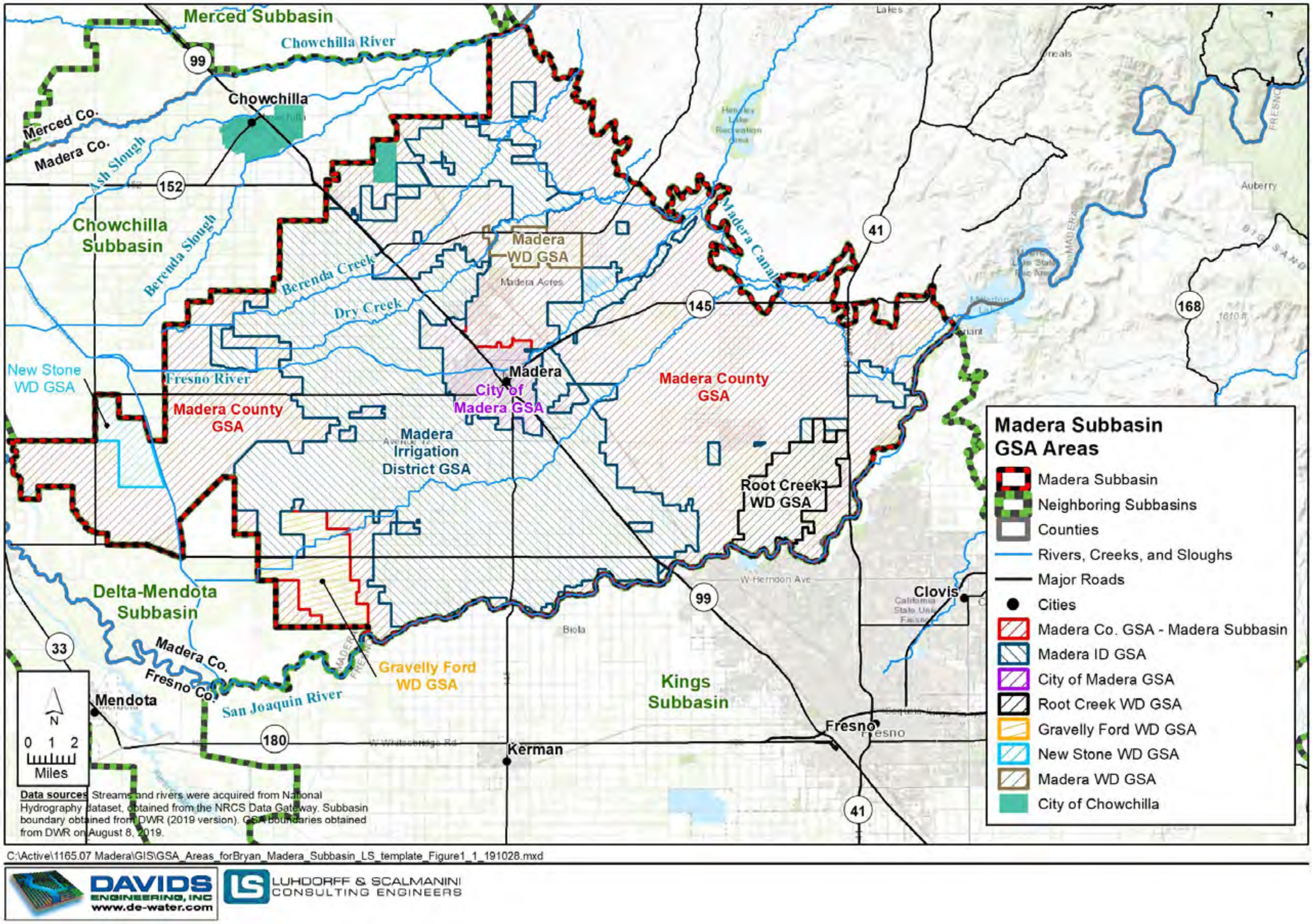

Figure A2.F.e-1. Madera Subbasin GSAs Map

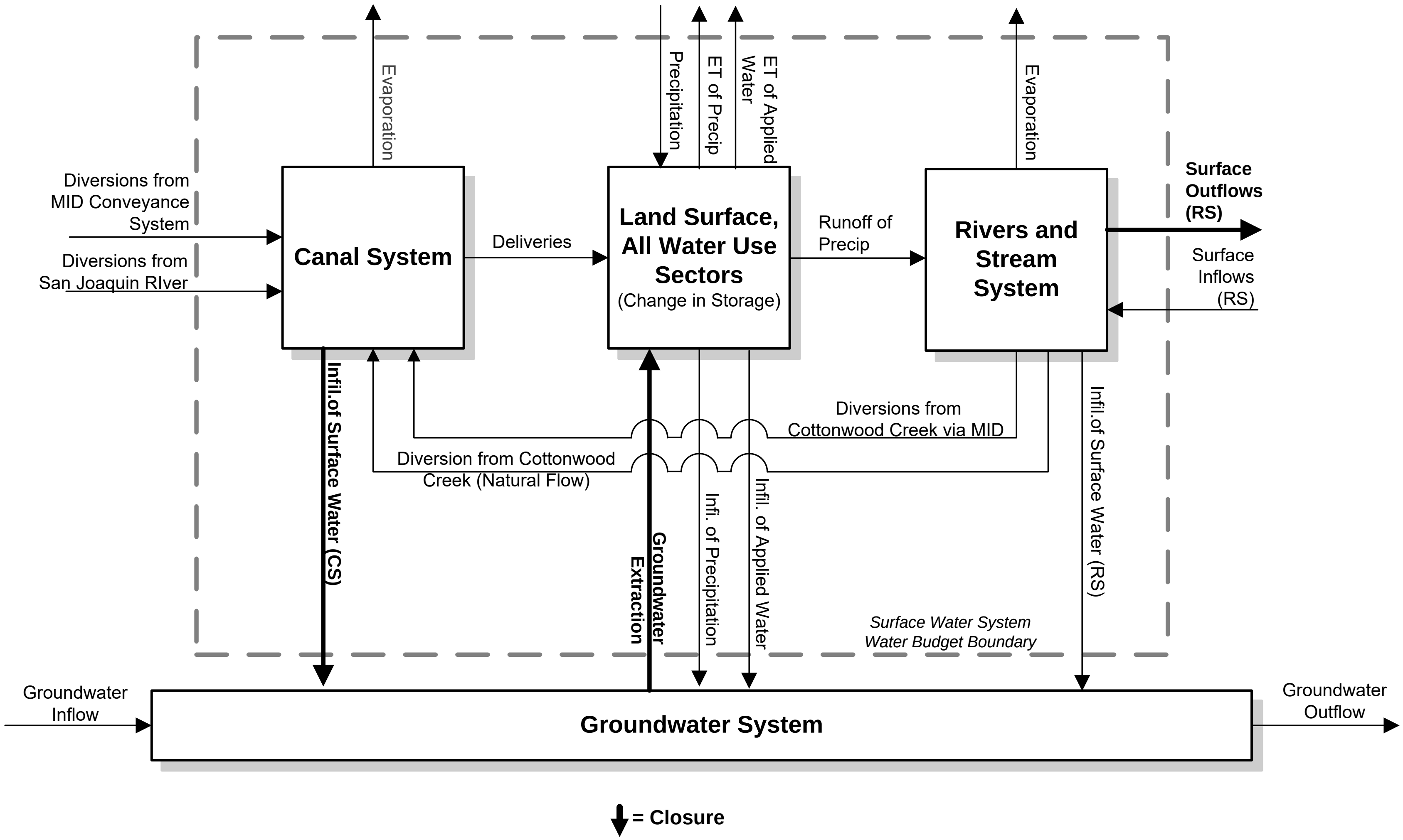

Figure A2.F.e-2. Gravelly Ford Water District GSA Water Budget Structure

Inflows to the SWS include precipitation, surface water inflows (in various canals and streams), and groundwater extraction. Outflows from the SWS include evapotranspiration (ET), surface water outflows (in various canals and streams), and infiltration to the groundwater system (seepage and deep percolation). Also represented in Figure A2.F.e-2 are inflows and outflows from the GWS, which are discussed and quantified at the subbasin level in the GWS water budget in GSP Section 2.2.3. Subsurface GWS inflows and outflows are not quantified on the water budget subregion scale.

Inflows and outflows were quantified following the process described in GSP Section 2.2.3 on a monthly time step for water years in the historical water budget base period (1989-2014 hydrologic and land use conditions), the current water budget (2015 land use using 1989-2014 average hydrologic conditions), and projected water budget. Four projected water budgets were prepared for the years 2019 through 2090 based on 1965 through 2015 hydrologic conditions:

1. Historical hydrologic conditions
    a. Without projects and management actions, and
    b. With projects and management actions
2. Historical hydrologic conditions adjusted for anticipated climate change per DWR-provided 2030 climate change factors
    a. Without projects and management actions, and
    b. With projects and management actions.

3 WATER BUDGET ANALYSIS

The historical water budget and current land use water budget for GFWD GSA are presented below following a summary of land use data relevant to water budget development. Land use data is provided for the 1989-2014 historical water budget period and for 2015, the current land use water budget period.

3.1 Land Use

Land use estimates for 1989 through 2015 corresponding to water use sectors (as defined by the GSP Regulations) are summarized in Figure A2.F.e-3 and Table A2.F.e-1 for GFWD GSA. According to GSP Regulations (23 CCR § 351(al)):

> *"Water use sector" refers to 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.*

In GFWD GSA, water use sectors include agricultural, native vegetation, and urban land use. The urban land use category includes urban and semi-agricultural[2] lands as well as industrial land, which covers only a small area in the subbasin.

As indicated, the majority of land in GFWD GSA is used for agriculture, covering an average of approximately 7,600 acres between 1989 and 2014. Agricultural lands remained generally constant between 1989 and 2001, after which a slight decrease in agricultural acreage coincided with expansion of areas classified as native vegetation and water surfaces. Urban lands covered approximately 700 acres between 1989 and 2014.

[2] As defined in the DWR county land use surveys, semi-agricultural land use subclasses include farmsteads, livestock feed lot operations, dairies, poultry farms, and miscellaneous semi-agricultural land use incidental to agriculture (small roads, ditches, non-planted areas of cropped fields (DWR, 2009).

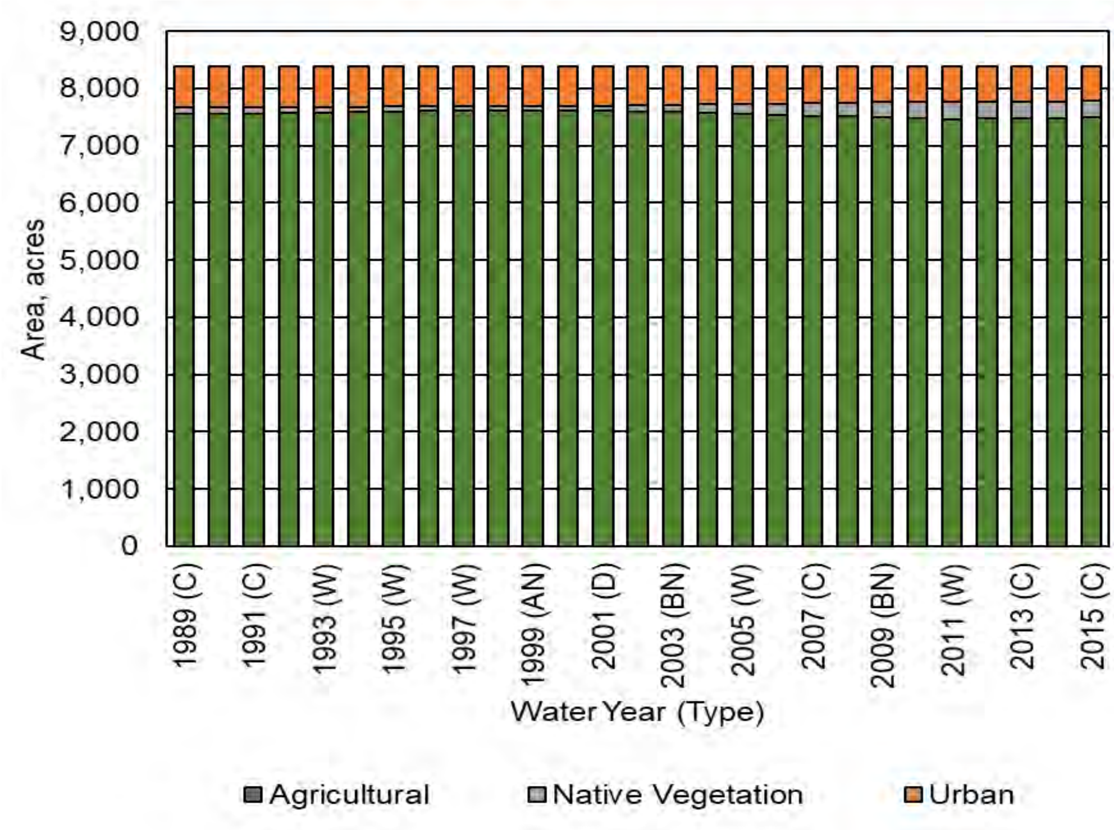

Figure A2.F.e-3. Gravelly Ford Water District GSA Land Use Areas

Table A2.F.e-1. Gravelly Ford Water District GSA Land Use Areas, acres

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
1989 (C)	7,559	108	712	8,379
1990 (C)	7,558	105	716	8,379
1991 (C)	7,564	103	712	8,379
1992 (C)	7,573	98	707	8,379
1993 (W)	7,583	94	702	8,379
1994 (C)	7,593	86	700	8,379
1995 (W)	7,601	81	696	8,379
1996 (W)	7,604	82	694	8,379
1997 (W)	7,606	82	691	8,379
1998 (W)	7,608	82	688	8,379
1999 (AN)	7,611	82	686	8,379
2000 (AN)	7,613	83	683	8,379
2001 (D)	7,615	83	681	8,379
2002 (D)	7,601	106	673	8,379
2003 (BN)	7,586	128	665	8,379
2004 (D)	7,571	151	657	8,379
2005 (W)	7,556	174	650	8,379

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
2006 (W)	7,541	196	642	8,379
2007 (C)	7,526	219	634	8,379
2008 (C)	7,511	242	627	8,379
2009 (BN)	7,496	265	619	8,379
2010 (AN)	7,481	287	611	8,379
2011 (W)	7,466	310	603	8,379
2012 (D)	7,470	305	603	8,379
2013 (C)	7,475	301	603	8,379
2014 (C)	7,480	296	603	8,379
2015 (C)	7,503	292	585	8,379
Average (1989-2014)	7,556	160	664	8,379

[1] Area includes land classified as native vegetation and water surfaces.
[2] Area includes land classified as urban, industrial, and semi-agricultural.

Agricultural land uses are further detailed in Figure A2.F.e-4 and Table A2.F.e-2. Historically, a majority of the agricultural area in GFWD has been comprised of permanent crops, such as grapes and orchard crops. While grape acreage has decreased since peaking in 2000, orchard acreage more than doubled between 1989 and 2015.

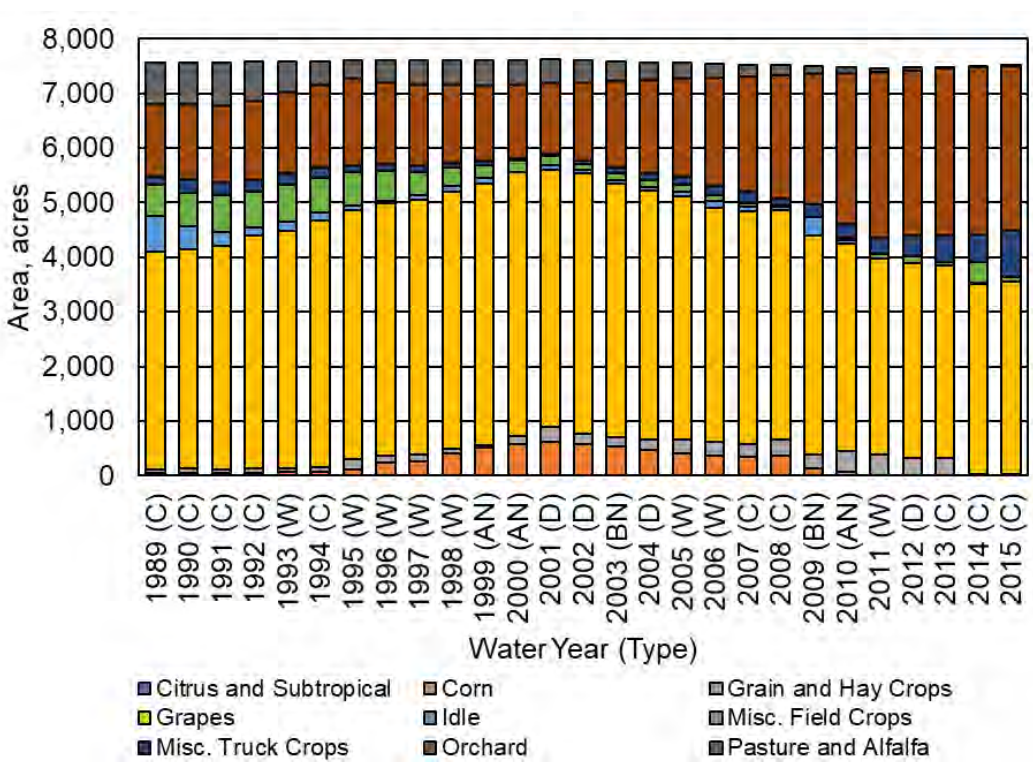

Figure A2.F.e-4. Gravelly Ford Water District GSA Agricultural Land Use Areas

Table A2.F.e-2. Gravelly Ford Water District GSA Agricultural Land Use Areas

Water Year (Type)	Citrus and Subtropical	Corn	Grain and Hay Crops	Grapes	Idle	Misc. Field Crops	Misc. Truck Crops	Orchard	Pasture and Alfalfa	Total
1989 (C)	1	42	60	3,990	670	573	146	1,325	752	7,559
1990 (C)	1	41	84	4,013	421	608	258	1,370	760	7,558
1991 (C)	2	42	61	4,106	244	675	235	1,410	789	7,564
1992 (C)	2	51	78	4,269	146	651	221	1,447	709	7,573
1993 (W)	2	59	80	4,338	179	659	209	1,483	574	7,583
1994 (C)	2	66	77	4,520	161	625	195	1,517	430	7,593
1995 (W)	2	103	189	4,567	84	603	137	1,575	341	7,601
1996 (W)	3	243	119	4,618	49	545	123	1,513	392	7,604
1997 (W)	6	248	136	4,659	79	434	120	1,478	447	7,606
1998 (W)	2	401	90	4,702	110	327	102	1,427	448	7,608
1999 (AN)	1	505	44	4,802	97	242	75	1,383	461	7,611
2000 (AN)	3	563	160	4,833	6	206	44	1,336	462	7,613
2001 (D)	3	608	286	4,714	68	185	26	1,288	439	7,615
2002 (D)	3	574	198	4,750	64	122	55	1,431	402	7,601
2003 (BN)	2	531	172	4,647	66	125	89	1,590	365	7,586
2004 (D)	2	478	187	4,549	61	142	115	1,709	327	7,571
2005 (W)	2	405	246	4,468	79	125	141	1,800	290	7,556
2006 (W)	1	367	244	4,294	133	93	179	1,976	253	7,541
2007 (C)	1	350	219	4,268	85	66	199	2,121	215	7,526
2008 (C)	1	371	280	4,200	70	18	124	2,269	178	7,511
2009 (BN)	0	124	259	4,021	321	3	235	2,392	141	7,496
2010 (AN)	0	73	372	3,805	71	35	261	2,759	104	7,481
2011 (W)	0	0	388	3,584	5	89	287	3,046	66	7,466
2012 (D)	0	13	318	3,550	10	122	377	3,023	57	7,470
2013 (C)	0	9	318	3,515	14	64	468	3,058	28	7,475
2014 (C)	0	0	36	3,481	6	395	496	3,060	6	7,480
2015 (C)	0	0	21	3,532	3	89	833	3,018	6	7,503
Average (1989-2014)	2	241	181	4,279	127	297	189	1,876	363	7,556

3.2 Surface Water System Water Budget

This section presents surface water system water budget components within GFWD GSA as per GSP regulations. These are followed by a summary of the water budget results by accounting center.

3.2.1 Inflows

3.2.1.1 Surface Water Inflow by Water Source Type

Surface water inflows include surface water flowing into GFWD across the subregion boundary. Per the Regulations, surface inflows 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.*

Additionally, runoff of precipitation from upgradient areas adjacent to the subregion represents a potential source of surface water inflow.

Local Supplies

Surface water inflows to GFWD GSA include local supplies of Cottonwood Creek natural flows. A portion of these flows are diverted into the GFWD conveyance system, while the remainder transverses and leaves the GSA as surface water outflows.

Local Imported Supplies

GFWD GSA does not receive local imported supplies for irrigation purposes.

CVP Supplies

GFWD GSA receives CVP supplies for irrigation purposes from the San Joaquin River and from the Madera Canal via MID. A portion of CVP supplies received via MID are diverted from MID's releases to Cottonwood Creek, while the remainder is received directly from the MID conveyance system.

Recycling and Reuse

Recycling and reuse are not a significant source of supply within GFWD.

Other Surface Inflows

For the water budgets presented herein, precipitation runoff from outside the subregion is considered relatively minimal and is expected to pass through the waterways accounted above following relatively large storm events. Precipitation runoff from lands inside the subregion is internal to the surface water system and is thus not considered as surface inflows to the subregion boundary.

Summary of Surface Inflows

The surface water inflows described above are summarized by water source type in Figure A2.F.e-5 and Table A2.F.e-3. During the study period, local supplies vary by water year type, averaging 14 taf during wet years and less than 2 taf during below normal, dry, and critical years. CVP supplies are steadier between years, averaging 10 taf per year between 1989 and 2014.

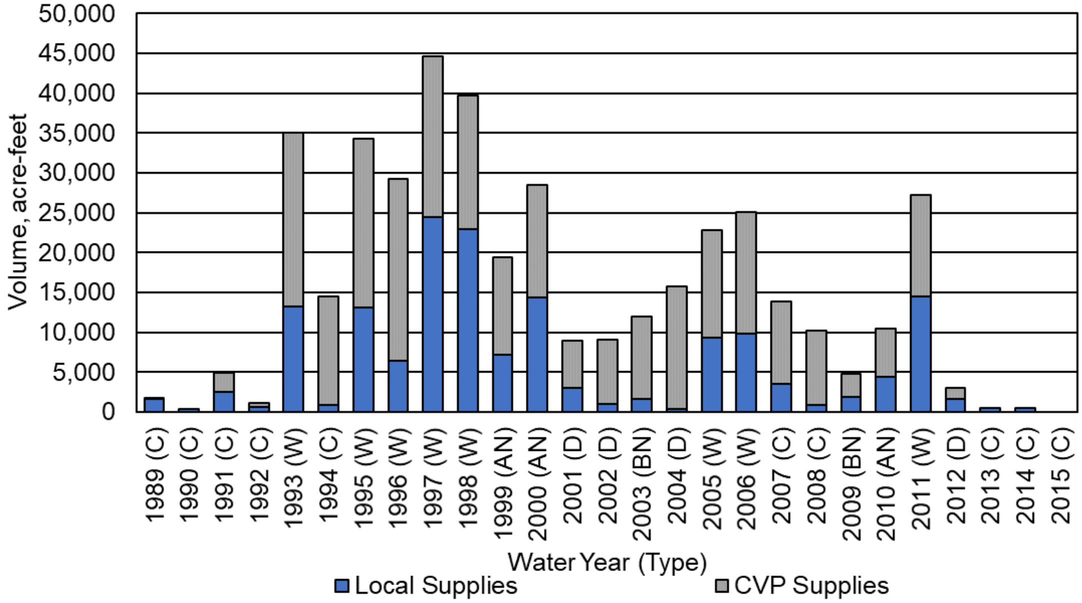

Figure A2.F.e-5. Gravelly Ford Water District GSA Surface Water Inflows by Water Source Type.

Table A2.F.e-3. Gravelly Ford Water District GSA Surface Water Inflows by Water Source Type (Acre-Feet).

Water Year (Type)	Local Supply	CVP Supply[1]	Total
1989 (C)	1,642	65	1,707
1990 (C)	426	0	426
1991 (C)	2,472	2,472	4,944
1992 (C)	660	424	1,084
1993 (W)	13,206	21,855	35,061
1994 (C)	839	13,657	14,496
1995 (W)	13,128	21,184	34,311
1996 (W)	6,464	22,801	29,265
1997 (W)	24,469	20,150	44,619
1998 (W)	22,914	16,777	39,691
1999 (AN)	7,182	12,221	19,403
2000 (AN)	14,329	14,155	28,484
2001 (D)	3,073	5,888	8,960
2002 (D)	975	8,070	9,045
2003 (BN)	1,674	10,262	11,936

Water Year (Type)	Local Supply	CVP Supply[1]	Total
2004 (D)	439	15,329	15,768
2005 (W)	9,281	13,578	22,860
2006 (W)	9,847	15,211	25,058
2007 (C)	3,485	10,325	13,810
2008 (C)	899	9,348	10,247
2009 (BN)	1,881	2,929	4,810
2010 (AN)	4,466	6,049	10,515
2011 (W)	14,491	12,783	27,274
2012 (D)	1,655	1,390	3,045
2013 (C)	519	0	519
2014 (C)	528	0	528
2015 (C)	0	0	0
Average (1989-2014)	6,190	9,882	16,072
Average (1989-2014) W	14,225	18,042	32,267
Average (1989-2014) AN	8,659	10,808	19,467
Average (1989-2014) BN	1,777	6,596	8,373
Average (1989-2014) D	1,535	7,669	9,205
Average (1989-2014) C	1,274	4,032	5,307

[1]CVP Supply is considered as all water supply released from CVP storage facilities. The volume of CVP Supply includes CVP deliveries to CVP contractors/water users, and flood releases from CVP facilities that largely pass through the subbasin.

3.2.1.2 Precipitation

Precipitation estimates for GFWD GSA are provided in Figure A2.F.e-6 and Table A2.F.e-4. Precipitation estimates are reported by water use sector.

Total precipitation is highly variable between years in the study area, ranging from approximately 6 taf (7.6 inches) during average dry years to 10 taf (14.4 inches) during average wet years.

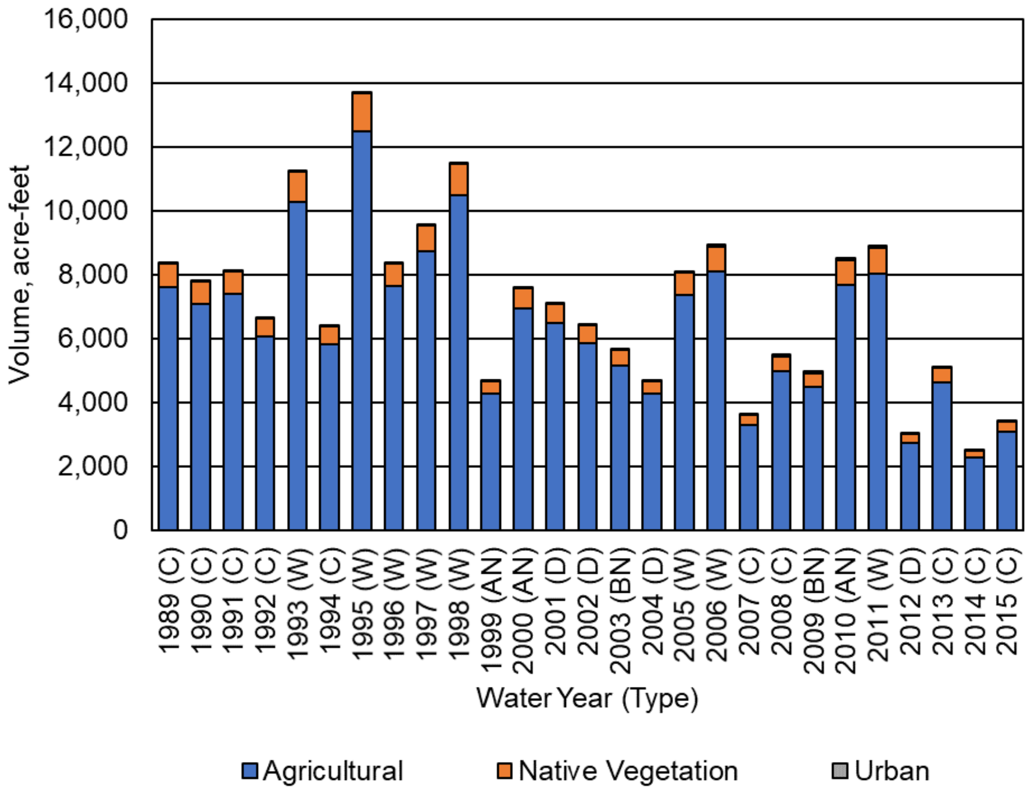

Figure A2.F.e-6. Gravelly Ford Water District GSA Precipitation by Water Use Sector.

Table A2.F.e-4. Gravelly Ford Water District GSA Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	7,597	738	15	8,350
1990 (C)	7,079	691	15	7,785
1991 (C)	7,400	717	15	8,132
1992 (C)	6,053	582	12	6,647
1993 (W)	10,265	978	19	11,262
1994 (C)	5,821	551	11	6,383
1995 (W)	12,504	1,176	20	13,700
1996 (W)	7,642	715	15	8,372
1997 (W)	8,732	815	17	9,564
1998 (W)	10,499	974	24	11,497
1999 (AN)	4,259	394	9	4,662
2000 (AN)	6,946	640	18	7,604
2001 (D)	6,481	595	19	7,095
2002 (D)	5,872	544	22	6,438
2003 (BN)	5,151	481	23	5,655
2004 (D)	4,273	404	23	4,700
2005 (W)	7,360	700	46	8,106
2006 (W)	8,096	776	59	8,931
2007 (C)	3,274	316	27	3,617

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2008 (C)	4,965	484	46	5,495
2009 (BN)	4,480	440	46	4,966
2010 (AN)	7,681	761	84	8,526
2011 (W)	8,025	802	95	8,922
2012 (D)	2,734	271	31	3,036
2013 (C)	4,622	458	52	5,132
2014 (C)	2,260	223	26	2,509
2015 (C)	3,093	295	35	3,423
Average (1989-2014)	6,541	624	30	7,196
Average (1989-2014) W	9,140	867	37	10,044
Average (1989-2014) AN	6,295	598	37	6,931
Average (1989-2014) BN	4,816	461	35	5,311
Average (1989-2014) D	4,840	454	24	5,317
Average (1989-2014) C	5,452	529	24	6,006

3.2.1.3 Groundwater Extraction by Water Use Sector

Estimates of groundwater extraction by water use sector are provided in Figure A2.F.e-7 and Table A2.F.e-5. For agricultural and urban (urban, semi-agricultural, industrial) lands, groundwater extraction represents pumping, while for native lands, groundwater extraction by riparian vegetation was considered to be negligible. In all water use sector water budgets, groundwater extraction served as the water budget closure term. Groundwater extraction is dominated by irrigated agriculture, varying substantially from year to year based on variability and/or uncertainty in surface water supplies, particularly during wet years in the 1990s.

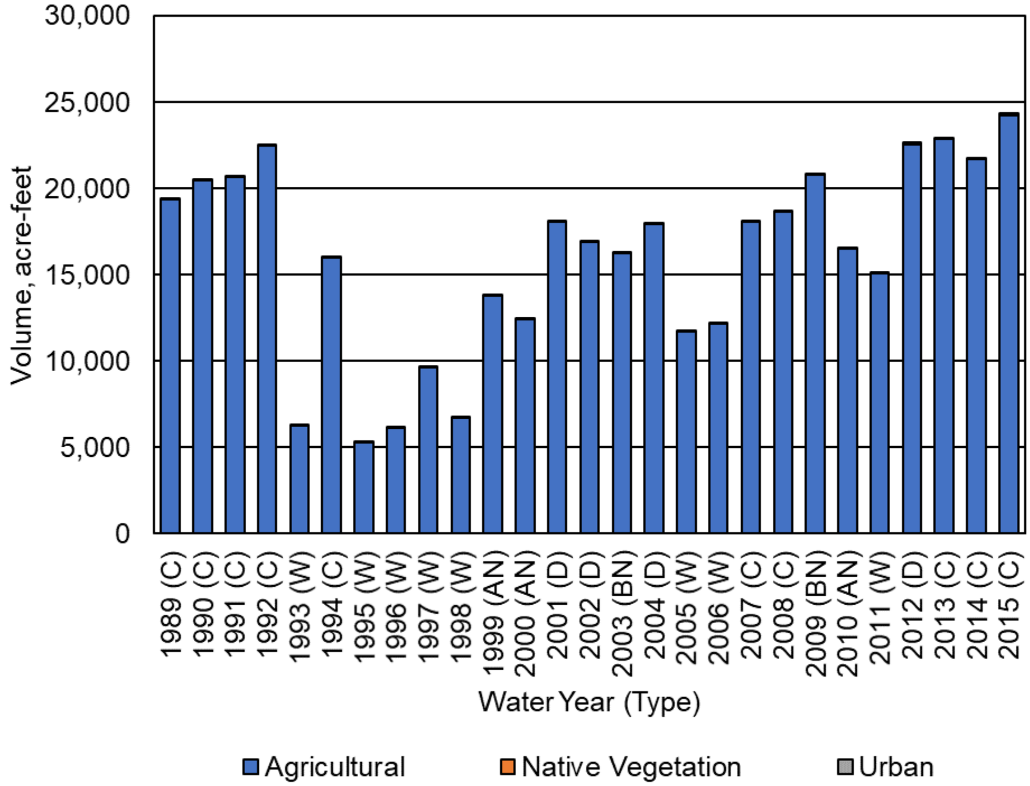

Figure A2.F.e-7. Gravelly Ford Water District GSA Groundwater Extraction by Water Use Sector.

Table A2.F.e-5. Gravelly Ford Water District GSA Groundwater Extraction by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	19,371	0	15	19,386
1990 (C)	20,501	0	14	20,515
1991 (C)	20,687	0	11	20,698
1992 (C)	22,506	0	16	22,522
1993 (W)	6,230	0	12	6,242
1994 (C)	15,999	0	12	16,011
1995 (W)	5,307	0	9	5,316
1996 (W)	6,111	0	9	6,120
1997 (W)	9,621	0	22	9,643
1998 (W)	6,699	0	14	6,713
1999 (AN)	13,764	0	22	13,786
2000 (AN)	12,422	0	21	12,443
2001 (D)	18,049	0	18	18,067
2002 (D)	16,903	0	29	16,932
2003 (BN)	16,264	0	41	16,305
2004 (D)	17,941	0	57	17,998
2005 (W)	11,707	0	38	11,745
2006 (W)	12,191	0	46	12,237
2007 (C)	18,084	0	74	18,158

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2008 (C)	18,650	0	75	18,725
2009 (BN)	20,779	0	83	20,862
2010 (AN)	16,519	0	61	16,580
2011 (W)	15,071	0	74	15,145
2012 (D)	22,571	0	99	22,670
2013 (C)	22,850	0	104	22,954
2014 (C)	21,698	0	98	21,796
2015 (C)	24,249	0	103	24,352
Average (1989-2014)	15,711	0	41	15,753
Average (1989-2014) W	9,117	0	28	9,145
Average (1989-2014) AN	14,235	0	35	14,270
Average (1989-2014) BN	18,522	0	62	18,584
Average (1989-2014) D	18,866	0	51	18,917
Average (1989-2014) C	20,038	0	47	20,085

3.2.1.4 Groundwater Discharge to Surface Water Sources

The depth to groundwater is greater than 100-200 ft across much of the Madera Subbasin. Given the depth to the water table in the Madera Subbasin, groundwater discharge to surface water sources is negligible.

3.2.2 Outflows

3.2.2.1 Evapotranspiration by Water Use Sector

Evapotranspiration (ET) by water use sector is reported in Figures A2.F.e-8 to A2.F.e-10 and Tables A2.F.e-6 to A2.F.e-8. First, total ET is reported, followed by ET from applied water and ET from precipitation.

Total ET varies between years, with the lowest observed in 1991, at approximately 18 taf, and greatest in 2004, at approximately 21 taf. Agricultural ET tends to increase in drier years, while native ET decreases.

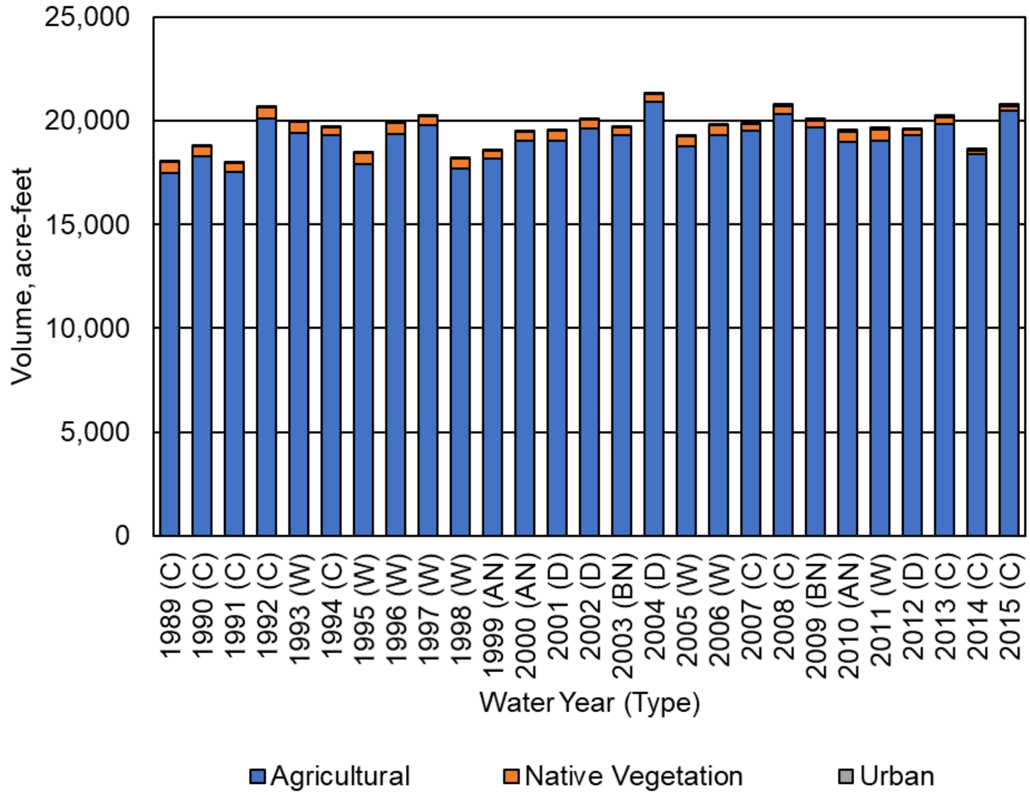

Figure A2.F.e-8. Gravelly Ford Water District GSA Evapotranspiration by Water Use Sector.

Table A2.F.e-6. Gravelly Ford Water District GSA Evapotranspiration by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	17,488	512	17	18,017
1990 (C)	18,287	486	19	18,792
1991 (C)	17,520	442	14	17,976
1992 (C)	20,098	518	18	20,634
1993 (W)	19,407	545	16	19,968
1994 (C)	19,304	386	15	19,705
1995 (W)	17,898	537	13	18,448
1996 (W)	19,348	522	14	19,884
1997 (W)	19,757	444	21	20,222
1998 (W)	17,714	467	21	18,202
1999 (AN)	18,180	353	21	18,554
2000 (AN)	19,016	437	24	19,477
2001 (D)	19,033	468	25	19,526
2002 (D)	19,609	442	35	20,086
2003 (BN)	19,326	360	45	19,731
2004 (D)	20,901	390	57	21,348
2005 (W)	18,774	471	53	19,298
2006 (W)	19,284	504	63	19,851
2007 (C)	19,492	330	73	19,895

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2008 (C)	20,309	392	86	20,787
2009 (BN)	19,685	337	94	20,116
2010 (AN)	18,981	494	89	19,564
2011 (W)	19,043	518	100	19,661
2012 (D)	19,304	253	89	19,646
2013 (C)	19,810	360	106	20,276
2014 (C)	18,377	196	88	18,661
2015 (C)	20,496	221	95	20,812
Average (1989-2014)	19,075	429	47	19,551
Average (1989-2014) W	18,903	501	38	19,442
Average (1989-2014) AN	18,726	428	45	19,198
Average (1989-2014) BN	19,506	349	70	19,924
Average (1989-2014) D	19,712	388	52	20,152
Average (1989-2014) C	18,965	402	48	19,416

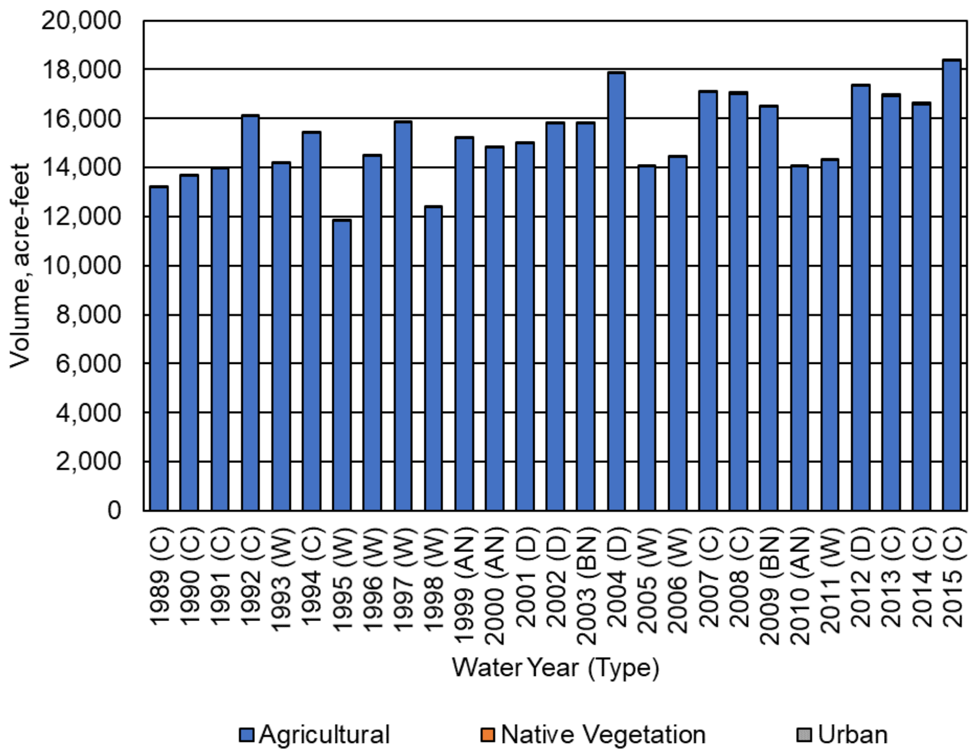

Figure A2.F.e-9. Gravelly Ford Water District GSA Evapotranspiration of Applied Water by Water Use Sector.

Table A2.F.e-7. Gravelly Ford Water District GSA Evapotranspiration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	13,179	0	9	13,188
1990 (C)	13,654	0	10	13,664
1991 (C)	13,983	0	7	13,990
1992 (C)	16,115	0	11	16,126
1993 (W)	14,161	0	8	14,169
1994 (C)	15,418	0	10	15,428
1995 (W)	11,829	0	3	11,832
1996 (W)	14,479	0	6	14,485
1997 (W)	15,836	0	12	15,848
1998 (W)	12,364	0	9	12,373
1999 (AN)	15,221	0	13	15,234
2000 (AN)	14,816	0	14	14,830
2001 (D)	14,985	0	14	14,999
2002 (D)	15,791	0	20	15,811
2003 (BN)	15,786	0	27	15,813
2004 (D)	17,858	0	38	17,896
2005 (W)	14,061	0	26	14,087
2006 (W)	14,424	0	30	14,454
2007 (C)	17,074	0	47	17,121
2008 (C)	17,003	0	55	17,058
2009 (BN)	16,460	0	62	16,522
2010 (AN)	14,054	0	44	14,098
2011 (W)	14,310	0	48	14,358
2012 (D)	17,334	0	63	17,397
2013 (C)	16,914	0	70	16,984
2014 (C)	16,578	0	66	16,644
2015 (C)	18,339	0	73	18,412
Average (1989-2014)	15,142	0	28	15,170
Average (1989-2014) W	13,933	0	18	13,951
Average (1989-2014) AN	14,697	0	24	14,721
Average (1989-2014) BN	16,123	0	45	16,168
Average (1989-2014) D	16,492	0	34	16,526
Average (1989-2014) C	15,546	0	32	15,578

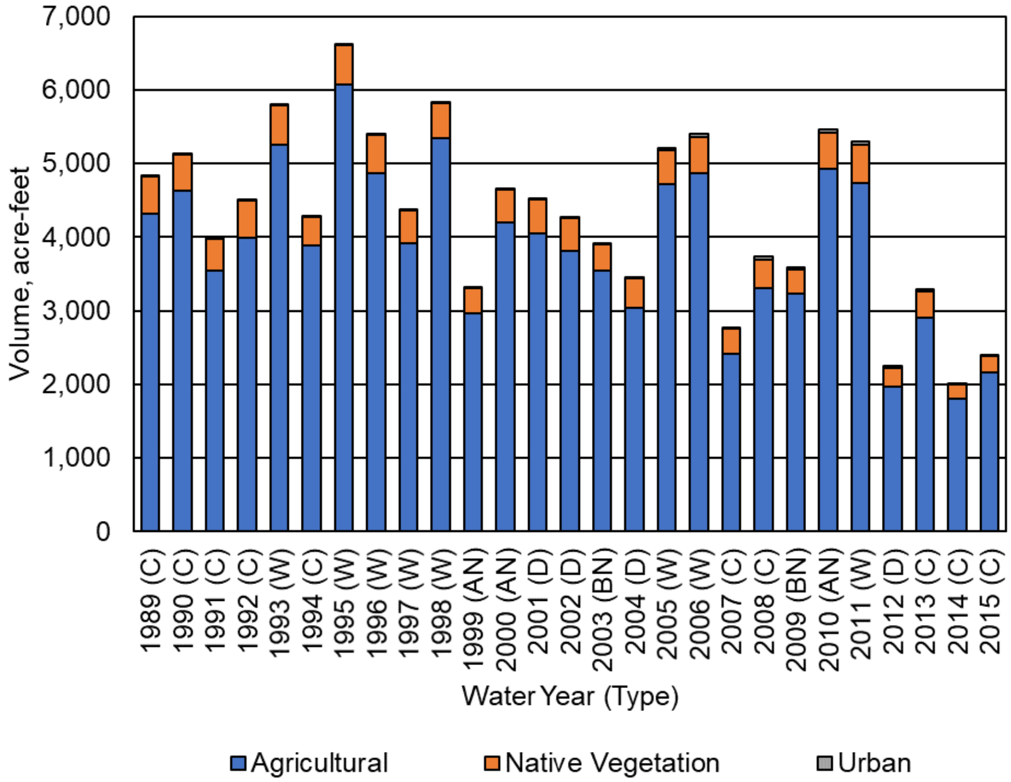

Figure A2.F.e-10. Gravelly Ford Water District GSA Evapotranspiration of Precipitation by Water Use Sector.

Table A2.F.e-8. Gravelly Ford Water District GSA Evapotranspiration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	4,309	512	8	4,829
1990 (C)	4,633	486	9	5,128
1991 (C)	3,537	442	7	3,986
1992 (C)	3,983	518	7	4,508
1993 (W)	5,246	545	8	5,799
1994 (C)	3,886	386	5	4,277
1995 (W)	6,069	537	10	6,616
1996 (W)	4,869	522	8	5,399
1997 (W)	3,921	444	9	4,374
1998 (W)	5,350	467	12	5,829
1999 (AN)	2,959	353	8	3,320
2000 (AN)	4,200	437	10	4,647
2001 (D)	4,048	468	11	4,527
2002 (D)	3,818	442	15	4,275
2003 (BN)	3,540	360	18	3,918
2004 (D)	3,043	390	19	3,452
2005 (W)	4,713	471	27	5,211
2006 (W)	4,860	504	33	5,397

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2007 (C)	2,418	330	26	2,774
2008 (C)	3,306	392	31	3,729
2009 (BN)	3,225	337	32	3,594
2010 (AN)	4,927	494	45	5,466
2011 (W)	4,733	518	52	5,303
2012 (D)	1,970	253	26	2,249
2013 (C)	2,896	360	36	3,292
2014 (C)	1,799	196	22	2,017
2015 (C)	2,157	221	22	2,400
Average (1989-2014)	3,933	429	19	4,381
Average (1989-2014) W	4,970	501	20	5,491
Average (1989-2014) AN	4,029	428	21	4,478
Average (1989-2014) BN	3,383	349	25	3,756
Average (1989-2014) D	3,220	388	18	3,626
Average (1989-2014) C	3,419	402	17	3,838

In addition to ET from land surfaces, estimates of evaporation from GFWD canals and rivers and streams are reported in Figure A2.F.e-11 and Table A2.F.e-9. Evaporation from the Rivers and Streams System includes evaporation of both surface inflows and of precipitation runoff within local sloughs and depressions. Evaporation from the canals includes evaporation of CVP supplies from MID via Cottonwood Creek and varies between years according to water availability. Total evaporation from all sources averaged less than 0.2 taf per year between 1989 and 2014.

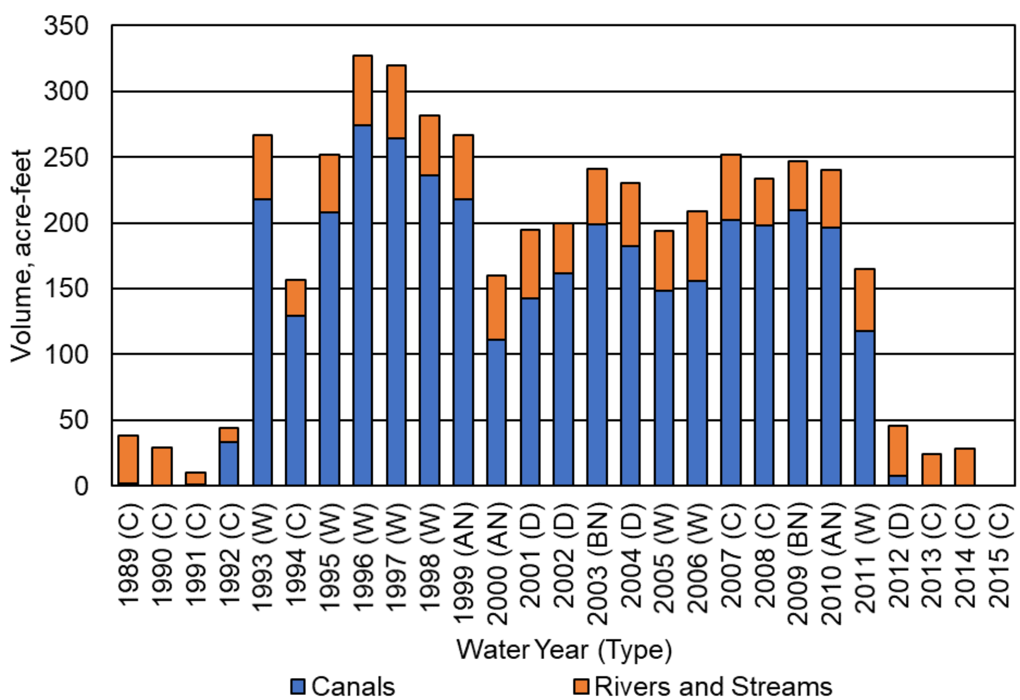

Figure A2.F.e-11. Gravelly Ford Water District GSA Evaporation from the Surface Water System.

Table A2.F.e-9. Gravelly Ford Water District GSA Evaporation from the Surface Water System (Acre-Feet).

Water Year (Type)	Canals	Rivers and Streams[1]	Total
1989 (C)	2	36	38
1990 (C)	0	29	29
1991 (C)	1	9	10
1992 (C)	33	11	44
1993 (W)	218	49	267
1994 (C)	129	28	157
1995 (W)	208	44	252
1996 (W)	274	53	327
1997 (W)	264	56	320
1998 (W)	236	46	282
1999 (AN)	218	49	267
2000 (AN)	111	49	160
2001 (D)	143	52	195
2002 (D)	162	38	200
2003 (BN)	199	42	241
2004 (D)	182	48	230
2005 (W)	148	46	194
2006 (W)	156	53	209
2007 (C)	202	50	252
2008 (C)	198	36	234
2009 (BN)	210	37	247
2010 (AN)	196	44	240
2011 (W)	118	47	165
2012 (D)	8	38	46
2013 (C)	0	24	24
2014 (C)	0	28	28
2015 (C)	0	0	0
Average (1989-2014)	139	40	179
Average (1989-2014) W	203	49	252
Average (1989-2014) AN	175	47	222
Average (1989-2014) BN	205	40	244
Average (1989-2014) D	124	44	168
Average (1989-2014) C	63	28	91

[1] Includes evaporation of surface inflows and of precipitation runoff.

3.2.2.2 Surface Water Outflow by Water Source Type

Surface water outflows by water source type are summarized in Figure A2.F.e-12 and Table A2.F.e-10. In GFWD GSA, runoff of applied water is assumed negligible and runoff of precipitation is collected in waterways within GFWD GSA, with most infiltrating to the groundwater system except following the largest storm events. Surface inflows of CVP supplies are expected to be used entirely in GFWD GSA. Thus, surface outflows from the GSA are expected to be primarily local supplies along Cottonwood Creek. Between 1989 and 2014, these outflows averaged over 9 taf during wet years and 1 taf during below normal, dry, and critical years.

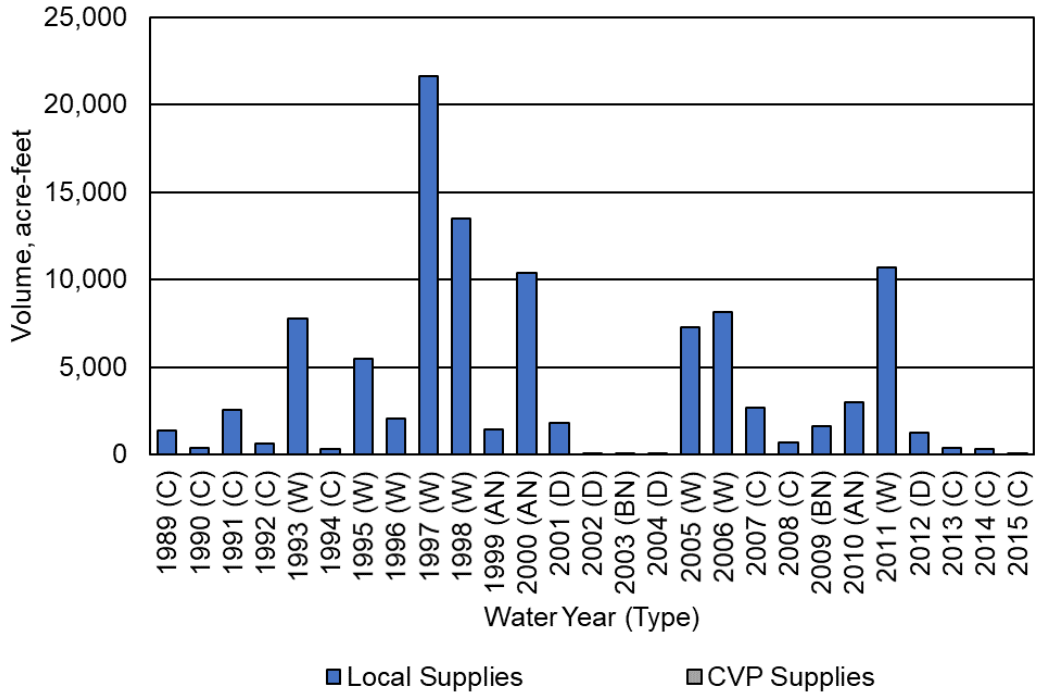

Figure A2.F.e-12. Gravelly Ford Water District GSA Surface Outflows by Water Source Type.

Table A2.F.e-10. Gravelly Ford Water District GSA Surface Outflows by Water Source Type (Acre-Feet).

Water Year (Type)	Local Supplies	CVP Supplies	Total
1989 (C)	1,374	0	1,374
1990 (C)	398	0	398
1991 (C)	2,586	0	2,586
1992 (C)	658	0	658
1993 (W)	7,762	0	7,762
1994 (C)	332	0	332
1995 (W)	5,501	0	5,501
1996 (W)	2,042	0	2,042
1997 (W)	21,651	0	21,651
1998 (W)	13,457	0	13,457
1999 (AN)	1,416	0	1,416
2000 (AN)	10,379	0	10,379
2001 (D)	1,820	0	1,820
2002 (D)	61	0	61
2003 (BN)	17	0	17
2004 (D)	8	0	8
2005 (W)	7,281	0	7,281
2006 (W)	8,170	0	8,170
2007 (C)	2,705	0	2,705
2008 (C)	721	0	721
2009 (BN)	1,643	0	1,643
2010 (AN)	3,022	0	3,022

Water Year (Type)	Local Supplies	CVP Supplies	Total
2011 (W)	10,692	0	10,692
2012 (D)	1,240	0	1,240
2013 (C)	354	0	354
2014 (C)	328	0	328
2015 (C)	85	0	85
Average (1989-2014)	4,062	0	4,062
Average (1989-2014) W	9,569	0	9,569
Average (1989-2014) AN	4,939	0	4,939
Average (1989-2014) BN	830	0	830
Average (1989-2014) D	782	0	782
Average (1989-2014) C	1,051	0	1,051

3.2.2.3 Infiltration of Precipitation

Estimated infiltration of precipitation (deep percolation of precipitation) by water use sector is provided in Figure A2.F.e-13 and Table A2.F.e-11. Infiltration of precipitation to the groundwater system is highly variable from year to year due to variation in the timing and amount of precipitation, ranging from less than 1 taf annually during some critical and dry years to more than 6 taf during 1995.

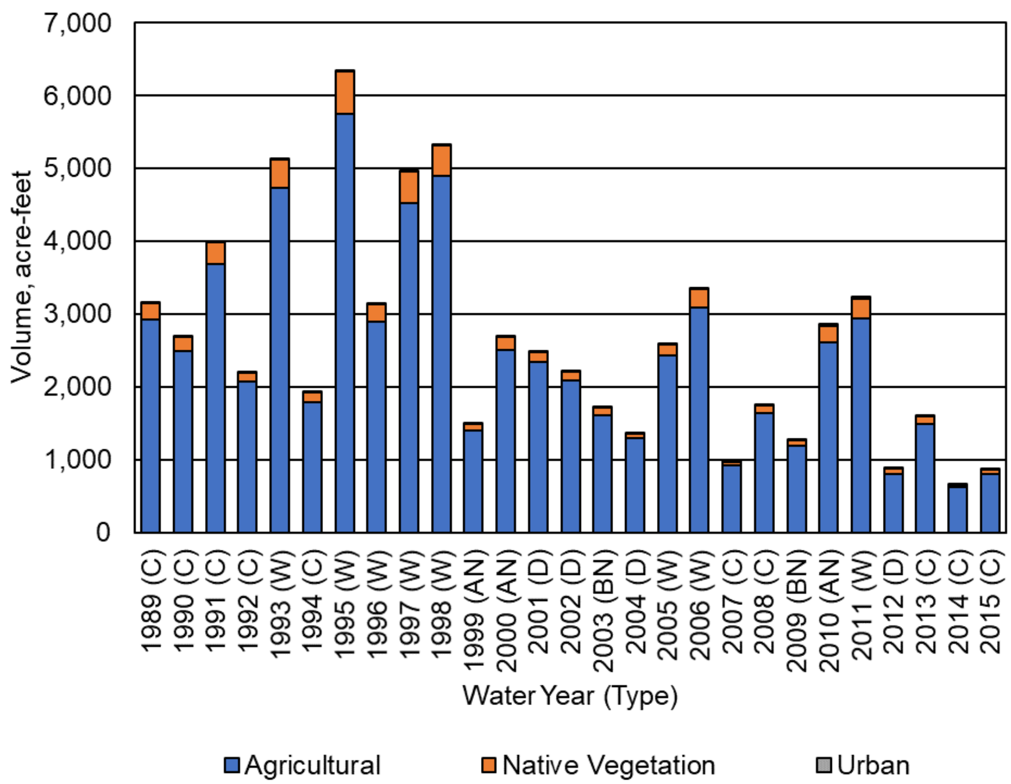

Figure A2.F.e-13. Gravelly Ford Water District GSA Infiltration of Precipitation by Water Use Sector.

Table A2.F.e-11. Gravelly Ford Water District GSA Infiltration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	2,928	214	6	3,148
1990 (C)	2,485	199	5	2,689
1991 (C)	3,686	295	6	3,987
1992 (C)	2,071	126	3	2,200
1993 (W)	4,734	383	7	5,124
1994 (C)	1,789	135	1	1,925
1995 (W)	5,748	579	9	6,336
1996 (W)	2,900	238	4	3,142
1997 (W)	4,520	431	8	4,959
1998 (W)	4,902	420	11	5,333
1999 (AN)	1,404	85	1	1,490
2000 (AN)	2,508	177	6	2,691
2001 (D)	2,345	133	4	2,482
2002 (D)	2,085	121	6	2,212
2003 (BN)	1,610	102	7	1,719
2004 (D)	1,290	69	5	1,364
2005 (W)	2,425	159	16	2,600
2006 (W)	3,094	244	24	3,362
2007 (C)	916	54	6	976
2008 (C)	1,645	104	14	1,763
2009 (BN)	1,192	68	12	1,272
2010 (AN)	2,611	228	32	2,871
2011 (W)	2,946	260	36	3,242
2012 (D)	806	64	13	883
2013 (C)	1,487	109	17	1,613
2014 (C)	621	32	7	660
2015 (C)	807	57	9	873
Average (1989-2014)	2,490	193	10	2,694
Average (1989-2014) W	3,909	339	14	4,262
Average (1989-2014) AN	2,174	163	13	2,351
Average (1989-2014) BN	1,401	85	10	1,496
Average (1989-2014) D	1,632	97	7	1,735
Average (1989-2014) C	1,959	141	7	2,107

3.2.2.4 Infiltration of Surface Water

Estimated infiltration of surface water (seepage) by source is provided in Figure A2.F.e-14 and Table A2.F.e-12. Seepage from the Rivers and Streams System includes seepage of both surface inflows and of precipitation runoff into local sloughs and depressions. The canal system predominantly contributes to seepage in GFWD, with seepage averaging 5.9 taf per year between 1989 and 2014. Seepage from rivers and streams is comparatively lower, averaging less than 1 taf per year.

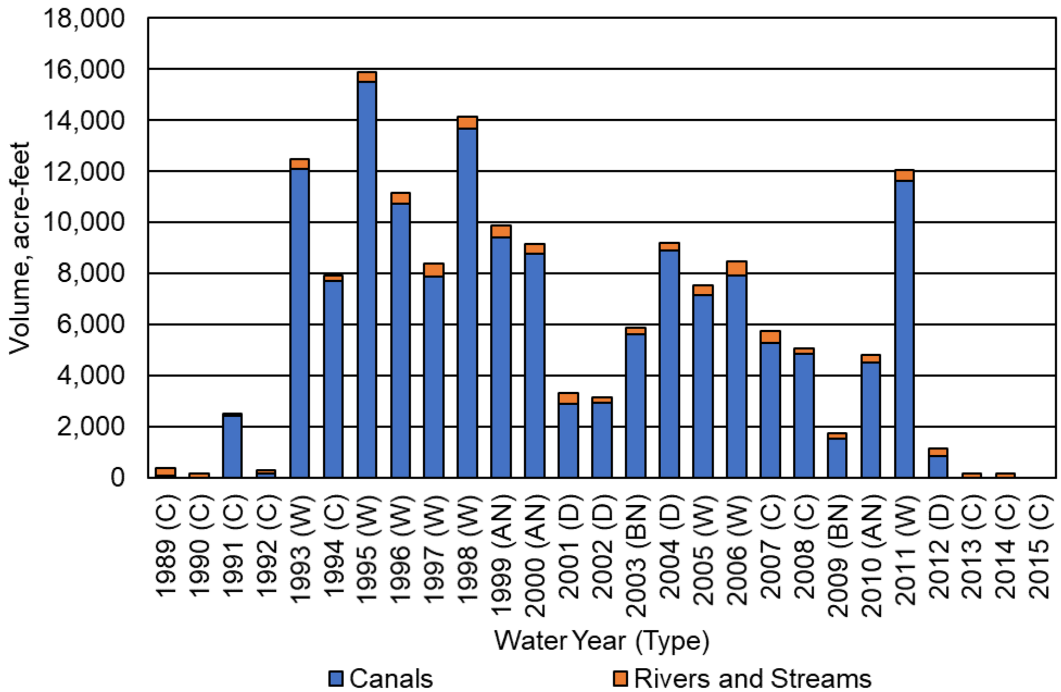

Figure A2.F.e-14. Gravelly Ford Water District GSA Infiltration of Surface Water.

Table A2.F.e-12. Gravelly Ford Water District GSA Infiltration of Surface Water (Acre-Feet).

Water Year (Type)	Canals	Rivers and Streams[1]	Total
1989 (C)	65	304	369
1990 (C)	0	172	172
1991 (C)	2,423	95	2,518
1992 (C)	191	86	277
1993 (W)	12,083	386	12,469
1994 (C)	7,698	205	7,903
1995 (W)	15,514	386	15,900
1996 (W)	10,721	428	11,149
1997 (W)	7,884	516	8,400
1998 (W)	13,684	465	14,149
1999 (AN)	9,427	432	9,859
2000 (AN)	8,765	386	9,151
2001 (D)	2,884	428	3,312
2002 (D)	2,945	216	3,161
2003 (BN)	5,629	258	5,887
2004 (D)	8,905	302	9,207
2005 (W)	7,151	386	7,537
2006 (W)	7,940	516	8,456
2007 (C)	5,292	443	5,735
2008 (C)	4,865	216	5,081
2009 (BN)	1,522	216	1,738
2010 (AN)	4,530	302	4,832
2011 (W)	11,607	430	12,037

Water Year (Type)	Canals	Rivers and Streams[1]	Total
2012 (D)	830	308	1,138
2013 (C)	0	156	156
2014 (C)	0	174	174
2015 (C)	0	0	0
Average (1989-2014)	5,867	316	6,183
Average (1989-2014) W	10,823	439	11,262
Average (1989-2014) AN	7,574	373	7,947
Average (1989-2014) BN	3,575	237	3,812
Average (1989-2014) D	3,891	314	4,205
Average (1989-2014) C	2,281	206	2,487

[1] Includes infiltration of surface inflows and of precipitation runoff.

3.2.2.5 Infiltration of Applied Water

Estimated infiltration of applied water (deep percolation of applied water) by water use sector is provided in Figure A2.F.e-15 and Table A2.F.e-13. Infiltration of applied water is dominated by agricultural irrigation and has slowly decreased over time, likely due to increase use of drip and micro-irrigation systems in place of flood irrigation.

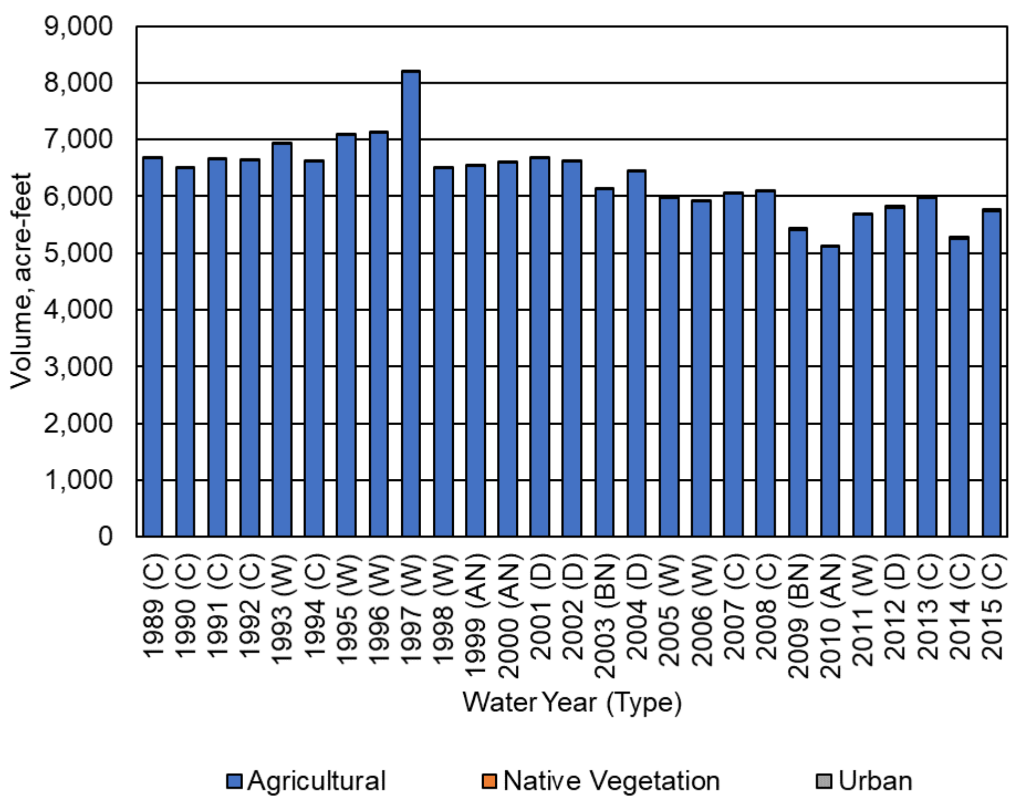

Figure A2.F.e-15. Gravelly Ford Water District GSA Infiltration of Applied Water by Water Use Sector.

Table A2.F.e-13. Gravelly Ford Water District GSA Infiltration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	6,663	0	7	6,670
1990 (C)	6,492	0	5	6,497
1991 (C)	6,645	0	6	6,651
1992 (C)	6,637	0	7	6,644
1993 (W)	6,933	0	9	6,942
1994 (C)	6,614	0	7	6,621
1995 (W)	7,086	0	6	7,092
1996 (W)	7,116	0	7	7,123
1997 (W)	8,189	0	11	8,200
1998 (W)	6,490	0	7	6,497
1999 (AN)	6,528	0	7	6,535
2000 (AN)	6,587	0	8	6,595
2001 (D)	6,668	0	8	6,676
2002 (D)	6,619	0	9	6,628
2003 (BN)	6,131	0	13	6,144
2004 (D)	6,446	0	16	6,462
2005 (W)	5,963	0	15	5,978
2006 (W)	5,906	0	16	5,922
2007 (C)	6,042	0	22	6,064
2008 (C)	6,078	0	21	6,099
2009 (BN)	5,409	0	26	5,435
2010 (AN)	5,112	0	23	5,135
2011 (W)	5,671	0	30	5,701
2012 (D)	5,801	0	27	5,828
2013 (C)	5,972	0	33	6,005
2014 (C)	5,256	0	28	5,284
2015 (C)	5,734	0	32	5,766
Average (1989-2014)	6,348	0	14	6,363
Average (1989-2014) W	6,669	0	13	6,682
Average (1989-2014) AN	6,076	0	13	6,088
Average (1989-2014) BN	5,770	0	20	5,790
Average (1989-2014) D	6,384	0	15	6,399
Average (1989-2014) C	6,267	0	15	6,282

3.2.3 Change in Surface Water System Storage

Estimates of change in SWS storage are provided in Figure A2.F.e-16 and Table A2.F.e-14. Inter-annual changes in storage within the surface water system consist primarily of root zone soil moisture storage changes, are relatively small, and tend to average near zero over many years.

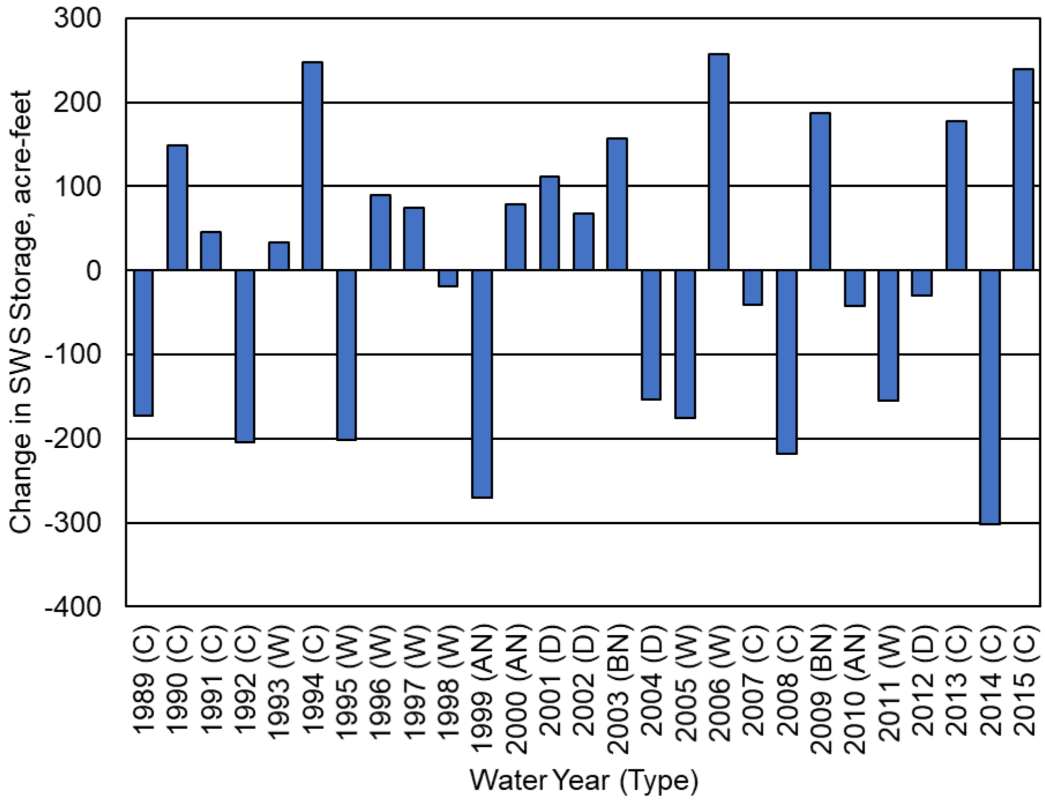

Figure A2.F.e-16. Gravelly Ford Water District GSA Change in Surface Water System Storage.

Table A2.F.e-14. Gravelly Ford Water District GSA Change in Surface Water System Storage (Acre-Feet).

Water Year (Type)	Change in SWS Storage
1989 (C)	-173
1990 (C)	149
1991 (C)	46
1992 (C)	-204
1993 (W)	33
1994 (C)	247
1995 (W)	-202
1996 (W)	90
1997 (W)	74
1998 (W)	-19
1999 (AN)	-270
2000 (AN)	78
2001 (D)	112
2002 (D)	67
2003 (BN)	157
2004 (D)	-153
2005 (W)	-176
2006 (W)	257

Water Year (Type)	Change in SWS Storage
2007 (C)	-41
2008 (C)	-218
2009 (BN)	187
2010 (AN)	-42
2011 (W)	-155
2012 (D)	-30
2013 (C)	177
2014 (C)	-302
2015 (C)	239
Average (1989-2014)	-12
Average (1989-2014) W	-12
Average (1989-2014) AN	-78
Average (1989-2014) BN	172
Average (1989-2014) D	-1
Average (1989-2014) C	-35

3.3 Historical Water Budget Summary

Annual inflows, outflows, and change in SWS storage during the historical water budget period (1989-2014) are summarized in Figure A2.F.e-17 and Table A2.F.e-15. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values. Review of the variability in component volumes across years provides insight into the impacts of hydrology on the surface water system water budget.

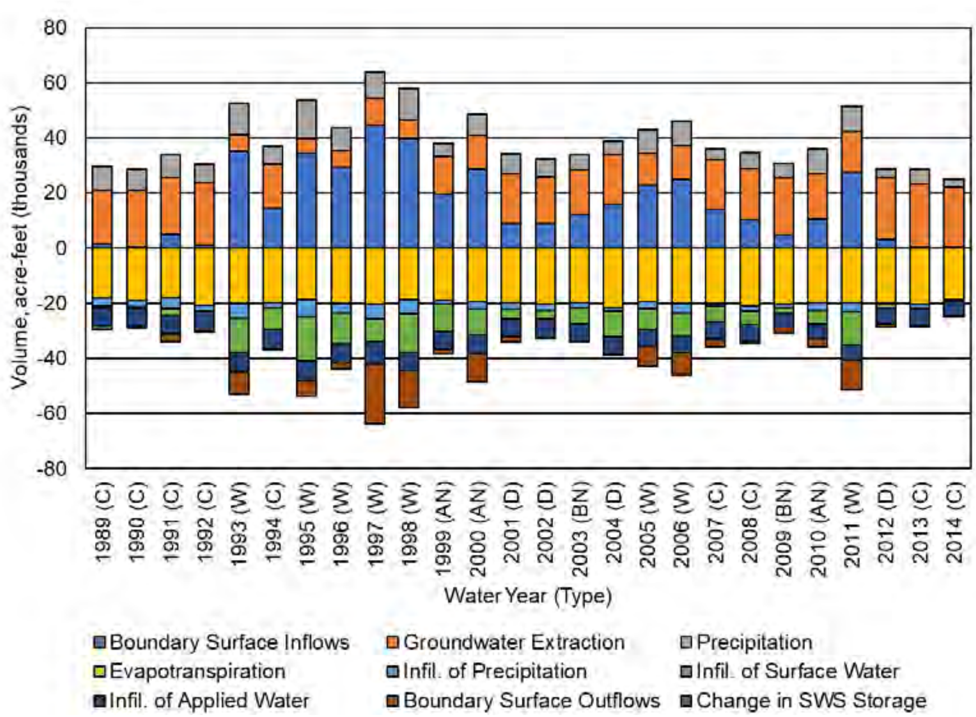

Figure A2.F.e-17. Gravelly Ford Water District GSA Surface Water System Historical Water Budget, 1989-2014.

Table A2.F.e-15. Gravelly Ford Water District GSA Surface Water System Historical Water Budget, 1989-2014 (Acre-Feet).

Water Year	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Evapo-transpiration[1]	Infil. of Precipitation	Infil. of Surface Water[2]	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	1,707	19,386	8,350	-18,055	-3,148	-369	-6,670	-1,374	173
1990 (C)	426	20,515	7,785	-18,821	-2,689	-172	-6,497	-398	-149
1991 (C)	4,944	20,698	8,132	-17,986	-3,987	-2,518	-6,651	-2,586	-46
1992 (C)	1,084	22,522	6,647	-20,678	-2,200	-277	-6,644	-658	204
1993 (W)	35,061	6,242	11,262	-20,235	-5,124	-12,469	-6,942	-7,762	-33
1994 (C)	14,496	16,011	6,383	-19,862	-1,925	-7,903	-6,621	-332	-247
1995 (W)	34,311	5,316	13,700	-18,700	-6,336	-15,900	-7,092	-5,501	202
1996 (W)	29,265	6,120	8,372	-20,211	-3,142	-11,149	-7,123	-2,042	-90
1997 (W)	44,619	9,643	9,564	-20,542	-4,959	-8,400	-8,200	-21,651	-74
1998 (W)	39,691	6,713	11,497	-18,484	-5,333	-14,149	-6,497	-13,457	19
1999 (AN)	19,403	13,786	4,662	-18,821	-1,490	-9,859	-6,535	-1,416	270
2000 (AN)	28,484	12,443	7,604	-19,637	-2,691	-9,151	-6,595	-10,379	-78
2001 (D)	8,960	18,067	7,095	-19,721	-2,482	-3,312	-6,676	-1,820	-112
2002 (D)	9,045	16,932	6,438	-20,286	-2,212	-3,161	-6,628	-61	-67
2003 (BN)	11,936	16,305	5,655	-19,972	-1,719	-5,887	-6,144	-17	-157
2004 (D)	15,768	17,998	4,700	-21,578	-1,364	-9,207	-6,462	-8	153
2005 (W)	22,860	11,745	8,106	-19,492	-2,600	-7,537	-5,978	-7,281	176
2006 (W)	25,058	12,237	8,931	-20,060	-3,362	-8,456	-5,922	-8,170	-257
2007 (C)	13,810	18,158	3,617	-20,147	-976	-5,735	-6,064	-2,705	41
2008 (C)	10,247	18,725	5,495	-21,021	-1,763	-5,081	-6,099	-721	218
2009 (BN)	4,810	20,862	4,966	-20,363	-1,272	-1,738	-5,435	-1,643	-187
2010 (AN)	10,515	16,580	8,526	-19,804	-2,871	-4,832	-5,135	-3,022	42
2011 (W)	27,274	15,145	8,922	-19,826	-3,242	-12,037	-5,701	-10,692	155
2012 (D)	3,045	22,670	3,036	-19,692	-883	-1,138	-5,828	-1,240	30
2013 (C)	519	22,954	5,132	-20,300	-1,613	-156	-6,005	-354	-177
2014 (C)	528	21,796	2,509	-18,689	-660	-174	-5,284	-328	302
Average (1989-2014)	16,072	15,753	7,196	-19,730	-2,694	-6,183	-6,363	-4,062	12
W	32,267	9,145	10,044	-19,694	-4,262	-11,262	-6,682	-9,569	12
AN	19,467	14,270	6,931	-19,421	-2,351	-7,947	-6,088	-4,939	78
BN	8,373	18,584	5,311	-20,168	-1,496	-3,812	-5,790	-830	-172
D	9,205	18,917	5,317	-20,319	-1,735	-4,205	-6,399	-782	1
C	5,307	20,085	6,006	-19,507	-2,107	-2,487	-6,282	-1,051	35

[1]Includes ET of applied water, ET of precipitation, and evaporation from rivers and streams.
[2]Includes infiltration from the Rivers and Streams System and the Canal System.

3.4 Current Water Budget Summary

The current water budget was developed following a similar process to the historical water budget using the 2015 land use in Table A2.F.e-1 and the same 1989-2014 average hydrologic conditions of the historical base period, including surface water flows, precipitation, and weather parameters. This allowed quantification of groundwater inflows and outflows for current consumptive use in the context of average water supply conditions.

Annual inflows, outflows, and change in SWS storage from the current water budget are summarized in Figure A2.F.e-18 and Table A2.F.e-16. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values.

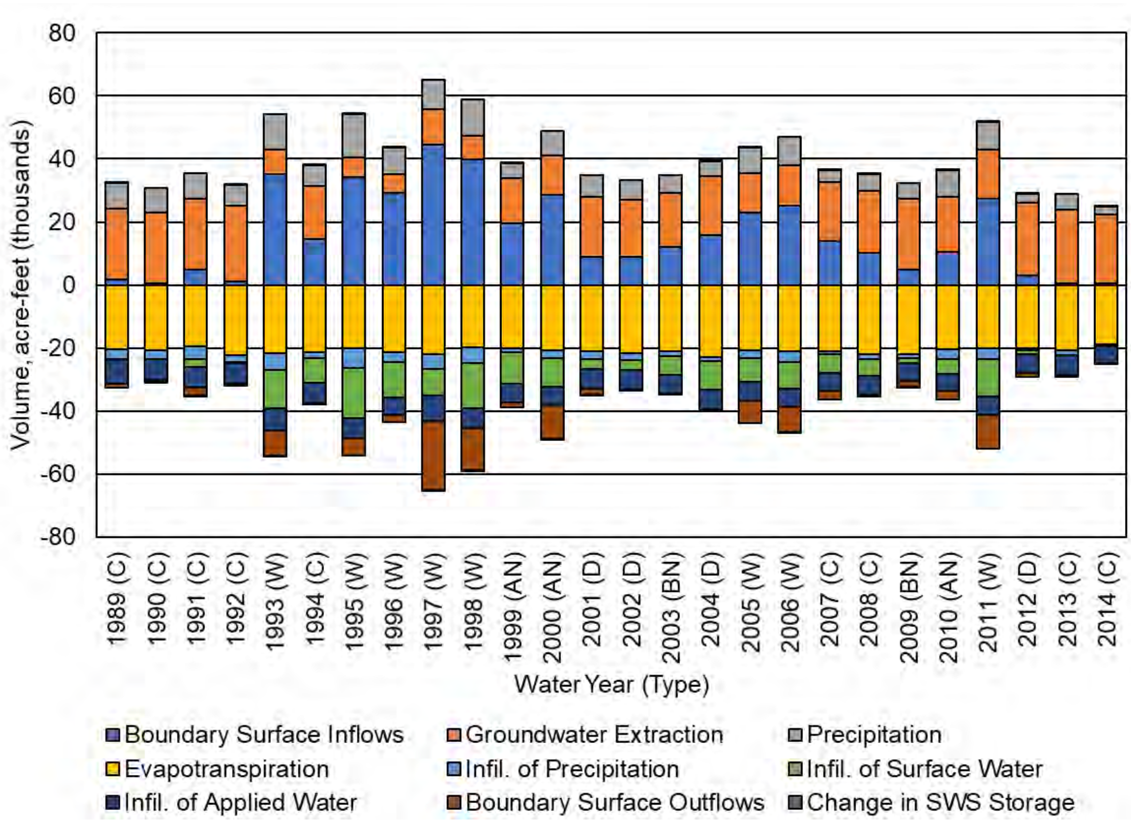

Figure A2.F.e-18. Gravelly Ford Water District GSA Surface Water System Current Water Budget.

Table A2.F.e-16. Gravelly Ford Water District GSA Surface Water System Current Water Budget (Acre-Feet).

Water Year	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Evapo-transpiration[1]	Infil. of Precipitation	Infil. of Surface Water[2]	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	1,707	22,384	8,351	-20,505	-3,062	-369	-7,318	-1,320	132
1990 (C)	426	22,622	7,786	-20,852	-2,596	-172	-6,786	-354	-74
1991 (C)	4,944	22,317	8,135	-19,628	-3,880	-2,518	-6,689	-2,554	-127
1992 (C)	1,084	24,051	6,647	-22,292	-2,132	-277	-6,639	-649	208
1993 (W)	35,061	7,904	11,263	-21,764	-5,091	-12,468	-7,044	-7,744	-118
1994 (C)	14,499	17,022	6,382	-21,324	-1,811	-7,903	-6,581	-327	44
1995 (W)	34,312	6,112	13,700	-19,981	-6,264	-15,900	-6,528	-5,499	48
1996 (W)	29,265	5,834	8,372	-21,439	-3,029	-11,150	-5,840	-2,041	28
1997 (W)	44,619	11,057	9,566	-21,921	-4,914	-8,404	-8,151	-21,653	-198
1998 (W)	39,691	7,702	11,500	-19,690	-5,199	-14,149	-6,361	-13,452	-43
1999 (AN)	19,403	14,421	4,664	-20,050	-1,342	-9,858	-6,146	-1,416	325
2000 (AN)	28,484	12,735	7,604	-20,740	-2,555	-9,152	-5,915	-10,383	-77
2001 (D)	8,960	18,891	7,094	-21,196	-2,260	-3,312	-6,269	-1,816	-92
2002 (D)	9,045	17,910	6,438	-21,659	-2,069	-3,161	-6,442	-61	-1
2003 (BN)	11,936	17,160	5,656	-21,176	-1,556	-5,887	-5,925	-15	-193
2004 (D)	15,768	18,796	4,699	-22,843	-1,216	-9,207	-6,123	-7	133
2005 (W)	22,860	12,703	8,107	-20,699	-2,433	-7,537	-5,887	-7,281	168
2006 (W)	25,058	12,970	8,931	-21,158	-3,225	-8,453	-5,757	-8,166	-201
2007 (C)	13,810	18,839	3,617	-21,162	-882	-5,735	-5,817	-2,704	35
2008 (C)	10,247	19,543	5,495	-22,011	-1,667	-5,081	-5,952	-718	144
2009 (BN)	4,810	22,579	4,965	-21,901	-1,235	-1,738	-5,705	-1,638	-136
2010 (AN)	10,515	17,377	8,526	-20,552	-2,867	-4,832	-5,201	-3,025	59
2011 (W)	27,274	15,579	8,924	-20,183	-3,258	-12,038	-5,746	-10,706	154
2012 (D)	3,045	22,932	3,037	-19,996	-864	-1,139	-5,799	-1,241	25
2013 (C)	519	23,307	5,132	-20,606	-1,601	-156	-6,043	-356	-196
2014 (C)	528	21,805	2,507	-18,737	-657	-174	-5,246	-328	302
Average (1989-2014)	16,072	16,714	7,196	-20,926	-2,603	-6,183	-6,227	-4,056	13
W	32,267	9,983	10,045	-20,854	-4,177	-11,262	-6,414	-9,568	-20
AN	19,467	14,844	6,931	-20,447	-2,255	-7,947	-5,754	-4,941	102
BN	8,373	19,870	5,310	-21,539	-1,396	-3,812	-5,815	-827	-164
D	9,205	19,632	5,317	-21,424	-1,603	-4,205	-6,158	-781	16
C	5,307	21,321	6,006	-20,791	-2,032	-2,487	-6,341	-1,035	52

[1]Includes ET of applied water, ET of precipitation, and evaporation from rivers and streams.
[2]Includes infiltration from the Rivers and Streams System and the Canal System.

3.5 Net Recharge from SWS

Overdraft is defined in DWR Bulletin 118 as "the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions" (DWR 2003). The Madera Subbasin water budget indicates that overdraft conditions occurred during the 1989-2014 historical base period. Per 23 CCR Section 354.18(b)(5), the subbasin overdraft has been quantified for this base period. The evaluation of overdraft conditions includes estimates of recharge from subsurface flows. However, estimates of recharge from subsurface flows are less accurate when estimated for areas less that an entire subbasin. Thus, for estimates of GSA level contribution to overdraft, the term net recharge from the SWS is defined as groundwater recharge minus groundwater extraction. Net recharge from the SWS is useful for understanding and analyzing the combined effects of land surface processes on the underlying GWS.

When calculated from the historical water budget, average net recharge from the SWS represents the average recharge (when positive) or shortage of recharge (when negative) based on historical cropping, land use practices, and average hydrologic conditions. When calculated from the current land use water budget, average net recharge represents the average recharge or shortage (negative net recharge) based on current cropping, land use practices, and average hydrologic conditions.

Average net recharge from the SWS is presented below for the GFWD GSA portion of the Madera Subbasin. Table A2.F.e-17 shows the average net recharge from the SWS for 1989-2014 based on the historical water budget, and Table A2.F.e-18 shows the same for the current water budget. Historically, the average net recharge in GFWD GSA was approximately -0.5 taf per year between 1989 and 2014. Under current land use conditions, the average net recharge in GFWD GSA is approximately -1.7 taf, indicating shortage conditions.

Table A2.F.e-17. Historical Water Budget: Average Net Recharge from SWS by Water Year Type, 1989-2014 (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water[1] (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	6,682	4,262	11,262	9,145	13,061
AN	3	6,088	2,351	7,947	14,270	2,116
BN	2	5,790	1,496	3,812	18,584	-7,486
D	4	6,399	1,735	4,205	18,917	-6,578
C	9	6,282	2,107	2,487	20,085	-9,209
Annual Average (1989-2014)	26	6,363	2,694	6,183	15,753	-513

[1] Includes infiltration from the Rivers and Streams System and Canal System.

Table A2.F.e-18. Current Water Budget: Average Net Recharge from SWS by Water Year Type (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water[1] (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	6,414	4,177	11,262	9,983	11,870
AN	3	5,754	2,255	7,947	14,844	1,112
BN	2	5,815	1,396	3,812	19,870	-8,847
D	4	6,158	1,603	4,205	19,632	-7,667
C	9	6,341	2,032	2,487	21,321	-10,461
Annual Average (1989-2014)	26	6,227	2,603	6,183	16,714	-1,700

[1] Includes infiltration from the Rivers and Streams System and Canal System.

3.6 Uncertainties in Water Budget Components

Uncertainties associated with each water budget component were estimated as a percentage representing approximately a 95% confidence interval following the procedure described by Clemmens and Burt (1997). Uncertainties for all independently measured or estimated water budget components were estimated based on the measurement accuracy, typical values reported in technical literature, typical values calculated in other water budgets, and professional judgement.

Table A2.F.e-19 provides a summary of typical uncertainty values associated with major SWS inflow and outflow components. These uncertainties provide a basis for evaluating confidence in water budget results and help to identify data needs that may be addressed during GSP implementation.

Table A2.F.e-19. Estimated Uncertainty of GSA Water Budget Components.

Flowpath Direction (SWS)	Water Budget Component	Data Source	Estimated Uncertainty (%)	Source
Inflows	Surface Water Inflows	Calculation	20%	Estimated streamflow measurement accuracy and adjustment for losses.
	Surface Water Diversions	Measurement	10%	Estimated measurement accuracy.
	Surface Water Deliveries	Measurement	6%	Estimated measurement accuracy.
	Precipitation	Calculation	30%	Clemmens, A.J. and C.M. Burt, 1997.
	Groundwater Extraction	Closure	20%	Typical uncertainty calculated for Land Surface System water balance closure.
Outflows	Surface Water Outflows	Closure	20%	Typical uncertainty calculated for Rivers and Streams System water balance closure.
	Evaporation	Calculation	20%	Estimated accuracy of calculation based on CIMIS reference ET and free water surface evaporation coefficient.
	ET of Applied Water	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, estimated crop coefficients from SEBAL energy balance, and annual land use.
	ET of Precipitation	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, precipitation, estimated crop coefficients from SEBAL energy balance, and annual land use.
	Infiltration of Applied Water	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use and NRCS soils characteristics.
	Infiltration of Precipitation	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use, NRCS soils characteristics, and CIMIS precipitation.
	Infiltration of Surface Water	Calculation	15%	Estimated accuracy of daily seepage calculation using NRCS soils characteristics and measured streamflow data.
	Change in SWS Storage	Calculation	50%	Professional Judgment.
Net Recharge from SWS		Calculation	25%	Estimated water budget accuracy; typical value calculated for GSA-level net recharge from SWS.

3.7 Comparison of Current Water Budget with GFWD GSA Individual GSP

GFWD GSA is among the three GSAs that are each separately satisfying the requirements of SGMA by preparing individual GSPs. These individual GSPs have been prepared separately from this joint plan. A coordination agreement is being developed by all seven GSAs in the Madera Subbasin detailing required GSA and GSP cooperation and coordination.

To maintain consistent estimates of subbasin groundwater storage and overdraft conditions between the joint and individual GSPs, comparisons of surface water supply and demand under current land use conditions have been prepared between the GSA-level current water budget from this coordinated plan and the current water budget from the individual GSP.

Table 20 provides a comparison between the GFWD GSA current water budget developed as part of this coordinated plan and the GFWD GSA current water budget developed by the District for its individual GSP. During the current water budget period (2015 land use, 1989-2014 average water supply), the District's water supplies and rural residential consumptive use volumes are within 30 AF/yr volume, indicating close correspondence between the water budgets. Land use areas are approximately identical between the plans, though agricultural consumptive use volumes differ by over 2,000 AF/yr on account of different estimated rates of ET of applied water.

ET of applied water in 2015 was estimated in the coordinated GSP water budget based on both the 2015 crop areas and the 2015 crop ET rates estimated from daily ET_o at the Madera II CIMIS station and crop coefficients derived from actual ET (ET_a) estimated by the Surface Energy Balance Algorithm for Land (SEBAL). In contrast, the 2015 ET of applied water was estimated in the individual GSP water budget based on a weighted-average rate derived from the 1989-2014 average ET of applied water rate of each crop and the 2015 acreage of each crop. As drought conditions in 2015 are estimated to have increased ET of applied water (due in part to lower than average precipitation), the process used in the individual GSP water budget would potentially underestimate ET of applied water in 2015, thus explaining the differences observed between the two water budgets.

Table 20. Comparison of Current Water Budget Results between GFWD GSA Individual GSP and Joint GSP.

Gravelly Ford Water District

Current Water Budget - Average Annual Values

Period of Record: 2015 land use, 1989-2014 average water supply

	GFWD GSA, Individual GSP	GFWD GSA, Joint GSP	Difference (Coordinated - Individual)	Units
Parameter	**Value**	**Value**	**Value**	**Units**
Agricultural Land				
Total Area	8,380	8,379	-1	ac (total in GSA area)
Average Agricultural Area (2015)	7,501	7,503	2	ac (including idle)
Average current ETAW (2015)	2.16	2.44	0	AF/ac/yr
Consumptive Use (2015)	16,200	18,339	2,139	AF/yr (for agricultural area)
Rural Residential Land				
Rural Residential Consumptive Use (2015)	100	73	-27	AF/yr
Total Consumptive Use				
Total Consumptive Use (2015)*	**16,300**	**18,412**	**2,112**	**AF/yr**
Water Supply (Average 1989-2014)				
Native Groundwater @ 0.5 af/ac	4,190	4,190	0	af/yr (for total area)
San Joaquin River (Class 2)	6,361	6,359	-2	AF/yr
Diversion from MID (6.2)	1,506	1,506	0	AF/yr
Diversion from Cottonwood Creek - MID	2,016	2,016	0	AF/yr
Diversion from Cottonwood Creek natural flow	1,849	1,874	25	AF/yr
Total Water Supply (Average 1989-2014)	**15,922**	**15,945**	**23**	**AF/yr**
Estimated Imbalance				
Estimated Imbalance (2015)**	**378**	**2,467**	**2,089**	**AF/yr**

*2015 Total Consumptive Use in Individual GSP based on average 1989-2014 crop ETAW rate, based on 2015 crop ETAW rate in Coordinated GSP

**Calculated as the difference between total consumptive use (2015) and total water supply (average 1989-2014).

APPENDIX 2.F. WATER BUDGET INFORMATION

2.F.f. Surface Water System Water Budget: New Stone Water District GSA

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

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1 INTRODUCTION

To ensure sustainable groundwater management throughout California's groundwater basins, the Sustainable Groundwater Management Act of 2014 (SGMA) requires Groundwater Sustainability Agencies (GSAs) to prepare and adopt Groundwater Sustainability Plans (GSPs) with strategies to achieve subbasin groundwater sustainability within 20 years of plan adoption. Integral to each GSP is a water budget used to quantify the subbasin's groundwater overdraft (if applicable) and sustainable yield.

In 2017, New Stone Water District (NSWD) GSA formed to manage approximately 4,200 acres of the Madera Subbasin. This document presents results of the surface water system (SWS) water budgets developed for historical and current land use conditions in NSWD GSA. The NSWD GSA water budgets were integrated with separate water budgets developed for the other six (6) GSAs in Madera Subbasin to prepare a boundary water budget for the Madera Subbasin SWS. Results of the subbasin boundary water budget are reported in the Madera Subbasin GSP Section 2.2.3 and were integrated with a subbasin groundwater model (GSP Appendix 6.D) to estimate subbasin sustainable yield (GSP Section 2.2.3).

2 WATER BUDGET CONCEPTUAL MODEL

A water budget is defined as a complete accounting of all water flowing into and out of a defined volume (e.g., a subbasin or a GSA) over a specified period of time. The conceptual model (or structure) of the NSWD GSA water budget developed for this investigation is consistent with the GSP Regulations defined under Title 23 of California Code of Regulations[1] (CCR) and adheres to sound water budget principles and practices defined by California Department of Water Resources (DWR) in the Water Budget Best Management Practice (BMP) guidelines (DWR, 2016).

The lateral extent of NSWD GSA is defined by the boundaries indicated in Figure A2.F.f-1. The vertical extent of NSWD GSA are the land surface (top) and the base of fresh water at the bottom of the basin (bottom), as described in the hydrogeologic conceptual model (HCM) developed in GSP Section 2.2.1. The vertical extent of Madera Subbasin and its GSAs is subdivided into a surface water system (SWS) and the underlying groundwater system (GWS), with separate but related water budgets prepared for each that together represent the overall subbasin water budget.

A conceptual representation of the NSWD GSA water budget is represented in Figure A2.F.f-2. This document details only the SWS portion of the NSWD GSA water budget. The SWS is divided into two primary accounting centers: the Land Surface System and the Rivers and Streams System. The Land Surface System is further divided into three accounting centers representing NSWD GSA's water use sectors: Agricultural Land, Native Vegetation Land, and Urban Land (urban, industrial, and semi-agricultural).

Water budget components, or directional flow of water between accounting centers and across the SWS boundary, are indicated by arrows. Inflows and outflows were calculated using measurements and other historical data or were calculated as the water budget closure term – the difference between all other estimated or measured inflows and outflows from each accounting center or water use sector (bold arrows).

[1] California Code of Regulations Title 23. Waters, Division 2. Department of Water Resources, Chapter 1.5. Groundwater Management, Subchapter 2. Groundwater Sustainability Plans.

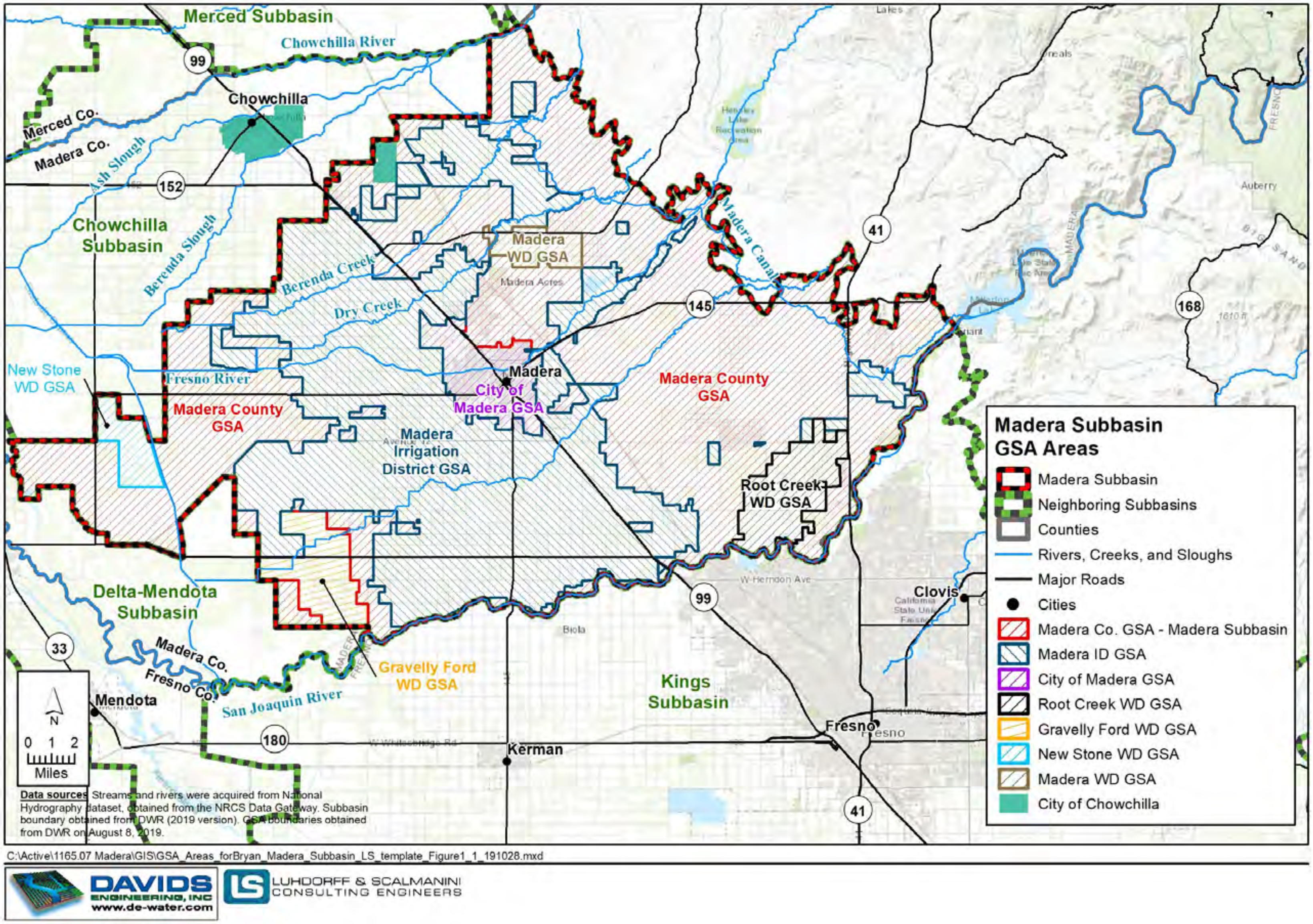

Figure A2.F.f-1. Madera Subbasin GSAs Map.

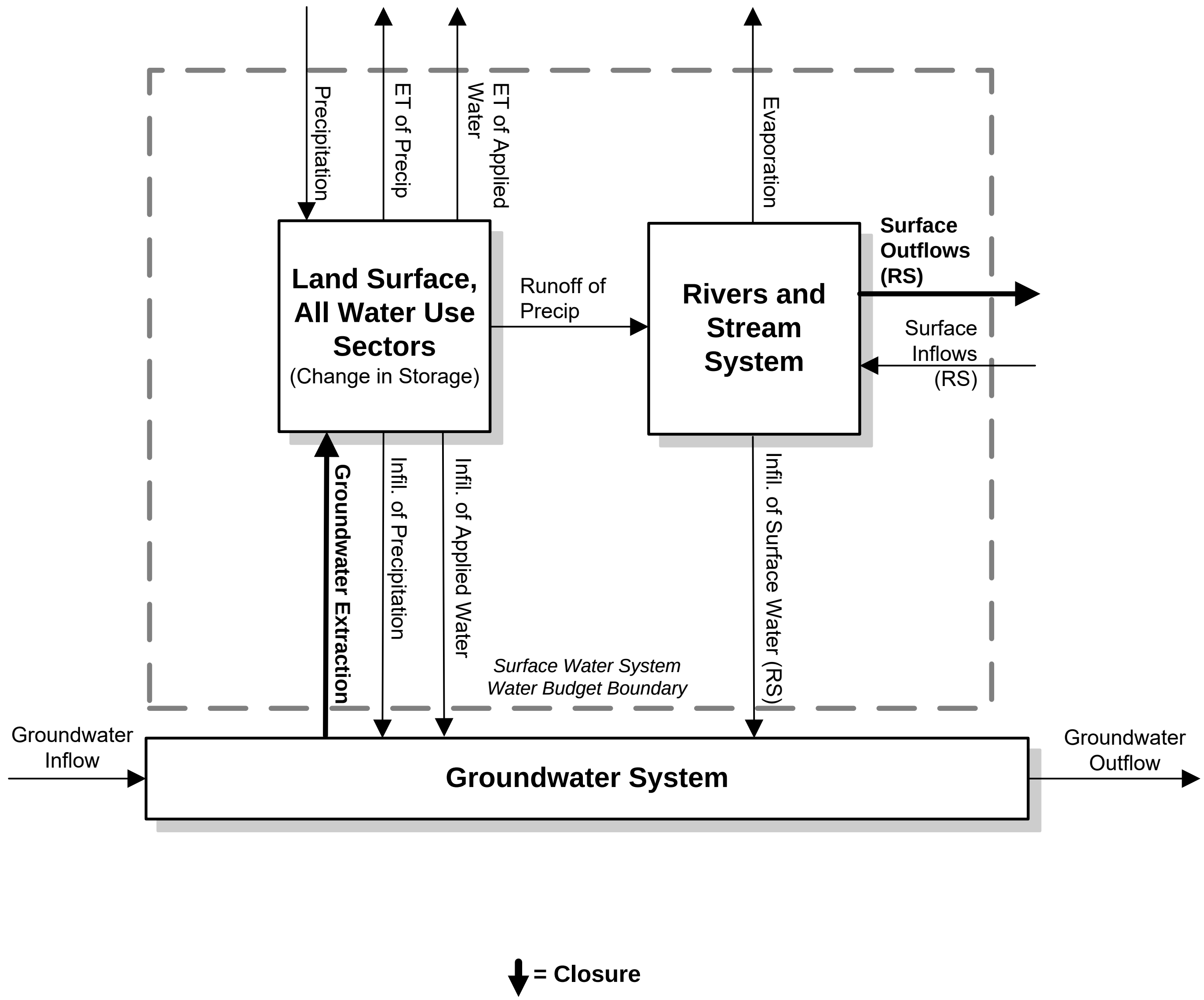

Figure A2.F.f-2. New Stone Water District GSA Water Budget Structure.

Inflows to the SWS include precipitation, surface water inflows (in various canals and streams), and groundwater extraction. Outflows from the SWS include evapotranspiration (ET), surface water outflows (in various canals and streams), and infiltration to the groundwater system (seepage and deep percolation). Also represented in Figure A2.F.f-2 are inflows and outflows from the GWS, which are discussed and quantified at the subbasin level in the GWS water budget in GSP Section 2.2.3. Subsurface GWS inflows and outflows are not quantified on the water budget subregion scale.

Inflows and outflows were quantified following the process described in GSP Section 2.2.3 on a monthly time step for water years in the historical water budget base period (1989-2014 hydrologic and land use conditions), the current water budget (2015 land use using 1989-2014 average hydrologic conditions), and projected water budget. Four projected water budgets were prepared for the years 2019 through 2090 based on 1965 through 2015 hydrologic conditions:

1. Historical hydrologic conditions
    a. Without projects and management actions, and
    b. With projects and management actions
2. Historical hydrologic conditions adjusted for anticipated climate change per DWR-provided 2030 climate change factors
    a. Without projects and management actions, and
    b. With projects and management actions.

3 WATER BUDGET ANALYSIS

The historical water budget and current land use water budget for NSWD GSA are presented below following a summary of land use data relevant to water budget development. Land use data is provided for the 1989-2014 historical water budget period and for 2015, the land use period used for current water budget development.

3.1 Land Use

Land use estimates for 1989-2015 corresponding to water use sectors are summarized in Figure A2.F.f-3 and Table A2.F.f-1 for NSWD GSA. According to GSP Regulations (23 CCR § 351(al)):

> *"Water use sector" refers to 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.*

In NSWD GSA, water use sectors include agricultural, native vegetation, and urban land use. The urban land use category includes urban and semi-agricultural[2] lands as well as industrial land, which covers only a small area in the subbasin.

Agricultural lands in NSWD GSA gradually expanded between 1989 and 2014, from just over 3,800 acres to approximately 3,950 acres. Urban lands have also expanded, albeit to a much lesser extent. The expansion of these lands has coincided with a decrease in native vegetation from over 300 acres in 1989 to under 200 in 2014.

[2] As defined in the DWR county land use surveys, semi-agricultural land use subclasses include farmsteads, livestock feed lot operations, dairies, poultry farms, and miscellaneous semi-agricultural land use incidental to agriculture (small roads, ditches, non-planted areas of cropped fields (DWR, 2009).

Agricultural land uses are further detailed in Figure A2.F.f-4 and Table A2.F.f-2. Between 1989 and the mid-1990s, agriculture in NSWD GSA was dominated by pasture and alfalfa crops. Since the late 1990s, much of this cropland has been replaced by grapes.

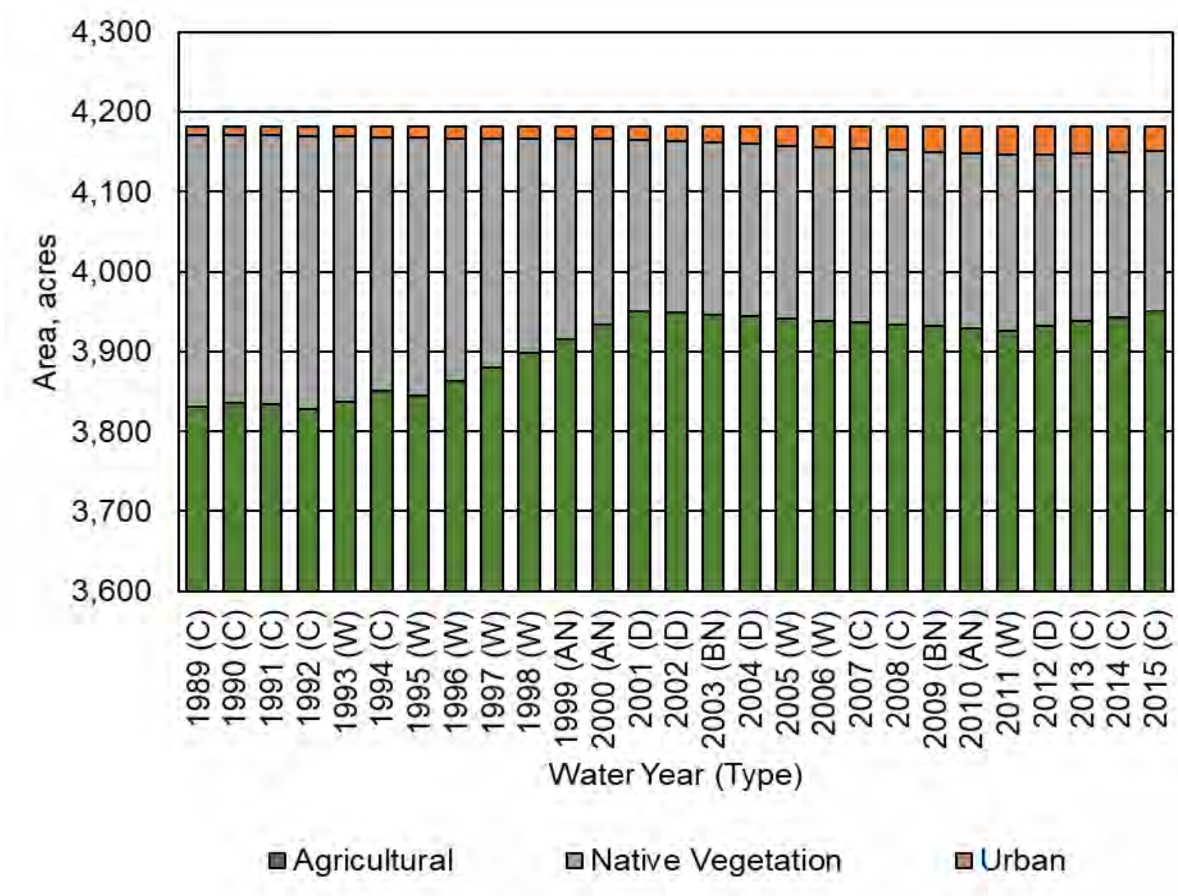

Figure A2.F.f-3. New Stone Water District GSA Land Use Areas.

Table A2.F.f-1. New Stone Water District GSA Land Use Areas (Acres).

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
1989 (C)	3,830	340	11	4,182
1990 (C)	3,836	335	12	4,182
1991 (C)	3,834	336	12	4,182
1992 (C)	3,828	342	12	4,182
1993 (W)	3,837	332	13	4,182
1994 (C)	3,851	317	14	4,182
1995 (W)	3,845	322	15	4,182
1996 (W)	3,863	304	15	4,182
1997 (W)	3,880	286	16	4,182
1998 (W)	3,898	268	16	4,182
1999 (AN)	3,916	250	16	4,182

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
2000 (AN)	3,933	232	16	4,182
2001 (D)	3,951	214	17	4,182
2002 (D)	3,949	215	19	4,182
2003 (BN)	3,946	216	20	4,182
2004 (D)	3,944	216	22	4,182
2005 (W)	3,941	217	24	4,182
2006 (W)	3,939	217	26	4,182
2007 (C)	3,936	218	28	4,182
2008 (C)	3,934	218	30	4,182
2009 (BN)	3,931	219	32	4,182
2010 (AN)	3,929	219	34	4,182
2011 (W)	3,926	220	36	4,182
2012 (D)	3,932	215	35	4,182
2013 (C)	3,938	210	34	4,182
2014 (C)	3,943	206	33	4,182
2015 (C)	3,951	200	32	4,182
Average (1989-2014)	3,903	257	22	4,182

[1] Area includes land classified as native vegetation and water surfaces.
[2] Area includes land classified as urban, industrial, and semi-agricultural.

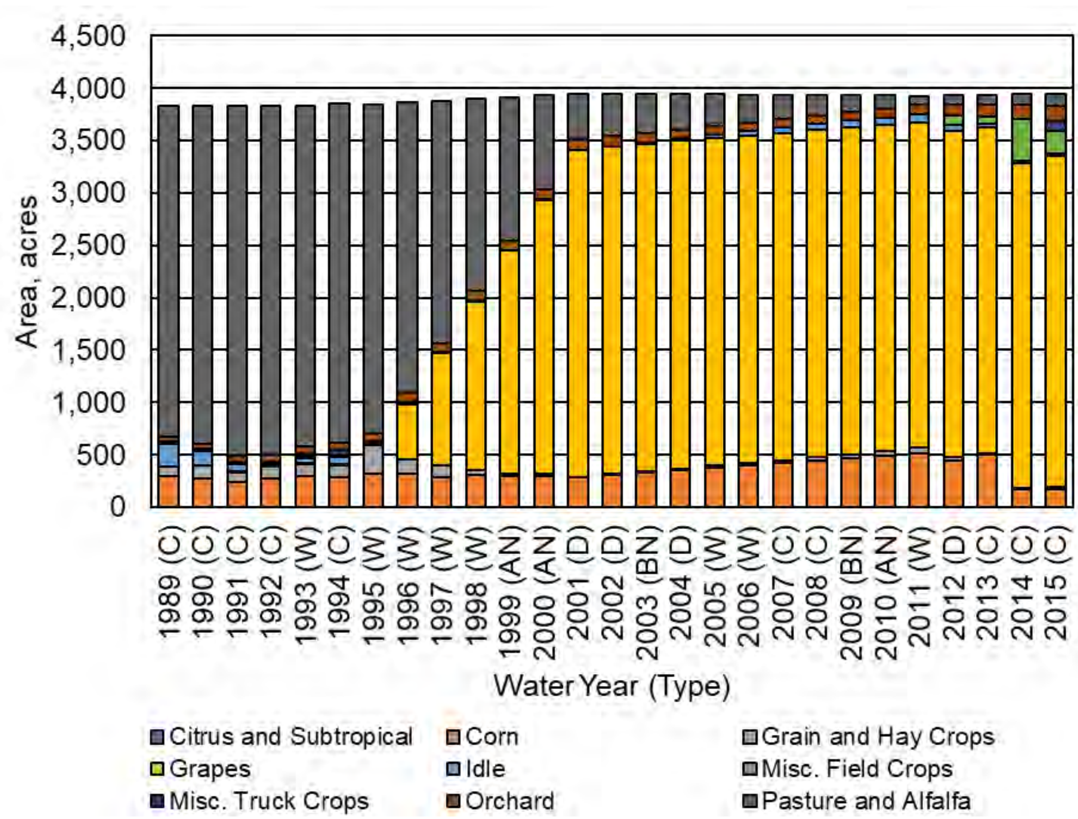

Figure A2.F.f-4. New Stone Water District GSA Agricultural Land Use Areas.

Table A2.F.f-2. New Stone Water District GSA Agricultural Land Use Areas (Acres).

Water Year (Type)	Citrus and Subtropical	Corn	Grain and Hay Crops	Grapes	Idle	Misc. Field Crops	Misc. Truck Crops	Orchard	Pasture and Alfalfa	Total
1989 (C)	0	293	93	4	219	20	0	49	3,152	3,830
1990 (C)	0	271	130	4	128	22	0	56	3,226	3,836
1991 (C)	0	243	94	4	66	25	1	62	3,339	3,834
1992 (C)	0	272	118	4	8	24	10	63	3,329	3,828
1993 (W)	0	293	120	4	53	24	19	68	3,256	3,837
1994 (C)	0	288	114	4	72	23	45	72	3,235	3,851
1995 (W)	0	324	274	8	0	21	0	85	3,132	3,845
1996 (W)	0	320	132	534	0	20	1	82	2,773	3,863
1997 (W)	0	285	112	1,071	0	13	0	85	2,314	3,880
1998 (W)	0	307	52	1,603	6	9	1	88	1,832	3,898
1999 (AN)	0	301	16	2,135	0	5	0	92	1,367	3,916
2000 (AN)	0	294	27	2,615	0	3	0	95	900	3,933
2001 (D)	0	287	0	3,125	0	0	0	97	442	3,951
2002 (D)	0	311	4	3,126	8	0	0	94	407	3,949
2003 (BN)	0	334	6	3,127	16	0	0	91	371	3,946
2004 (D)	0	357	10	3,129	24	0	0	88	336	3,944
2005 (W)	0	378	17	3,128	33	0	0	85	300	3,941
2006 (W)	0	402	20	3,125	42	0	0	85	265	3,939
2007 (C)	0	425	21	3,129	48	0	0	84	229	3,936
2008 (C)	0	446	31	3,125	56	0	0	82	194	3,934
2009 (BN)	0	466	31	3,127	69	0	0	80	158	3,931
2010 (AN)	0	488	49	3,114	71	0	0	83	123	3,929
2011 (W)	0	510	56	3,110	79	0	0	84	87	3,926
2012 (D)	0	446	38	3,107	62	86	0	100	93	3,932
2013 (C)	0	497	20	3,104	44	59	0	118	96	3,938
2014 (C)	0	176	2	3,102	26	404	0	134	98	3,943
2015 (C)	0	172	26	3,160	13	223	85	153	119	3,951
Average (1989-2014)	0	347	61	1,987	43	29	3	85	1,348	3,903

3.2 Surface Water System Water Budget

This section presents surface water system water budget components within NSWD GSA as per GSP regulations. These are followed by a summary of the water budget results by accounting center.

3.2.1 Inflows

3.2.1.1 Surface Water Inflow by Water Source Type

Surface water inflows include surface water flowing into the basin across the basin boundary. Per the Regulations, surface inflows 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.*

Additionally, runoff of precipitation from upgradient areas adjacent to the subregion represents a potential source of surface water inflow.

Local Supplies

Primary surface water inflows to NSWD GSA include local supplies along Chowchilla Bypass.

Local Imported Supplies

NSWD GSA does not receive local imported supplies for irrigation purposes.

CVP Supplies

NSWD GSA does not receive CVP supplies for irrigation purposes.

Recycling and Reuse

Recycling and reuse are not a significant source of supply within NSWD GSA.

Other Surface Inflows

For the water budgets presented herein, precipitation runoff from outside the subregion is considered relatively minimal and is expected to pass through the waterways accounted above following relatively large storm events. Precipitation runoff from lands inside the subregion is internal to the surface water system and is thus not considered as surface inflows to the subregion boundary.

Summary of Surface Inflows

Surface water inflows in Chowchilla Bypass are summarized by water year type in Figure A2.F.f-5 and Table A2.F.f-3. During the study period, surface water supplies vary greatly with water year type, with substantial local supply inflows during wet years when flood flows along San Joaquin River are directed down Chowchilla Bypass. Total surface water inflows are on average approximately 590 thousand acre-feet (taf) during wet years.

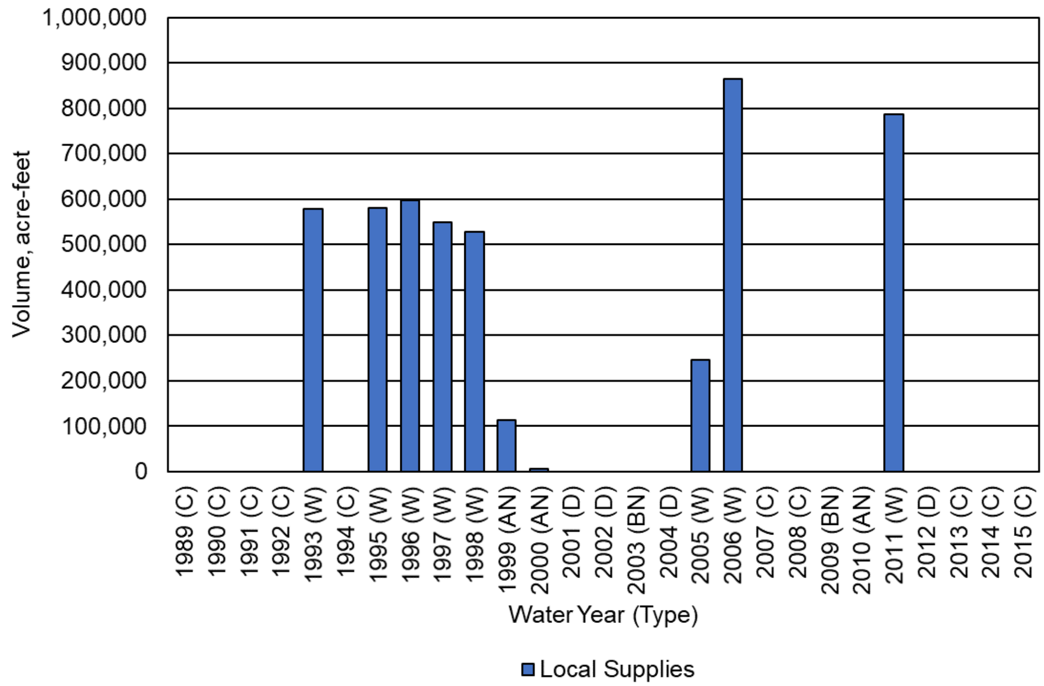

Figure A2.F.f-5. New Stone Water District GSA Surface Water Inflows by Water Source Type.

Table A2.F.f-3. New Stone Water District GSA Surface Water Inflows by Water Source Type (Acre-Feet).

Water Year (Type)	Local Supply	CVP Supply[1]	Other Surface Inflows	Total
1989 (C)	0	0	0	0
1990 (C)	0	0	0	0
1991 (C)	0	0	0	0
1992 (C)	0	0	0	0
1993 (W)	578,875	0	0	578,875
1994 (C)	0	0	0	0
1995 (W)	579,464	0	0	579,464
1996 (W)	597,233	0	0	597,233
1997 (W)	549,449	0	0	549,449
1998 (W)	526,604	0	0	526,604
1999 (AN)	113,200	0	0	113,200
2000 (AN)	5,146	0	0	5,146
2001 (D)	0	0	0	0
2002 (D)	0	0	0	0
2003 (BN)	0	0	0	0
2004 (D)	0	0	0	0
2005 (W)	246,647	0	0	246,647
2006 (W)	864,794	0	0	864,794
2007 (C)	0	0	0	0

Water Year (Type)	Local Supply	CVP Supply[1]	Other Surface Inflows	Total
2008 (C)	0	0	0	0
2009 (BN)	0	0	0	0
2010 (AN)	0	0	0	0
2011 (W)	785,848	0	0	785,848
2012 (D)	0	0	0	0
2013 (C)	0	0	0	0
2014 (C)	0	0	0	0
2015 (C)	0	0	0	0
Average (1989-2014)	186,433	0	0	186,433
Average (1989-2014) W	591,114	0	0	591,114
Average (1989-2014) AN	39,448	0	0	39,448
Average (1989-2014) BN	0	0	0	0
Average (1989-2014) D	0	0	0	0
Average (1989-2014) C	0	0	0	0

[1]CVP Supply is considered as all water supply released from CVP storage facilities. The volume of CVP Supply includes CVP deliveries to CVP contractors/water users, and flood releases from CVP facilities that largely pass through the subbasin.

3.2.1.2 Precipitation

Precipitation estimates for the NSWD GSA are provided in Figure A2.F.f-6 and Table A2.F.f-4. Precipitation estimates are reported by water use sector.

Total precipitation is variable between years in the study area, ranging from approximately 3 taf (8.6 inches) during critical years to 5 taf (14.4 inches) during wet years.

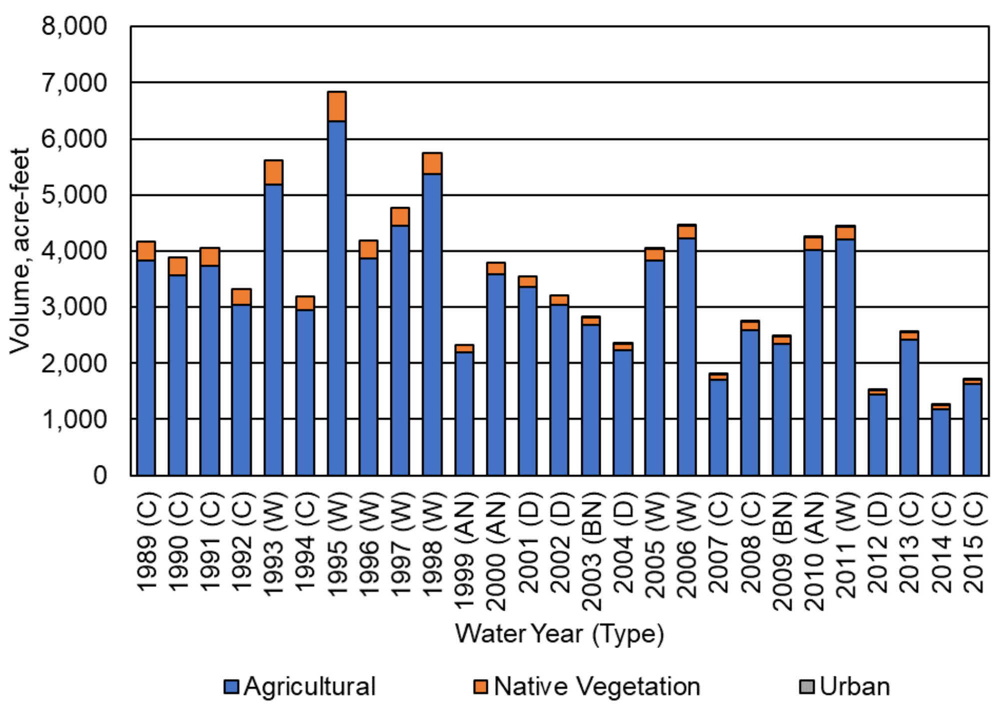

Figure A2.F.f-6. New Stone Water District GSA Precipitation by Water Use Sector.

Table A2.F.f-4. New Stone Water District GSA Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	3,829	340	0	4,169
1990 (C)	3,574	310	0	3,884
1991 (C)	3,734	324	0	4,058
1992 (C)	3,047	270	0	3,317
1993 (W)	5,176	448	0	5,624
1994 (C)	2,945	241	0	3,186
1995 (W)	6,313	526	0	6,839
1996 (W)	3,874	304	0	4,178
1997 (W)	4,447	329	0	4,776
1998 (W)	5,371	369	0	5,740
1999 (AN)	2,189	139	0	2,328
2000 (AN)	3,584	212	0	3,796
2001 (D)	3,359	181	0	3,540
2002 (D)	3,047	167	0	3,214
2003 (BN)	2,675	146	1	2,822
2004 (D)	2,221	121	2	2,344
2005 (W)	3,830	208	6	4,044
2006 (W)	4,218	234	9	4,461
2007 (C)	1,708	94	2	1,804
2008 (C)	2,590	142	8	2,740
2009 (BN)	2,340	129	7	2,476
2010 (AN)	4,017	223	16	4,256
2011 (W)	4,202	234	16	4,452
2012 (D)	1,433	77	6	1,516
2013 (C)	2,425	129	8	2,562
2014 (C)	1,185	61	4	1,250
2015 (C)	1,621	81	4	1,706
Average (1989-2014)	3,359	229	3	3,591
Average (1989-2014) W	4,679	332	4	5,014
Average (1989-2014) AN	3,263	191	5	3,460
Average (1989-2014) BN	2,508	138	4	2,649
Average (1989-2014) D	2,515	137	2	2,654
Average (1989-2014) C	2,782	212	2	2,997

3.2.1.3 Groundwater Extraction by Water Use Sector

Estimates of groundwater extraction by water use sector are provided in Figure A2.F.f-7 and Table A2.F.f-5. For agricultural and urban (urban, semi-agricultural, industrial) lands, groundwater extraction represents pumping, while for native lands, groundwater extraction by riparian vegetation was considered to be negligible. For all water use sectors, groundwater extraction served as the water budget closure term. Groundwater extraction varies between years depending on surface water supplies and crop water demands or urban land consumptive use requirements. However, between 1989 and 2014 groundwater extraction has, on average, slightly decreased across agricultural lands as land use has shifted from alfalfa and pasture to grapes.

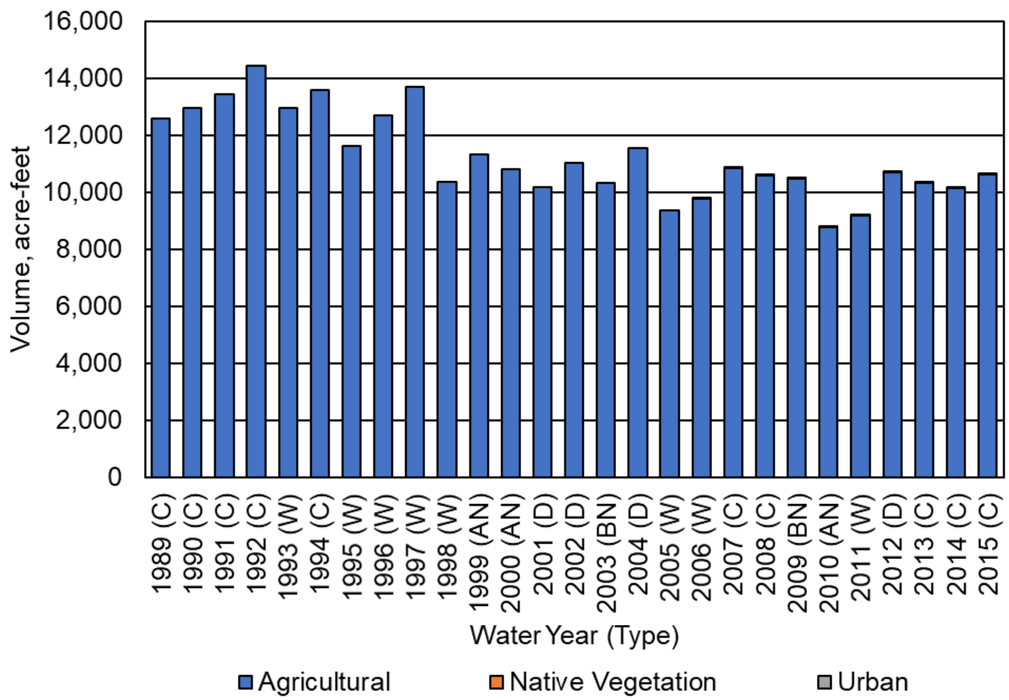

Figure A2.F.f-7. New Stone Water District GSA Groundwater Extraction by Water Use Sector.

Table A2.F.f-5. New Stone Water District GSA Groundwater Extraction by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	12,591	0	0	12,591
1990 (C)	12,978	0	0	12,978
1991 (C)	13,450	0	0	13,450
1992 (C)	14,432	0	0	14,432
1993 (W)	12,984	0	0	12,984
1994 (C)	13,597	0	0	13,597
1995 (W)	11,617	0	0	11,617
1996 (W)	12,711	0	0	12,711
1997 (W)	13,718	0	0	13,718
1998 (W)	10,366	0	0	10,366
1999 (AN)	11,343	0	0	11,343
2000 (AN)	10,800	0	0	10,800
2001 (D)	10,203	0	0	10,203
2002 (D)	11,050	0	0	11,050
2003 (BN)	10,318	0	0	10,318
2004 (D)	11,573	0	0	11,573
2005 (W)	9,389	0	0	9,389
2006 (W)	9,780	0	1	9,781
2007 (C)	10,836	0	5	10,841
2008 (C)	10,582	0	7	10,589
2009 (BN)	10,497	0	6	10,503
2010 (AN)	8,772	0	12	8,784

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2011 (W)	9,169	0	16	9,185
2012 (D)	10,696	0	16	10,712
2013 (C)	10,346	0	14	10,360
2014 (C)	10,132	0	11	10,143
2015 (C)	10,638	0	9	10,647
Average (1989-2014)	11,305	0	3	11,308
Average (1989-2014) W	11,217	0	2	11,219
Average (1989-2014) AN	10,305	0	4	10,309
Average (1989-2014) BN	10,408	0	3	10,411
Average (1989-2014) D	10,881	0	4	10,885
Average (1989-2014) C	12,105	0	4	12,109

3.2.1.4 Groundwater Discharge to Surface Water Sources

The depth to groundwater is greater than 100-200 ft across much of the Madera Subbasin. Given the depth to the water table in the Madera Subbasin, groundwater discharge to surface water sources is negligible.

3.2.2 Outflows

3.2.2.1 Evapotranspiration by Water Use Sector

Evapotranspiration (ET) by water use sector is reported in Figures A2.F.f-8 to A2.F.f-10 and Tables A2.F.f-6 to A2.F.f-8. First, total ET is reported, followed by ET from applied water and ET from precipitation.

Total ET varies between years but has generally decreased over time following changes in cropping from alfalfa and pasture to grapes. Total ET ranges from a low of approximately 8.4 taf in 2014 to a high of 12.8 taf in 1992.

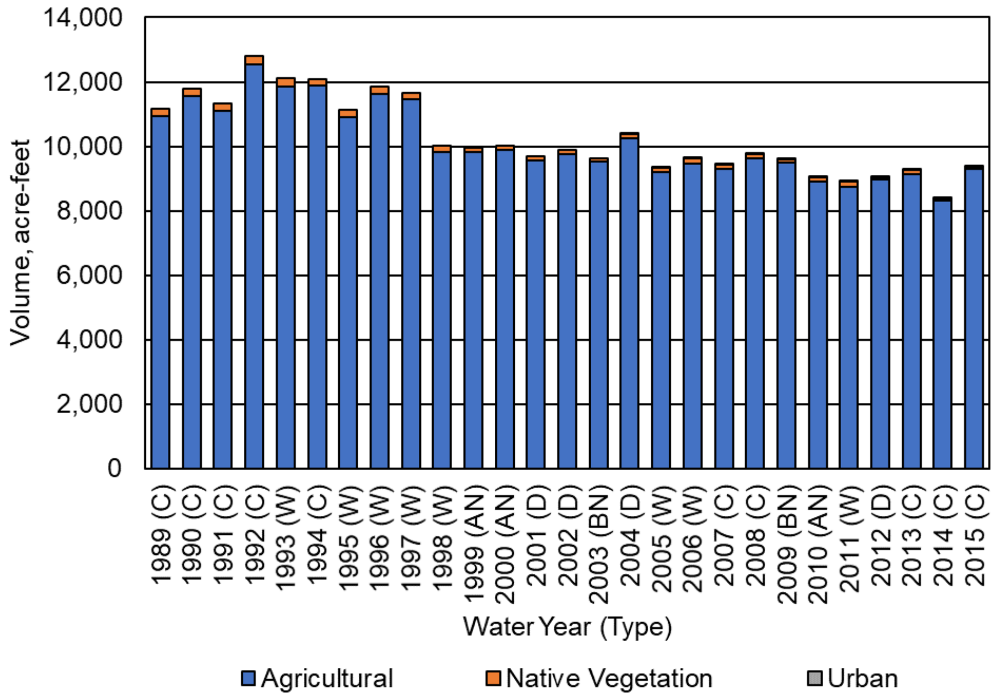

Figure A2.F.f-8. New Stone Water District GSA Evapotranspiration by Water Use Sector.

Table A2.F.f-6. New Stone Water District GSA Evapotranspiration by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	10,924	247	0	11,171
1990 (C)	11,563	234	0	11,797
1991 (C)	11,105	214	0	11,319
1992 (C)	12,551	260	0	12,811
1993 (W)	11,855	254	0	12,109
1994 (C)	11,899	187	0	12,086
1995 (W)	10,907	242	0	11,149
1996 (W)	11,613	233	0	11,846
1997 (W)	11,462	194	0	11,656
1998 (W)	9,831	177	0	10,008
1999 (AN)	9,810	139	0	9,949
2000 (AN)	9,876	151	0	10,027
2001 (D)	9,554	149	0	9,703
2002 (D)	9,759	141	0	9,900
2003 (BN)	9,523	115	0	9,638
2004 (D)	10,260	124	2	10,386
2005 (W)	9,197	142	3	9,342
2006 (W)	9,459	155	7	9,621
2007 (C)	9,306	111	8	9,425
2008 (C)	9,642	120	14	9,776
2009 (BN)	9,490	100	14	9,604
2010 (AN)	8,900	146	18	9,064

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2011 (W)	8,749	157	21	8,927
2012 (D)	8,972	82	13	9,067
2013 (C)	9,150	109	19	9,278
2014 (C)	8,327	56	14	8,397
2015 (C)	9,311	63	12	9,386
Average (1989-2014)	10,142	163	5	10,310
Average (1989-2014) W	10,384	194	4	10,582
Average (1989-2014) AN	9,529	145	6	9,680
Average (1989-2014) BN	9,507	108	7	9,621
Average (1989-2014) D	9,636	124	4	9,764
Average (1989-2014) C	10,496	171	6	10,673

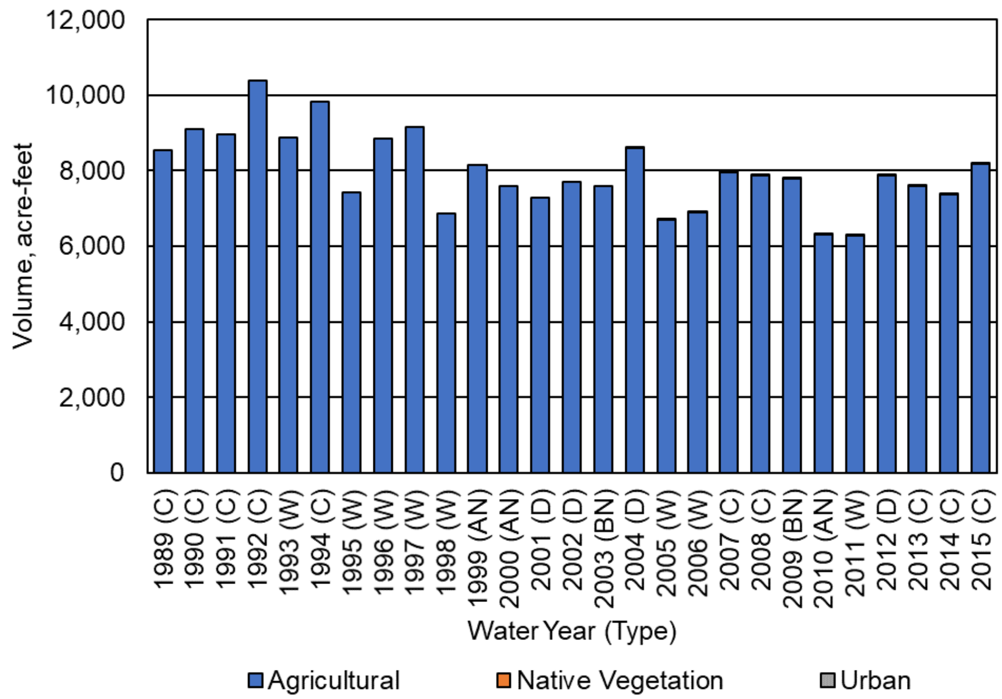

Figure A2.F.f-9. New Stone Water District GSA Evapotranspiration of Applied Water by Water Use Sector.

Table A2.F.f-7. New Stone Water District GSA Evapotranspiration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	8,552	0	0	8,552
1990 (C)	9,102	0	0	9,102
1991 (C)	8,973	0	0	8,973
1992 (C)	10,377	0	0	10,377
1993 (W)	8,882	0	0	8,882
1994 (C)	9,840	0	0	9,840
1995 (W)	7,419	0	0	7,419
1996 (W)	8,845	0	0	8,845
1997 (W)	9,152	0	0	9,152
1998 (W)	6,880	0	0	6,880
1999 (AN)	8,151	0	0	8,151
2000 (AN)	7,603	0	0	7,603
2001 (D)	7,297	0	0	7,297
2002 (D)	7,720	0	0	7,720
2003 (BN)	7,587	0	0	7,587
2004 (D)	8,596	0	1	8,597
2005 (W)	6,708	0	1	6,709
2006 (W)	6,894	0	3	6,897
2007 (C)	7,961	0	6	7,967
2008 (C)	7,871	0	10	7,881
2009 (BN)	7,793	0	11	7,804
2010 (AN)	6,300	0	9	6,309
2011 (W)	6,282	0	8	6,290
2012 (D)	7,867	0	9	7,876
2013 (C)	7,603	0	13	7,616
2014 (C)	7,361	0	12	7,373
2015 (C)	8,188	0	11	8,199
Average (1989-2014)	7,985	0	3	7,988
Average (1989-2014) W	7,633	0	2	7,634
Average (1989-2014) AN	7,351	0	3	7,354
Average (1989-2014) BN	7,690	0	6	7,696
Average (1989-2014) D	7,870	0	3	7,873
Average (1989-2014) C	8,627	0	5	8,631

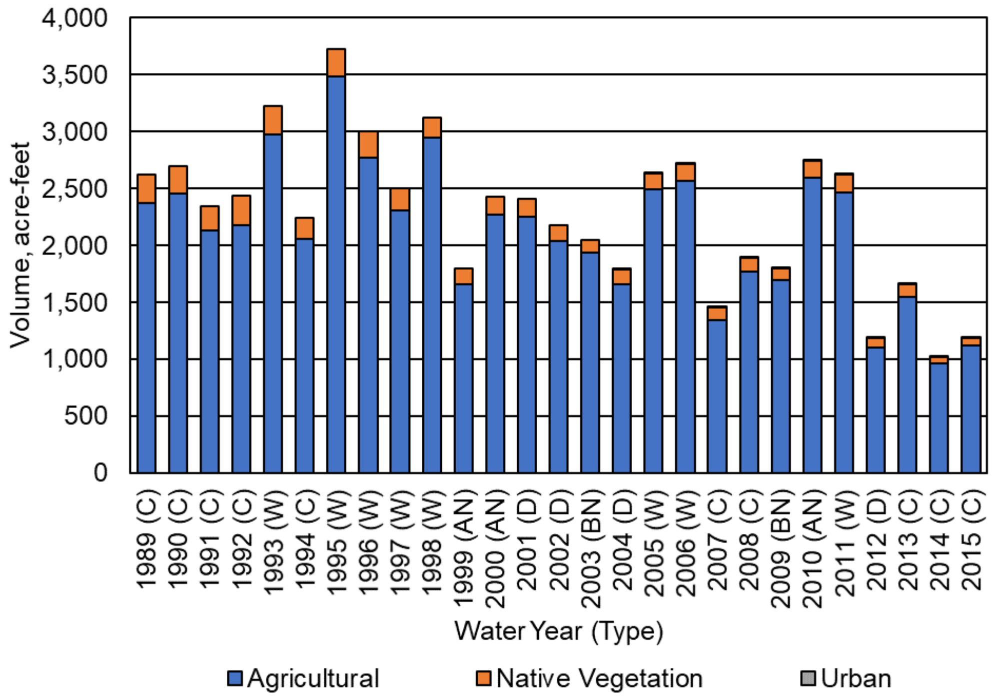

Figure A2.F.f-10. New Stone Water District GSA Evapotranspiration of Precipitation by Water Use Sector.

Table A2.F.f-8. New Stone Water District GSA Evapotranspiration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	2,372	247	0	2,619
1990 (C)	2,461	234	0	2,695
1991 (C)	2,132	214	0	2,346
1992 (C)	2,174	260	0	2,434
1993 (W)	2,973	254	0	3,227
1994 (C)	2,059	187	0	2,246
1995 (W)	3,488	242	0	3,730
1996 (W)	2,768	233	0	3,001
1997 (W)	2,310	194	0	2,504
1998 (W)	2,951	177	0	3,128
1999 (AN)	1,659	139	0	1,798
2000 (AN)	2,273	151	0	2,424
2001 (D)	2,257	149	0	2,406
2002 (D)	2,039	141	0	2,180
2003 (BN)	1,936	115	0	2,051
2004 (D)	1,664	124	1	1,789
2005 (W)	2,489	142	2	2,633
2006 (W)	2,565	155	4	2,724
2007 (C)	1,345	111	2	1,458
2008 (C)	1,771	120	4	1,895
2009 (BN)	1,697	100	3	1,800

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2010 (AN)	2,600	146	9	2,755
2011 (W)	2,467	157	13	2,637
2012 (D)	1,105	82	4	1,191
2013 (C)	1,547	109	6	1,662
2014 (C)	966	56	2	1,024
2015 (C)	1,123	63	1	1,187
Average (1989-2014)	2,156	163	2	2,321
Average (1989-2014) W	2,751	194	2	2,948
Average (1989-2014) AN	2,177	145	3	2,326
Average (1989-2014) BN	1,817	108	2	1,926
Average (1989-2014) D	1,766	124	1	1,892
Average (1989-2014) C	1,870	171	2	2,042

In addition to ET from land surfaces, estimates of evaporation from rivers and streams are reported in Figure A2.F.f-11 and Table A2.F.f-9. Evaporation from the Rivers and Streams System includes evaporation of both surface inflows and of precipitation runoff within local sloughs and depressions. Evaporation is highest in wet years when surface water inflows are typically higher, averaging approximately 0.3 taf per wet year.

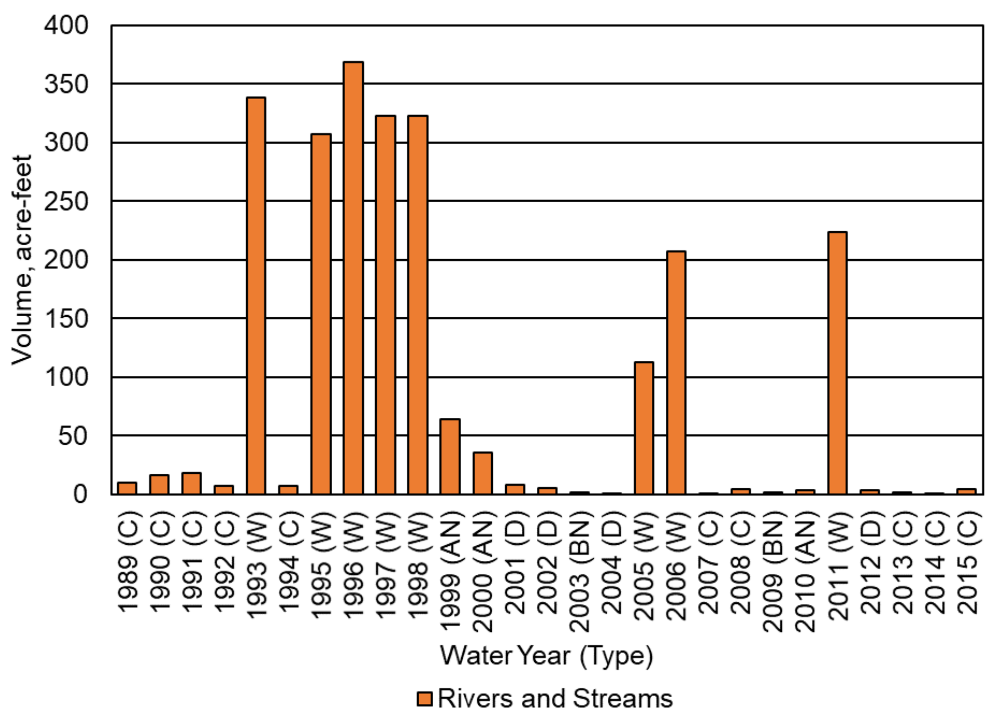

Figure A2.F.f-11. New Stone Water District GSA Evaporation from the Surface Water System.

Table A2.F.f-9. New Stone Water District GSA Evaporation from the Surface Water System (Acre-Feet).

Water Year (Type)	Rivers and Streams[1]
1989 (C)	10
1990 (C)	17
1991 (C)	18
1992 (C)	7
1993 (W)	339
1994 (C)	7
1995 (W)	307
1996 (W)	369
1997 (W)	323
1998 (W)	323
1999 (AN)	64
2000 (AN)	36
2001 (D)	8
2002 (D)	6
2003 (BN)	1
2004 (D)	1
2005 (W)	113
2006 (W)	207
2007 (C)	0
2008 (C)	4
2009 (BN)	2
2010 (AN)	4
2011 (W)	224
2012 (D)	4
2013 (C)	2
2014 (C)	1
2015 (C)	5
Average (1989-2014)	92
Average (1989-2014) W	276
Average (1989-2014) AN	34
Average (1989-2014) BN	2
Average (1989-2014) D	4
Average (1989-2014) C	7

[1] Includes evaporation of surface inflows and of precipitation runoff.

3.2.2.2 Surface Water Outflow by Water Source Type

Surface water outflows by water source type are summarized in Figure A2.F.f-12 and Table A2.F.f-10. In NSWD GSA, runoff of applied water is assumed negligible and runoff of precipitation is collected in waterways within NSWD GSA, reentering the groundwater system through infiltration except during the largest storm events. Thus, surface outflows primarily from local supplies along Chowchilla Bypass are expected to leave the subregion. These outflows primarily occur during wet years, averaging approximately 586 taf per wet year.

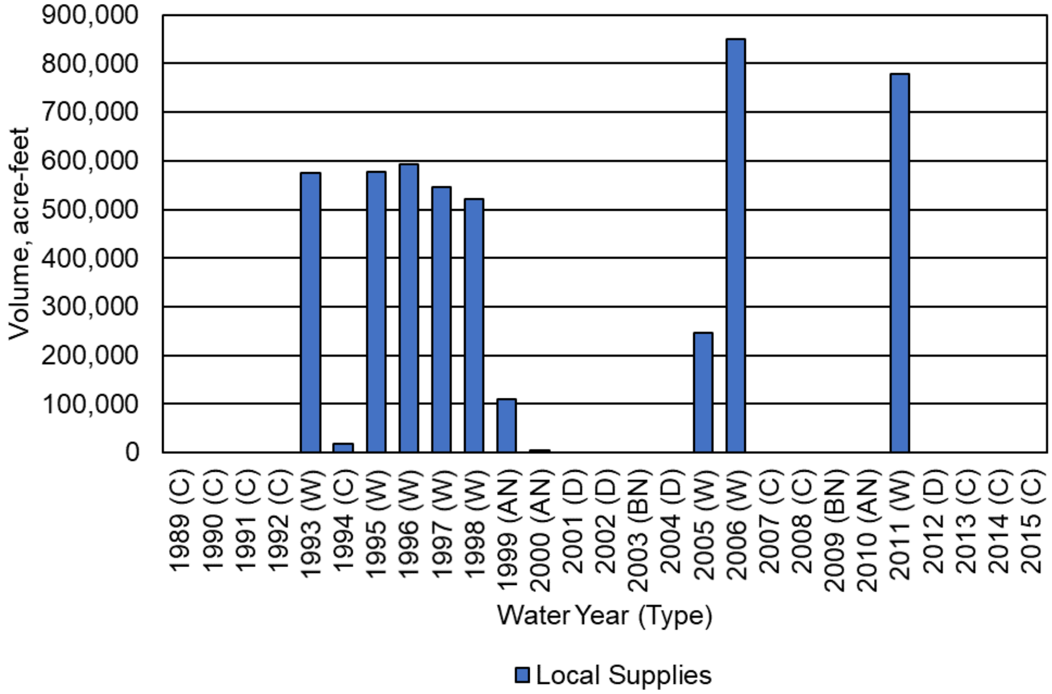

Figure A2.F.f-12. New Stone Water District GSA Surface Outflows by Water Source Type.

Table A2.F.f-10. New Stone Water District GSA Surface Outflows by Water Source Type (Acre-Feet).

Water Year (Type)	Local Supplies	CVP Supplies	Total
1989 (C)	0	0	0
1990 (C)	0	0	0
1991 (C)	0	0	0
1992 (C)	0	0	0
1993 (W)	575,310	0	575,310
1994 (C)	0	0	0
1995 (W)	576,248	0	576,248
1996 (W)	592,679	0	592,679
1997 (W)	545,538	0	545,538
1998 (W)	522,140	0	522,140
1999 (AN)	111,033	0	111,033
2000 (AN)	4,721	0	4,721
2001 (D)	0	0	0
2002 (D)	0	0	0
2003 (BN)	0	0	0
2004 (D)	0	0	0
2005 (W)	245,701	0	245,701
2006 (W)	850,602	0	850,602
2007 (C)	0	0	0
2008 (C)	0	0	0
2009 (BN)	0	0	0
2010 (AN)	0	0	0

Water Year (Type)	Local Supplies	CVP Supplies	Total
2011 (W)	779,184	0	779,184
2012 (D)	0	0	0
2013 (C)	0	0	0
2014 (C)	0	0	0
2015 (C)	0	0	0
Average (1989-2014)	184,737	0	184,737
Average (1989-2014) W	585,925	0	585,925
Average (1989-2014) AN	38,585	0	38,585
Average (1989-2014) BN	0	0	0
Average (1989-2014) D	0	0	0
Average (1989-2014) C	0	0	0

3.2.2.3 Infiltration of Precipitation

Estimated infiltration of precipitation (deep percolation of precipitation) by water use sector is provided in Figure A2.F.f-13 and Table A2.F.f-11. Infiltration of precipitation to the groundwater system is highly variable from year to year due to variation in the timing and amount of precipitation, ranging from over 1.8 taf on average during wet years to less than 1 taf annually during below normal, dry, and critical year types.

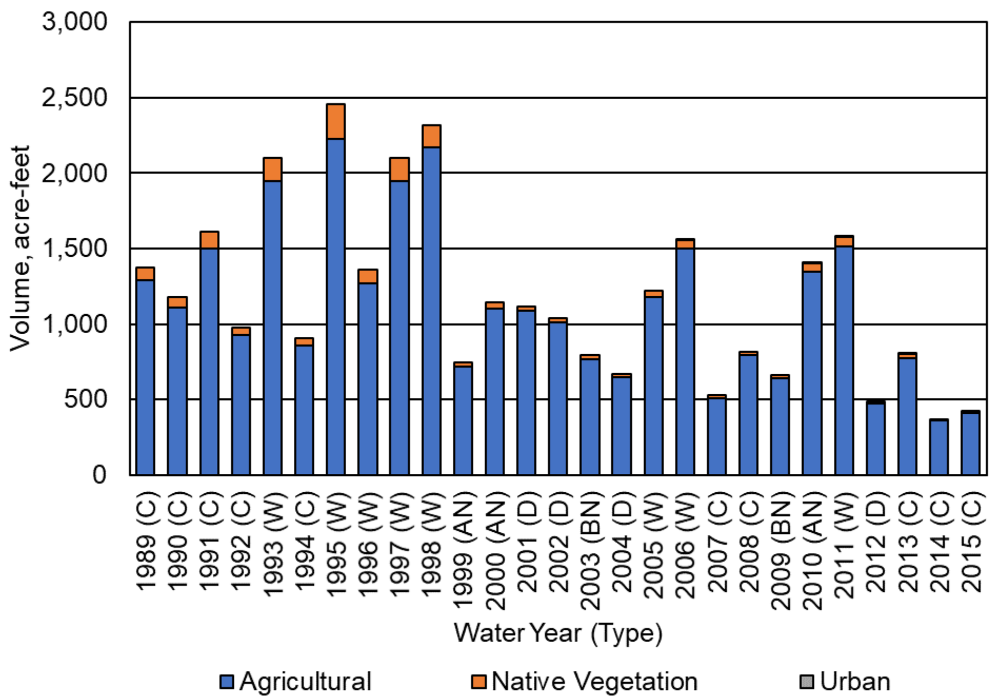

Figure A2.F.f-13. New Stone Water District GSA Infiltration of Precipitation by Water Use Sector.

Table A2.F.f-11. New Stone Water District GSA Infiltration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	1,290	81	0	1,371
1990 (C)	1,107	72	0	1,179
1991 (C)	1,503	108	0	1,611
1992 (C)	929	46	0	975
1993 (W)	1,946	151	0	2,097
1994 (C)	858	48	0	906
1995 (W)	2,229	230	0	2,459
1996 (W)	1,272	90	0	1,362
1997 (W)	1,945	158	0	2,103
1998 (W)	2,173	141	0	2,314
1999 (AN)	718	26	0	744
2000 (AN)	1,102	44	0	1,146
2001 (D)	1,085	33	0	1,118
2002 (D)	1,009	28	0	1,037
2003 (BN)	767	24	0	791
2004 (D)	650	18	0	668
2005 (W)	1,180	40	0	1,220
2006 (W)	1,497	60	1	1,558
2007 (C)	510	17	0	527
2008 (C)	794	23	0	817
2009 (BN)	644	16	0	660
2010 (AN)	1,345	55	4	1,404
2011 (W)	1,512	65	4	1,581
2012 (D)	470	17	0	487
2013 (C)	772	26	2	800
2014 (C)	359	10	0	369
2015 (C)	411	15	0	426
Average (1989-2014)	1,141	63	0	1,204
Average (1989-2014) W	1,719	117	1	1,837
Average (1989-2014) AN	1,055	42	1	1,098
Average (1989-2014) BN	706	20	0	726
Average (1989-2014) D	804	24	0	828
Average (1989-2014) C	902	48	0	951

3.2.2.4 Infiltration of Surface Water

Estimated infiltration of surface water (seepage) by source is provided in Figure A2.F.f-14 and Table A2.F.f-12. Seepage from the Rivers and Streams System includes seepage of both Chowchilla Bypass flows and of precipitation runoff. The total infiltration of surface water exhibits substantial variability over time, similar to the annual variability of surface water inflows. Seepage particularly increases during times when the Chowchilla Bypass exceeds the capacity of its pilot channel and fills the entire bypass, such as in 2006 and 2011.

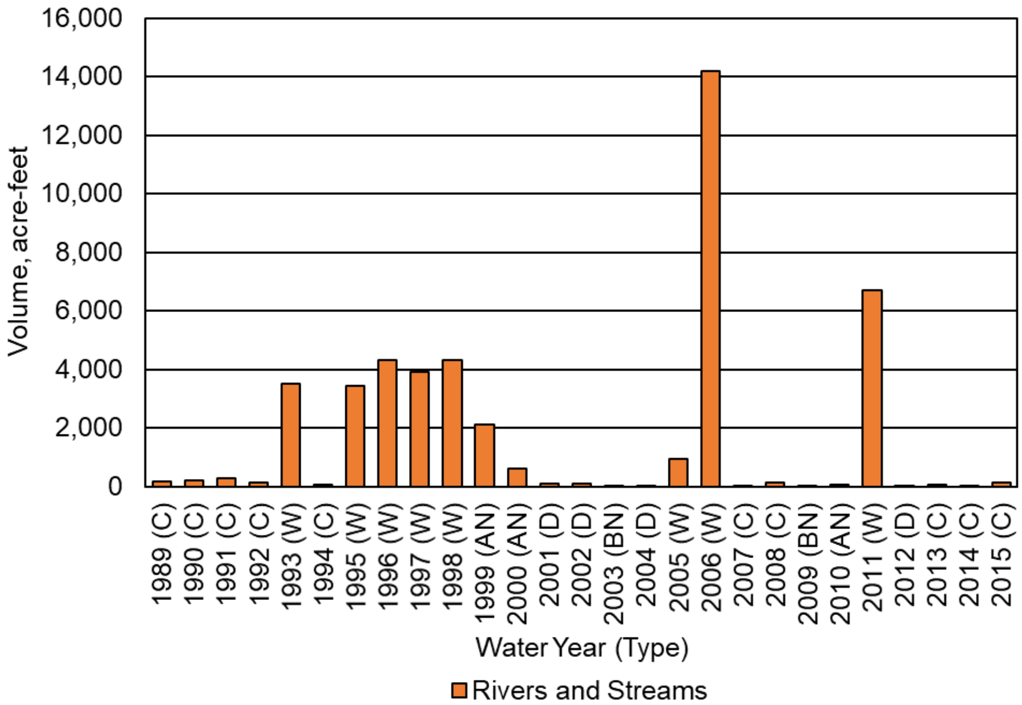

Figure A2.F.f-14. New Stone Water District GSA Infiltration of Surface Water.

Table A2.F.f-12. New Stone Water District GSA Infiltration of Surface Water (Acre-Feet).

Water Year (Type)	Rivers and Streams[1]
1989 (C)	155
1990 (C)	195
1991 (C)	262
1992 (C)	121
1993 (W)	3,507
1994 (C)	65
1995 (W)	3,427
1996 (W)	4,313
1997 (W)	3,916
1998 (W)	4,325
1999 (AN)	2,106
2000 (AN)	589
2001 (D)	89
2002 (D)	92
2003 (BN)	27
2004 (D)	13
2005 (W)	921
2006 (W)	14,204
2007 (C)	10
2008 (C)	114
2009 (BN)	24
2010 (AN)	56
2011 (W)	6,704

Water Year (Type)	Rivers and Streams[1]
2012 (D)	35
2013 (C)	38
2014 (C)	7
2015 (C)	119
Average (1989-2014)	1,743
Average (1989-2014) W	5,165
Average (1989-2014) AN	917
Average (1989-2014) BN	26
Average (1989-2014) D	57
Average (1989-2014) C	107

[1] Includes infiltration of surface inflows and of precipitation runoff.

3.2.2.5 Infiltration of Applied Water

Estimated infiltration of applied water (deep percolation of applied water) by water use sector is provided in Figure A2.F.f-15 and Table A2.F.f-13. During all years, infiltration of applied water was dominated by agricultural irrigation, which generally decreased from the late-1990s through 2014 following changes in cropping from pasture and alfalfa to grapes. Between 1989 and 2014, agricultural applied water provided an average of approximately 3.2 taf per year to the groundwater system.

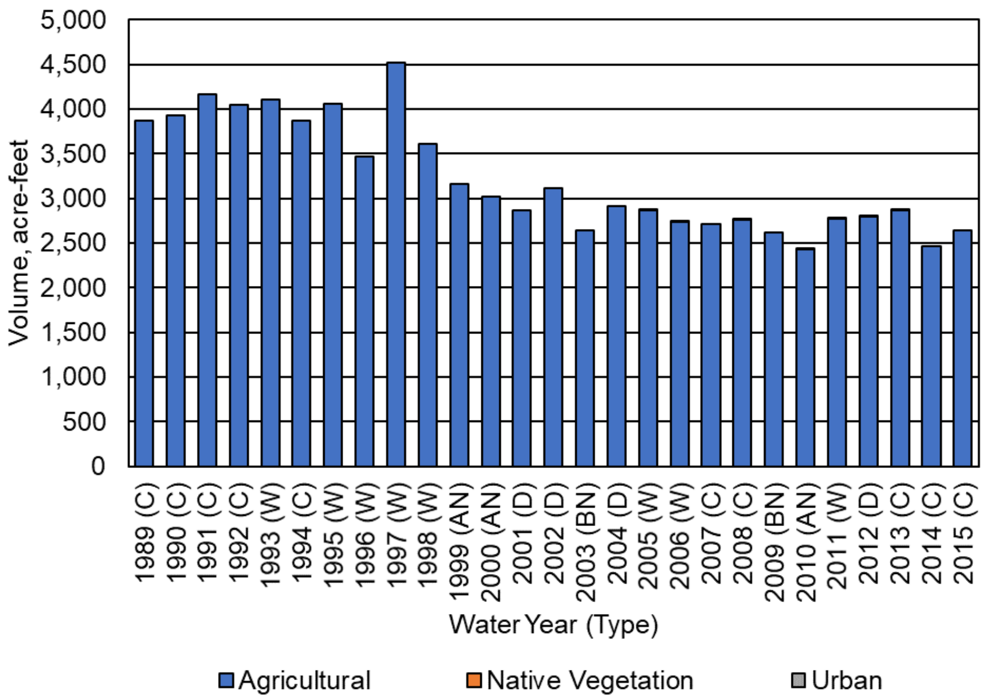

Figure A2.F.f-15. New Stone Water District GSA Infiltration of Applied Water by Water Use Sector.

Table A2.F.f-13. New Stone Water District GSA Infiltration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	3,868	0	0	3,868
1990 (C)	3,929	0	0	3,929
1991 (C)	4,159	0	0	4,159
1992 (C)	4,044	0	0	4,044
1993 (W)	4,100	0	0	4,100
1994 (C)	3,874	0	0	3,874
1995 (W)	4,060	0	0	4,060
1996 (W)	3,465	0	0	3,465
1997 (W)	4,525	0	0	4,525
1998 (W)	3,611	0	0	3,611
1999 (AN)	3,161	0	0	3,161
2000 (AN)	3,016	0	0	3,016
2001 (D)	2,867	0	0	2,867
2002 (D)	3,119	0	0	3,119
2003 (BN)	2,639	0	0	2,639
2004 (D)	2,909	0	0	2,909
2005 (W)	2,861	0	1	2,862
2006 (W)	2,735	0	2	2,737
2007 (C)	2,707	0	0	2,707
2008 (C)	2,762	0	1	2,763
2009 (BN)	2,619	0	0	2,619
2010 (AN)	2,427	0	5	2,432
2011 (W)	2,773	0	7	2,780
2012 (D)	2,790	0	8	2,798
2013 (C)	2,863	0	1	2,864
2014 (C)	2,466	0	0	2,466
2015 (C)	2,641	0	0	2,641
Average (1989-2014)	3,244	0	1	3,245
Average (1989-2014) W	3,516	0	1	3,518
Average (1989-2014) AN	2,868	0	2	2,870
Average (1989-2014) BN	2,629	0	0	2,629
Average (1989-2014) D	2,921	0	2	2,923
Average (1989-2014) C	3,408	0	0	3,408

3.2.3 Change in Surface Water System Storage

Estimates of change in SWS storage are provided in Figure A2.F.f-16 and Table A2.F.f-14. Inter-annual changes in storage within the surface water system consist primarily of root zone soil moisture storage changes, are relatively small, and tend to average near zero over many years.

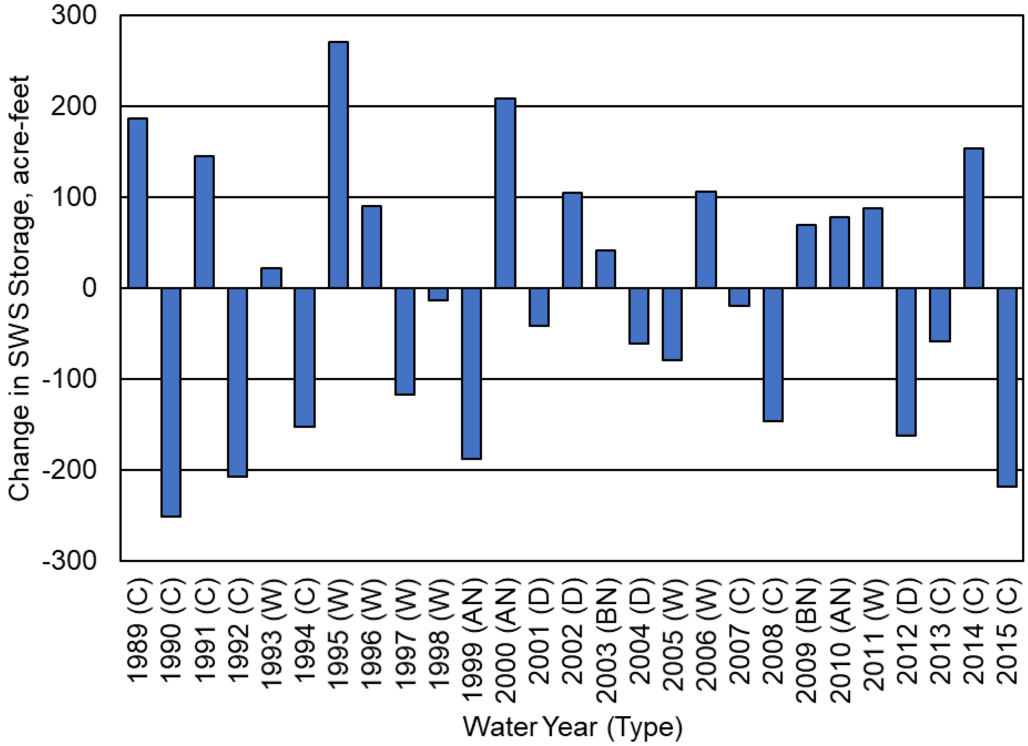

Figure A2.F.f-16. New Stone Water District GSA Change in Surface Water System Storage.

Table A2.F.f-14. New Stone Water District GSA Change in Surface Water System Storage (Acre-Feet).

Water Year (Type)	Change in SWS Storage
1989 (C)	186
1990 (C)	-252
1991 (C)	145
1992 (C)	-208
1993 (W)	22
1994 (C)	-153
1995 (W)	270
1996 (W)	90
1997 (W)	-117
1998 (W)	-14
1999 (AN)	-188
2000 (AN)	208
2001 (D)	-42
2002 (D)	104
2003 (BN)	41
2004 (D)	-61
2005 (W)	-80
2006 (W)	106
2007 (C)	-20
2008 (C)	-146
2009 (BN)	69

Water Year (Type)	Change in SWS Storage
2010 (AN)	78
2011 (W)	88
2012 (D)	-163
2013 (C)	-59
2014 (C)	153
2015 (C)	-219
Average (1989-2014)	2
Average (1989-2014) W	46
Average (1989-2014) AN	33
Average (1989-2014) BN	55
Average (1989-2014) D	-41
Average (1989-2014) C	-39

3.3 Historical Water Budget Summary

Annual inflows, outflows, and change in SWS storage in the surface water system during the historical water budget period (1989-2014) are summarized in Figure A2.F.f-17 and Table A2.F.f-15. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values. During wet years, boundary surface inflow and outflow volumes are substantially higher than other components. Figure A2.F.f-17 thus only shows the difference between the surface inflows and surface outflows after seepage and evaporation are accounted within NSWD GSA. Review of the variability in component volumes across years provides insight into the impacts of hydrology on the surface water system water budget.

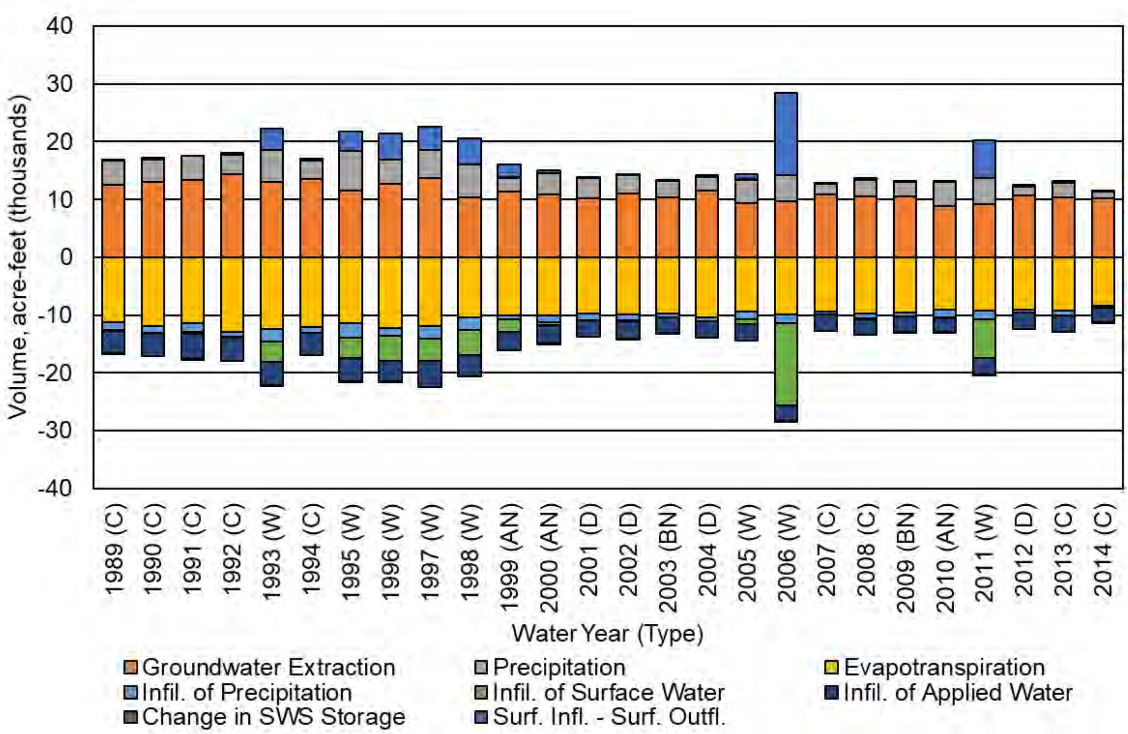

Figure A2.F.f-17. New Stone Water District GSA Surface Water System Historical Water Budget, 1989-2014.

Table A2.F.f-15. New Stone Water District GSA Surface Water System Historical Water Budget, 1989-2014 (Acre-Feet).

Water Year (Type)	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Evapo-transpiration[1]	Infil. of Precipitation	Infil. of Surface Water	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	0	12,591	4,169	-11,181	-1,371	-155	-3,868	0	-186
1990 (C)	0	12,980	3,884	-11,814	-1,179	-195	-3,929	0	252
1991 (C)	0	13,455	4,058	-11,337	-1,611	-262	-4,159	0	-145
1992 (C)	0	14,432	3,317	-12,818	-975	-121	-4,044	0	208
1993 (W)	578,875	12,984	5,624	-12,448	-2,097	-3,507	-4,100	-575,310	-22
1994 (C)	0	13,598	3,186	-12,093	-906	-65	-3,874	1	153
1995 (W)	579,464	11,617	6,839	-11,456	-2,459	-3,427	-4,060	-576,248	-270
1996 (W)	597,233	12,713	4,178	-12,215	-1,362	-4,313	-3,465	-592,679	-90
1997 (W)	549,449	13,718	4,776	-11,979	-2,103	-3,916	-4,525	-545,538	117
1998 (W)	526,604	10,363	5,740	-10,331	-2,314	-4,325	-3,611	-522,140	14
1999 (AN)	113,200	11,341	2,328	-10,013	-744	-2,106	-3,161	-111,033	188
2000 (AN)	5,146	10,801	3,796	-10,063	-1,146	-589	-3,016	-4,721	-208
2001 (D)	0	10,202	3,540	-9,711	-1,118	-89	-2,867	0	42
2002 (D)	0	11,043	3,214	-9,906	-1,037	-92	-3,119	0	-104
2003 (BN)	0	10,315	2,822	-9,639	-791	-27	-2,639	0	-41
2004 (D)	0	11,572	2,344	-10,387	-668	-13	-2,909	0	61
2005 (W)	246,647	9,388	4,044	-9,455	-1,220	-921	-2,862	-245,701	80
2006 (W)	864,794	9,780	4,461	-9,828	-1,558	-14,204	-2,737	-850,602	-106
2007 (C)	0	10,845	1,804	-9,425	-527	-10	-2,707	0	20
2008 (C)	0	10,588	2,740	-9,780	-817	-114	-2,763	0	146
2009 (BN)	0	10,502	2,476	-9,606	-660	-24	-2,619	0	-69
2010 (AN)	0	8,781	4,256	-9,068	-1,404	-56	-2,432	0	-78
2011 (W)	785,848	9,187	4,452	-9,151	-1,581	-6,704	-2,780	-779,184	-88
2012 (D)	0	10,711	1,516	-9,071	-487	-35	-2,798	0	163
2013 (C)	0	10,361	2,562	-9,280	-800	-38	-2,864	0	59
2014 (C)	0	10,143	1,250	-8,398	-369	-7	-2,466	0	-153
Average (1989-2014)	186,433	11,308	3,591	-10,402	-1,204	-1,743	-3,245	-184,737	-2
Average (1989-2014) W	591,114	11,219	5,014	-10,858	-1,837	-5,165	-3,518	-585,925	-46
Average (1989-2014) AN	39,448	10,308	3,460	-9,714	-1,098	-917	-2,870	-38,585	-33
Average (1989-2014) BN	0	10,409	2,649	-9,623	-726	-26	-2,629	0	-55
Average (1989-2014) D	0	10,882	2,654	-9,768	-828	-57	-2,923	0	41
Average (1989-2014) C	0	12,110	2,997	-10,681	-951	-107	-3,408	0	39

[1]Includes ET of applied water, ET of precipitation, and evaporation from rivers and streams.

3.4 Current Water Budget Summary

The current water budget was developed following a similar process to the historical water budget using the 2015 land use in Table 1 and the same 1989-2014 average hydrologic conditions of the historical base period, including surface water flows, precipitation, and weather parameters. This allowed quantification of groundwater inflows and outflows for current consumptive use in the context of average water supply conditions.

Annual inflows, outflows, and change in SWS storage from the current water budget are summarized in Figure A2.F.f-18 and Table A2.F.f-16. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values. Similar to Figure A2.F.f-17, Figure A2.F.f-18 only shows the difference between the surface inflows and surface outflows after seepage and evaporation are accounted within NSWD GSA.

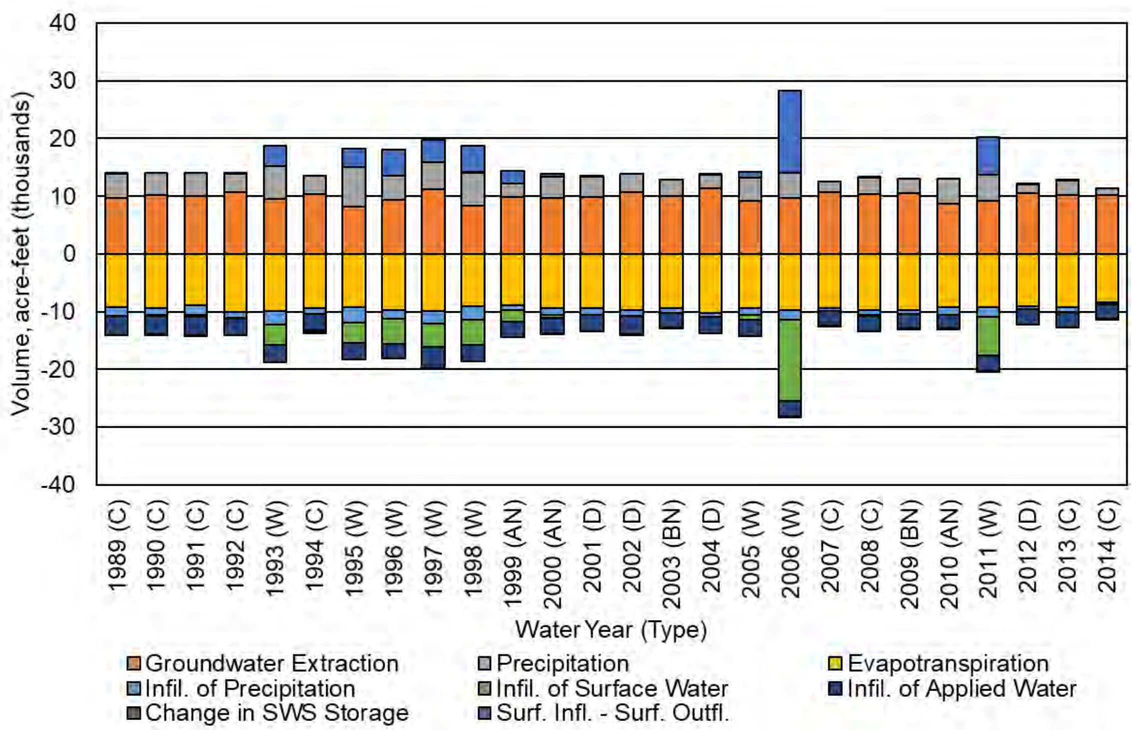

Figure A2.F.f-18. New Stone Water District GSA Surface Water System Current Water Budget, 1989-2014.

Table A2.F.f-16. New Stone Water District GSA Surface Water System Current Water Budget, 1989-2014 (Acre-Feet).

Water Year (Type)	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Evapo-transpiration[1]	Infil. of Precipitation	Infil. of Surface Water	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	0	9,671	4,168	-9,167	-1,488	-140	-3,228	0	184
1990 (C)	0	10,144	3,886	-9,330	-1,268	-199	-3,039	0	-194
1991 (C)	0	10,076	4,060	-8,806	-1,792	-293	-3,210	0	-34
1992 (C)	0	10,624	3,318	-9,998	-1,028	-141	-2,926	0	151
1993 (W)	578,875	9,603	5,621	-9,945	-2,272	-3,512	-3,075	-575,334	38
1994 (C)	0	10,311	3,185	-9,403	-960	-64	-2,859	0	-210
1995 (W)	579,464	8,180	6,838	-9,149	-2,770	-3,426	-2,916	-576,294	73
1996 (W)	597,233	9,382	4,179	-9,785	-1,476	-4,320	-2,527	-592,690	4
1997 (W)	549,449	11,161	4,775	-9,924	-2,198	-3,924	-3,692	-545,577	-70
1998 (W)	526,604	8,373	5,740	-9,033	-2,440	-4,338	-2,857	-522,159	110
1999 (AN)	113,200	9,841	2,328	-8,918	-742	-2,106	-2,685	-111,034	117
2000 (AN)	5,146	9,625	3,795	-9,325	-1,176	-609	-2,658	-4,728	-70
2001 (D)	0	9,837	3,541	-9,401	-1,119	-110	-2,755	0	6
2002 (D)	0	10,723	3,213	-9,662	-1,038	-107	-3,035	0	-94
2003 (BN)	0	9,991	2,823	-9,434	-775	-32	-2,530	0	-43
2004 (D)	0	11,291	2,345	-10,214	-654	-15	-2,814	0	60
2005 (W)	246,647	9,164	4,046	-9,344	-1,198	-925	-2,759	-245,702	70
2006 (W)	864,794	9,648	4,457	-9,751	-1,567	-14,208	-2,671	-850,603	-99
2007 (C)	0	10,663	1,805	-9,358	-499	-8	-2,588	0	-16
2008 (C)	0	10,405	2,743	-9,781	-788	-109	-2,643	0	173
2009 (BN)	0	10,492	2,478	-9,689	-640	-19	-2,533	0	-89
2010 (AN)	0	8,720	4,255	-9,152	-1,389	-42	-2,344	0	-48
2011 (W)	785,848	9,190	4,454	-9,264	-1,554	-6,693	-2,691	-779,174	-116
2012 (D)	0	10,538	1,516	-9,097	-460	-30	-2,640	0	173
2013 (C)	0	10,173	2,562	-9,264	-766	-32	-2,747	0	74
2014 (C)	0	10,123	1,251	-8,423	-361	-6	-2,428	0	-155
Average (1989-2014)	186,433	9,921	3,592	-9,408	-1,247	-1,746	-2,802	-184,742	0
Average (1989-2014) W	591,114	9,338	5,014	-9,524	-1,934	-5,168	-2,898	-585,942	1
Average (1989-2014) AN	39,448	9,395	3,460	-9,131	-1,103	-919	-2,562	-38,587	-1
Average (1989-2014) BN	0	10,241	2,650	-9,562	-707	-25	-2,532	0	-66
Average (1989-2014) D	0	10,597	2,654	-9,593	-818	-66	-2,811	0	36
Average (1989-2014) C	0	10,243	2,998	-9,281	-994	-110	-2,852	0	-3

[1]Includes ET of applied water, ET of precipitation, and evaporation from rivers and streams.

3.5 Net Recharge from SWS

Overdraft is defined in DWR Bulletin 118 as “the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions” (DWR 2003). The Madera Subbasin water budget indicates that overdraft conditions occurred during the 1989-2014 historical base period. Per 23 CCR Section 354.18(b)(5), the subbasin overdraft has been quantified for this base period. The evaluation of overdraft conditions includes estimates of recharge from subsurface flows. However, estimates of recharge from subsurface flows are less accurate when estimated for areas less that an entire subbasin. Thus, for estimates of GSA level contribution to overdraft, the term net recharge from the SWS is defined as groundwater recharge minus groundwater extraction. Net recharge from the SWS is useful for understanding and analyzing the combined effects of land surface processes on the underlying GWS.

When calculated from the historical water budget, average net recharge from the SWS represents the average recharge (when positive) or shortage of recharge (when negative) based on historical cropping, land use practices, and average hydrologic conditions. When calculated from the current land use water budget, average net recharge represents the average recharge or shortage (negative net recharge) based on current cropping, land use practices, and average hydrologic conditions.

Average net recharge from the SWS is presented below for the NSWD GSA portion of the Madera Subbasin. Table A2.F.f-17 shows the average net recharge from the SWS for 1989-2014 based on the historical water budget, and Table A2.F.f-18 shows the same for the current water budget. Under current and historical land use conditions, average annual shortage from NSWD GSA is approximately 4 to 5 taf.

Table A2.F.f-17. Historical Water Budget: Average Net Recharge from SWS by Water Year Type, 1989-2014 (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	3,518	1,837	5,165	11,219	-700
AN	3	2,870	1,098	917	10,308	-5,423
BN	2	2,629	726	26	10,409	-7,028
D	4	2,923	828	57	10,882	-7,074
C	9	3,408	951	107	12,110	-7,644
Annual Average (1989-2014)	26	3,245	1,204	1,743	11,308	-5,116

Table A2.F.f-18. Current Water Budget: Average Net Recharge from SWS by Water Year Type (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	2,898	1,934	5,168	9,338	663
AN	3	2,562	1,103	919	9,395	-4,812
BN	2	2,532	707	25	10,241	-6,977
D	4	2,811	818	66	10,597	-6,903
C	9	2,852	994	110	10,243	-6,287
Annual Average (1989-2014)	26	2,802	1,247	1,746	9,921	-4,126

3.6 Uncertainties in Water Budget Components

Uncertainties associated with each water budget component were estimated as a percentage representing approximately a 95% confidence interval following the procedure described by Clemmens and Burt (1997). Uncertainties for all independently measured or estimated water budget components were estimated based on the measurement accuracy, typical values reported in technical literature, typical values calculated in other water budgets, and professional judgement.

Table A2.F.f-19 provides a summary of typical uncertainty values associated with major SWS inflow and outflow components. These uncertainties provide a basis for evaluating confidence in water budget results and help to identify data needs that may be addressed during GSP implementation.

Table A2.F.f-19. Estimated Uncertainty of GSA Water Budget Components.

Flowpath Direction (SWS Boundary)	Water Budget Component	Data Source	Estimated Uncertainty (%)	Source
Inflows	Surface Water Inflows	Calculation	20%	Estimated streamflow measurement accuracy and adjustment for losses.
	Precipitation	Calculation	30%	Clemmens, A.J. and C.M. Burt, 1997.
	Groundwater Extraction	Closure	20%	Typical uncertainty calculated for Land Surface System water balance closure.
Outflows	Surface Water Outflows	Closure	20%	Typical uncertainty calculated for Rivers and Streams System water balance closure.
	Evaporation	Calculation	20%	Estimated accuracy of calculation based on CIMIS reference ET and free water surface evaporation coefficient.
	ET of Applied Water	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, estimated crop coefficients from SEBAL energy balance, and annual land use.
	ET of Precipitation	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, precipitation, estimated crop coefficients from SEBAL energy balance, and annual land use.
	Infiltration of Applied Water	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use and NRCS soils characteristics.
	Infiltration of Precipitation	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use, NRCS soils characteristics, and CIMIS precipitation.
	Infiltration of Surface Water	Calculation	15%	Estimated accuracy of daily seepage calculation using NRCS soils characteristics and measured streamflow data.
	Change in SWS Storage	Calculation	50%	Professional Judgment.
Net Recharge from SWS		Calculation	25%	Estimated water budget accuracy; typical value calculated for GSA-level net recharge from SWS.

3.7 Comparison of Historical Water Budget with NSWD GSA Individual GSP

NSWD GSA is among the three GSAs that are each separately satisfying the requirements of SGMA by preparing individual GSPs. These individual GSPs have been prepared separately from this joint plan. A coordination agreement is being developed by all seven GSAs in the Madera Subbasin detailing required GSA and GSP cooperation and coordination.

To maintain consistent estimates of subbasin groundwater storage and overdraft conditions between the joint and individual GSPs, comparisons of historical surface water-groundwater exchanges have been prepared between the GSA-level historical water budgets from this coordinated plan and the historical water budgets from each of the three individual GSPs.

Table A2.F.f-20 provides a comparison between the NSWD GSA historical water budget developed as part of this coordinated plan and the NSWD GSA historical water budget developed by the District for its individual GSP. During the historical water budget period of 2003-2012, all flow paths compared between the two water budgets were within 1,000 AF/yr with the exception of estimated non-recoverable losses from precipitation. Whereas the individual GSP water budget assumed precipitation runoff to be a non-recoverable loss, the coordinated GSP water budget assumed that much of this would provide recharge in local streams and rivers via infiltration. The net recharge from SWS within the District was estimated to be approximately -6,100 AF/yr and -4,300 AF/yr, as calculated for the NSWD GSA individual GSP and this coordinated GSP, respectively. This translates to a difference of less than 2,000 AF/yr, indicating fairly close correspondence between the plans, particularly in the context of the estimated -103,000 AF/yr total net recharge from SWS across the entire subbasin.

Table A2.F.f-20. Comparison of Historical Water Budget Results between NSWD GSA Individual GSP and Joint GSP, 2003-2012.

New Stone Water District

Historical Water Budget - Average Annual Values

Period of Record: 2003-2012

	NSWD GSA, Individual GSP			NSWD GSA, Joint GSP					
	Estim. Irrig. Eff.	81%		Summary from WY 2003-2012, rounded to nearest 10 acre-feet					
Flow Path*	**Symbol**	**Volume (AF/yr)**	**Source**	**Volume (AF/yr)**	**Estimated Uncertainty (%)**	**Volume, Lower Estimate Bound (AF/yr)**	**Volume, Upper Estimate Bound (AF/yr)**	**Difference (Coordinated - Individual)**	**Coordinated GSP Source**
Supply									
Groundwater Pumping - Irrigation (Private Wells)	Gwirrp	9,700	Residual	10,160	20%	8,100	12,200	460	Residual
Groundwater Pumping - M&I (Private Wells)	Gwmip	0	Calculated	10	20%	0	100	10	Residual
Precipitation	P	3,300	Measured	3,090	30%	2,100	4,100	-210	Measured (Madera CIMIS)
Total Supply		**13,000**		**13,260**				**260**	
Demand									
Consumptive Use									
Evapotranspiration - Applied Water	ETc	7,900	Calculated	7,390	10%	6,600	8,200	-510	Calculated (IDC)
Evapotranspiration - Effective Precipitation	ETp	1,600	Calculated	2,090	10%	1,800	2,300	490	Calculated (IDC)
Evapotranspiration - M&I	ETmi	0	Calculated	10	10%	0	100	10	Calculated (IDC)
Consumptive Use Subtotal		**9,500**		**9,490**				**-10**	
Groundwater Recharge									
Deep Percolation - Irrigation	PRCirr	1,800	Calculated	2,720	20%	2,100	3,300	920	Calculated (IDC)
Deep Percolation - Precipitation	PRCp	200	Calculated	970	20%	700	1,200	770	Calculated (IDC)
Local Streams/Rivers - Recharge	Rst	1,600	Calculated	2,210	15%	1,800	2,600	610	Calculated (seepage of Chowchilla Bypass, runoff)
Groundwater Recharge Subtotal		**3,600**		**5,900**				**2,300**	
Nonrecoverable Losses									
Precipitation - Evaporation and Runoff	Ep	1,500	Residual	60	20%	0	100	-1,440	Calculated (evaporation of Chowchilla Bypass, runoff)
Nonrecoverable Subtotal		**1,500**		**60**				**-1,440**	
Net Recharge from SWS**		**-6,100**	Calculated	**-4,270**	25%	-3,200	-5,400	**1,830**	

***List excludes subsurface groundwater inflows/outflows and flow paths with zero volume.**

****Calculated as the sum of groundwater recharge minus the sum of groundwater pumping; excludes subsurface groundwater inflows/outflows.**

APPENDIX 2.F. WATER BUDGET INFORMATION

2.F.g. Surface Water System Water Budget: Root Creek Water District GSA

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

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1 INTRODUCTION

To ensure sustainable groundwater management throughout California's groundwater basins, the Sustainable Groundwater Management Act of 2014 (SGMA) requires Groundwater Sustainability Agencies (GSAs) to prepare and adopt Groundwater Sustainability Plans (GSPs) with strategies to achieve subbasin groundwater sustainability within 20 years of plan adoption. Integral to each GSP is a water budget used to quantify the subbasin's groundwater overdraft (if applicable) and sustainable yield.

In 2017, Root Creek Water District (RCWD) GSA formed to manage approximately 9,300 acres of the Madera Subbasin. This document presents results of the surface water system (SWS) water budgets developed for historical and current land use conditions in RCWD GSA. The RCWD GSA water budgets were integrated with separate water budgets developed for the other six (6) GSAs in Madera Subbasin to prepare a boundary water budget for the Madera Subbasin SWS. Results of the subbasin boundary water budget are reported in the Madera Subbasin GSP Section 2.2.3 and were integrated with a subbasin groundwater model (GSP Appendix 6.D) to estimate subbasin sustainable yield (GSP Section 2.2.3).

2 WATER BUDGET CONCEPTUAL MODEL

A water budget is defined as a complete accounting of all water flowing into and out of a defined volume (e.g., a subbasin or a GSA) over a specified period of time. The conceptual model (or structure) of the RCWD GSA water budget developed for this investigation is consistent with the GSP Regulations defined under Title 23 of California Code of Regulations[1] (CCR) and adheres to sound water budget principles and practices defined by California Department of Water Resources (DWR) in the Water Budget Best Management Practice (BMP) guidelines (DWR, 2016).

The lateral extent of RCWD GSA is defined by the boundaries indicated in Figure A2.F.g-1. The vertical extent of RCWD GSA are the land surface (top) and the base of fresh water at the bottom of the basin (bottom), as described in the hydrogeologic conceptual model (HCM) developed in GSP Section 2.2.1. The vertical extent of Madera Subbasin and its GSAs is subdivided into a surface water system (SWS) and the underlying groundwater system (GWS), with separate but related water budgets prepared for each that together represent the overall subbasin water budget.

A conceptual representation of the RCWD GSA water budget is represented in Figure A2.F.g-2. This document details only the SWS portion of the RCWD GSA water budget. The SWS is divided into two primary accounting centers: the Land Surface System and the Rivers and Streams System. The Land Surface System is further divided into three accounting centers representing RCWD GSA's water use sectors: Agricultural Land, Native Vegetation Land, and Urban Land (urban, industrial, and semi-agricultural).

Water budget components, or directional flow of water between accounting centers and across the SWS boundary, are indicated by arrows. Inflows and outflows were calculated using measurements and other historical data or were calculated as the water budget closure term – the difference between all other estimated or measured inflows and outflows from each accounting center or water use sector (bold arrows).

[1] California Code of Regulations Title 23. Waters, Division 2. Department of Water Resources, Chapter 1.5. Groundwater Management, Subchapter 2. Groundwater Sustainability Plans.

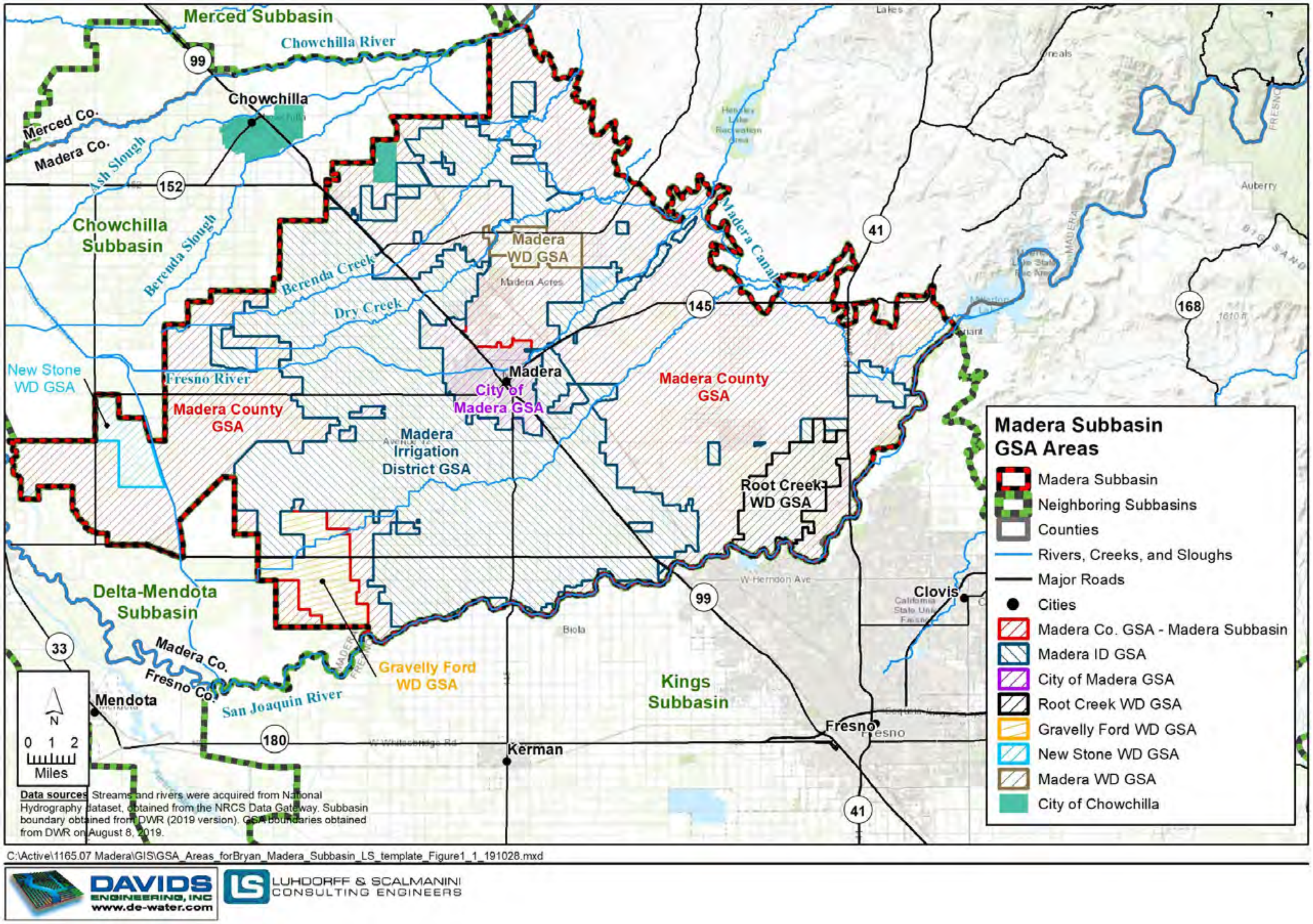

Figure A2.F.g-1. Madera Subbasin GSAs Map.

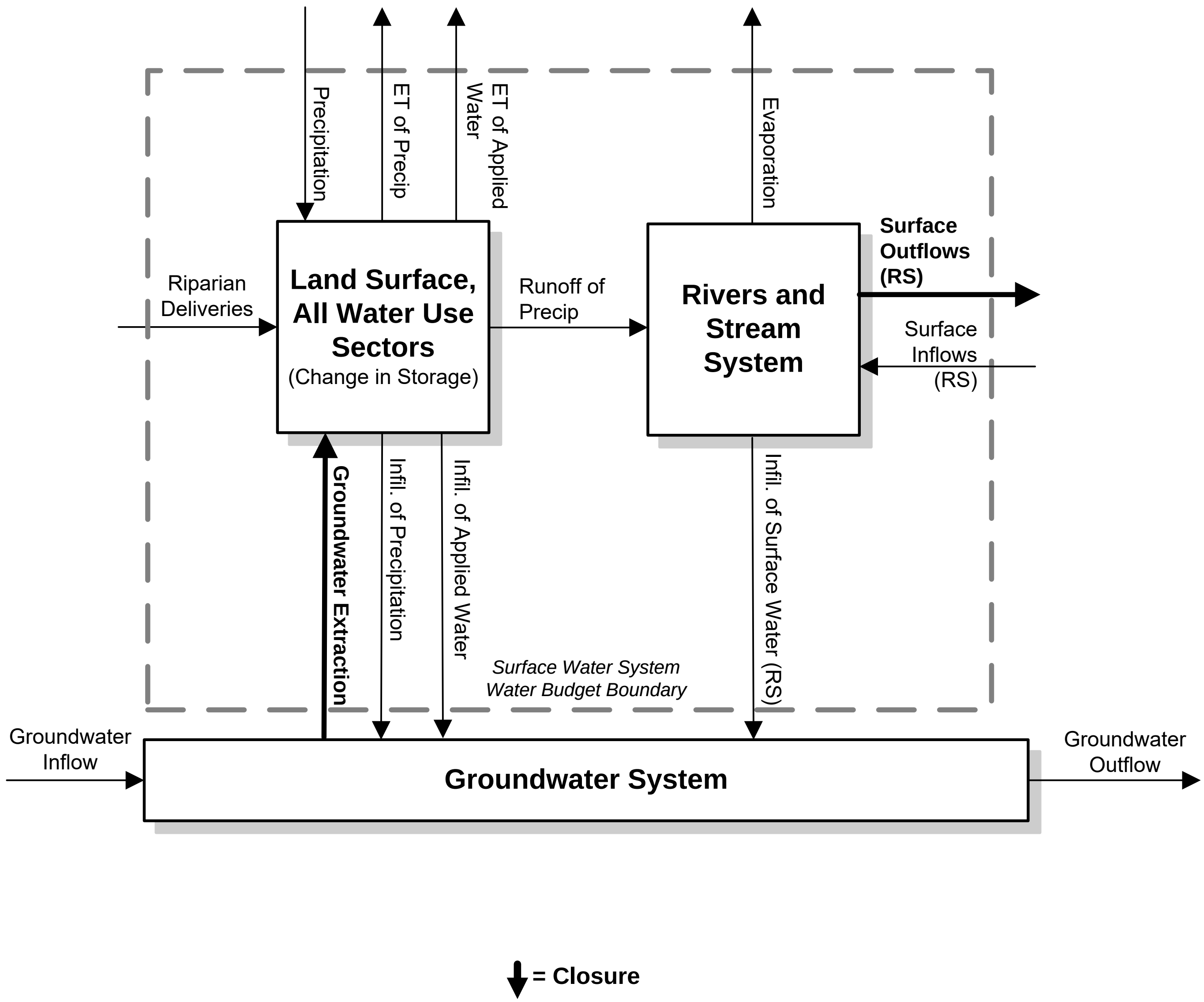

Figure A2.F.g-2. Root Creek Water District GSA Water Budget Structure.

Inflows to the SWS include precipitation, surface water inflows (in various canals and streams), and groundwater extraction. Outflows from the SWS include evapotranspiration (ET), surface water outflows (in various canals and streams), and infiltration to the groundwater system (seepage and deep percolation). Also represented in Figure A2.F.g-2 are inflows and outflows from the GWS, which are discussed and quantified at the subbasin level in the GWS water budget in GSP Section 2.2.3. Subsurface GWS inflows and outflows are not quantified on the water budget subregion scale.

Inflows and outflows were quantified following the process described in GSP Section 2.2.3 on a monthly time step for water years in the historical water budget base period (1989-2014 hydrologic and land use conditions), the current water budget (2015 land use using 1989-2014 average hydrologic conditions), and projected water budget. Four projected water budgets were prepared for the years 2019 through 2090 based on 1965 through 2015 hydrologic conditions:

1. Historical hydrologic conditions
    a. Without projects and management actions, and
    b. With projects and management actions
2. adjusted for anticipated climate change per DWR-provided 2030 climate change factors.

3 WATER BUDGET ANALYSIS

The historical water budget and current land use water budget for RCWD GSA are presented below following a summary of land use data relevant to water budget development. Land use data is provided for the 1989-2014 historical water budget period and for 2015, the land use period used for current water budget development.

3.1 Land Use

Land use estimates for 1989-2015 corresponding to water use sectors are summarized in Figure A2.F.g-3 and Table A2.F.g-1 for RCWD GSA. According to GSP Regulations (23 CCR § 351(al)):

> *"Water use sector" refers to 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.*

In RCWD GSA, water use sectors include agricultural, native vegetation, and urban land use. The urban land use category includes urban and semi-agricultural[2] lands as well as industrial land, which covers only a small area in the subbasin.

The distribution of land between water use sectors remained relatively stable on average between 1989 and 2011. Since 2011, agricultural lands and urban lands in RCWD GSA expanded slightly while native vegetation decreased in area.

Agricultural land uses are further detailed in Figure A2.F.g-4 and Table A2.F.g-2. Between 1989 and 2011, agriculture in RCWD GSA has been dominated by orchard, citrus, and subtropical fruit tree crops. Since 2011, citrus and subtropical crops have decreased while orchard crops have expanded.

[2] As defined in the DWR county land use surveys, semi-agricultural land use subclasses include farmsteads, livestock feed lot operations, dairies, poultry farms, and miscellaneous semi-agricultural land use incidental to agriculture (small roads, ditches, non-planted areas of cropped fields (DWR, 2009).

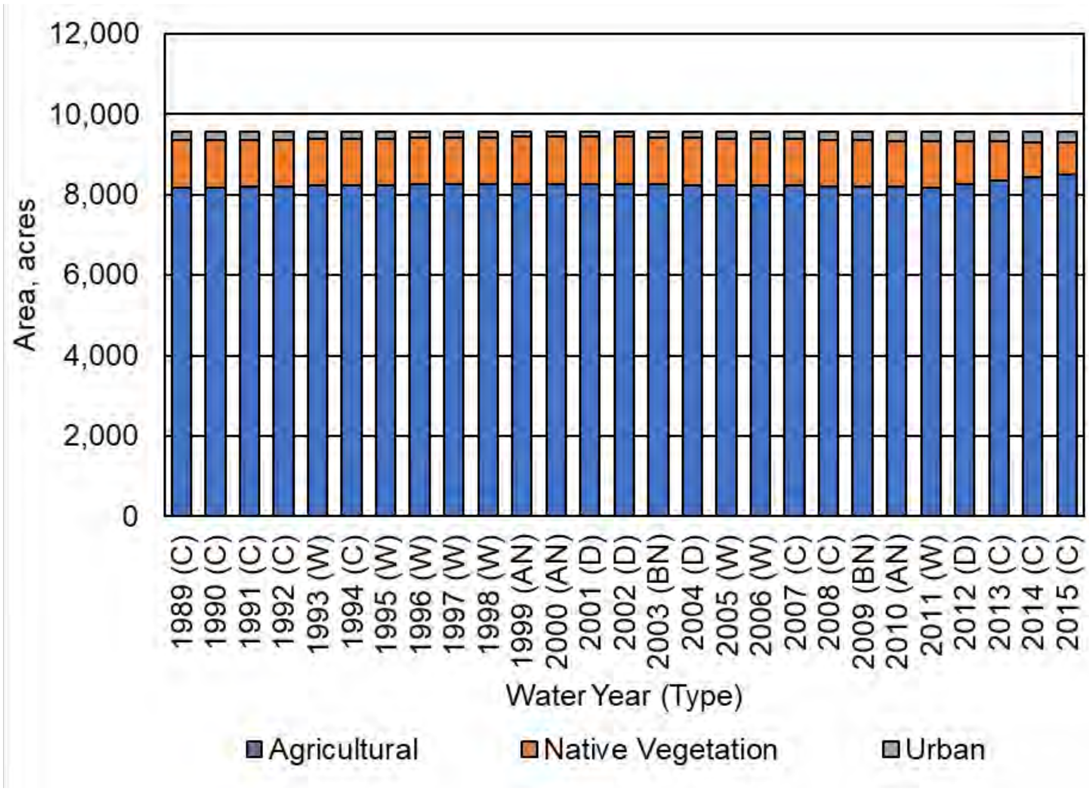

Figure A2.F.g-3. Root Creek Water District GSA Land Use Areas.

Table A2.F.g-1. Root Creek Water District GSA Land Use Areas (Acres).

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
1989 (C)	8,157	1,190	202	9,550
1990 (C)	8,173	1,181	196	9,550
1991 (C)	8,190	1,171	190	9,550
1992 (C)	8,206	1,161	182	9,550
1993 (W)	8,216	1,159	174	9,550
1994 (C)	8,226	1,158	166	9,550
1995 (W)	8,240	1,154	156	9,550
1996 (W)	8,245	1,158	147	9,550
1997 (W)	8,250	1,162	138	9,550
1998 (W)	8,255	1,166	129	9,550
1999 (AN)	8,260	1,171	120	9,550
2000 (AN)	8,265	1,175	110	9,550
2001 (D)	8,270	1,179	101	9,550
2002 (D)	8,260	1,176	114	9,550
2003 (BN)	8,251	1,173	127	9,550
2004 (D)	8,241	1,169	140	9,550
2005 (W)	8,231	1,166	153	9,550
2006 (W)	8,222	1,163	166	9,550

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
2007 (C)	8,212	1,160	178	9,550
2008 (C)	8,202	1,157	191	9,550
2009 (BN)	8,192	1,153	204	9,550
2010 (AN)	8,183	1,150	217	9,550
2011 (W)	8,173	1,147	230	9,550
2012 (D)	8,262	1,054	234	9,550
2013 (C)	8,351	961	238	9,550
2014 (C)	8,441	868	242	9,550
2015 (C)	8,499	795	256	9,550
Average (1989-2014)	8,237	1,142	171	9,550

[1] Area includes land classified as native vegetation and water surfaces.
[2] Area includes land classified as urban, industrial, and semi-agricultural.

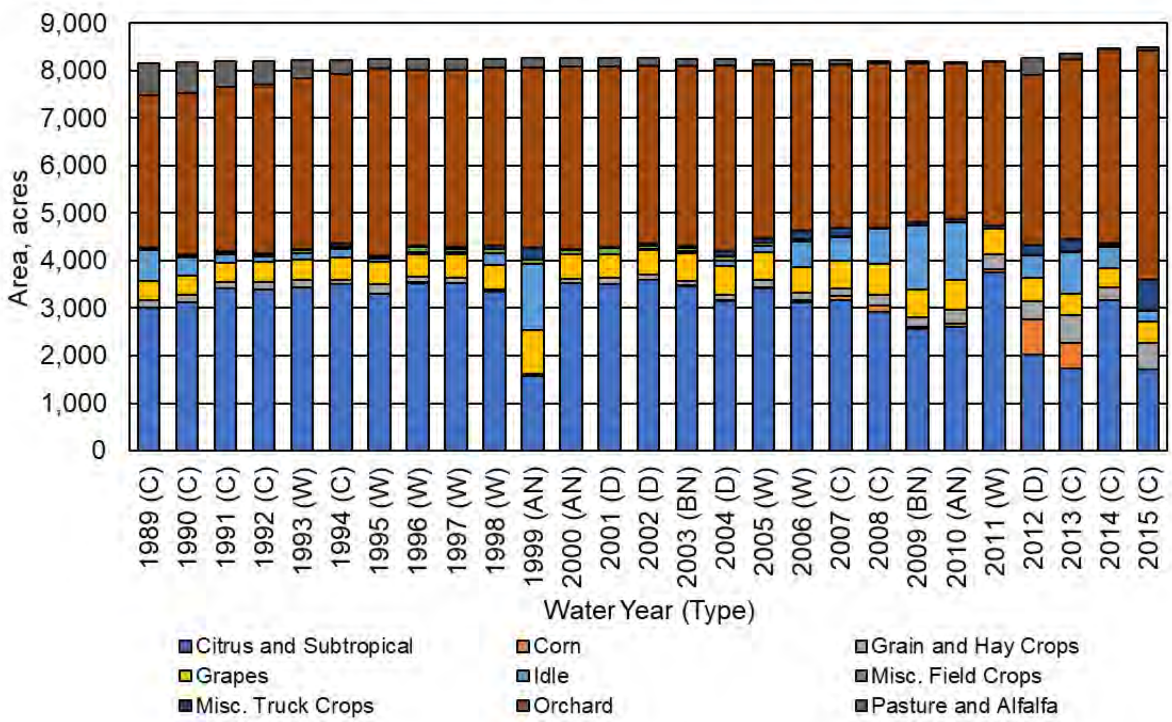

Figure A2.F.g-4. Root Creek Water District GSA Agricultural Land Use Areas.

Table A2.F.g-2. Root Creek Water District GSA Agricultural Land Use Areas (Acres).

Water Year (Type)	Citrus and Subtropical	Corn	Grain and Hay Crops	Grapes	Idle	Misc. Field Crops	Misc. Truck Crops	Orchard	Pasture and Alfalfa	Total
1989 (C)	3,020	0	152	391	656	44	5	3,219	670	8,157
1990 (C)	3,115	0	171	389	385	48	28	3,386	651	8,173
1991 (C)	3,407	0	136	401	185	55	13	3,458	534	8,190
1992 (C)	3,403	0	149	423	115	54	20	3,545	498	8,206
1993 (W)	3,437	0	148	432	146	55	26	3,603	370	8,216
1994 (C)	3,510	0	94	457	176	54	61	3,588	286	8,226
1995 (W)	3,300	0	211	462	71	54	10	3,933	199	8,240
1996 (W)	3,527	16	114	481	36	110	24	3,708	227	8,245
1997 (W)	3,526	0	113	492	49	75	39	3,732	224	8,250
1998 (W)	3,339	0	65	497	264	78	69	3,752	191	8,255
1999 (AN)	1,583	0	27	938	1,387	80	247	3,813	185	8,260
2000 (AN)	3,522	0	85	517	1	97	19	3,845	178	8,265
2001 (D)	3,508	0	129	488	6	133	21	3,813	173	8,270
2002 (D)	3,594	7	100	529	9	84	27	3,754	156	8,260
2003 (BN)	3,467	18	95	565	50	81	48	3,787	139	8,251
2004 (D)	3,138	32	113	594	124	85	121	3,912	122	8,241
2005 (W)	3,415	27	158	569	147	69	83	3,659	105	8,231
2006 (W)	3,122	36	167	548	533	46	169	3,513	88	8,222
2007 (C)	3,179	88	159	584	490	28	170	3,444	71	8,212
2008 (C)	2,922	134	213	668	728	6	33	3,444	54	8,202
2009 (BN)	2,552	50	206	593	1,336	1	61	3,356	36	8,192
2010 (AN)	2,601	63	309	625	1,208	5	68	3,285	19	8,183
2011 (W)	3,749	61	334	534	0	0	71	3,422	2	8,173
2012 (D)	2,034	733	369	494	480	9	224	3,575	344	8,262
2013 (C)	1,736	534	589	454	875	6	246	3,815	97	8,351
2014 (C)	3,175	3	255	414	454	42	23	4,075	0	8,441
2015 (C)	1,702	0	557	467	223	1	654	4,811	85	8,499
Average (1989-2014)	3,111	69	179	521	381	54	74	3,632	216	8,237

3.2 Surface Water System Water Budget

This section presents surface water system water budget components within RCWD GSA as per GSP regulations. These are followed by a summary of the water budget results by accounting center.

3.2.1 Inflows

3.2.1.1 Surface Water Inflow by Water Source Type

Surface water inflows include surface water flowing into the basin across the basin boundary. Per the Regulations, surface inflows 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.*

Additionally, runoff of precipitation from upgradient areas adjacent to the subregion represents a potential source of surface water inflow.

Local Supplies

RCWD GSA receives local supplies in the form of riparian diversions to agricultural lands, including lands with holding contracts, from the San Joaquin River. Measured deliveries were available beginning in 2010. Prior to 2010, riparian deliveries were estimated as the average monthly deliveries of years with available data.

Local Imported Supplies

RCWD GSA does not receive local imported supplies for irrigation purposes.

CVP Supplies

Between 1989 and 2014, RCWD GSA did not receive CVP supplies for irrigation purposes.

Recycling and Reuse

Recycling and reuse are not a significant source of supply within RCWD GSA.

Other Surface Inflows

For the water budgets presented herein, precipitation runoff from outside the subregion is considered relatively minimal and is expected to pass through the waterways accounted above following relatively large storm events. Precipitation runoff from lands inside the subregion is internal to the surface water system and is thus not considered as surface inflows to the subregion boundary.

Summary of Surface Inflows

Surface water inflows are summarized by water source type in Figure A2.F.g-5 and Table A2.F.g-3. Between 1989 and 2014, the only surface water inflows to RCWD GSA were riparian deliveries from San Joaquin River directly to agricultural lands, averaging approximately 1.9 taf per year during this period. No CVP supplies or imported supplies were received by the district during this period, and no waterways are considered to transverse the boundaries of RCWD GSA. The San Joaquin River serves as part of the

RCWD GSA boundary and is thus not considered as surface inflow to the GSA, although boundary seepage from the San Joaquin River is considered in net recharge calculations below.

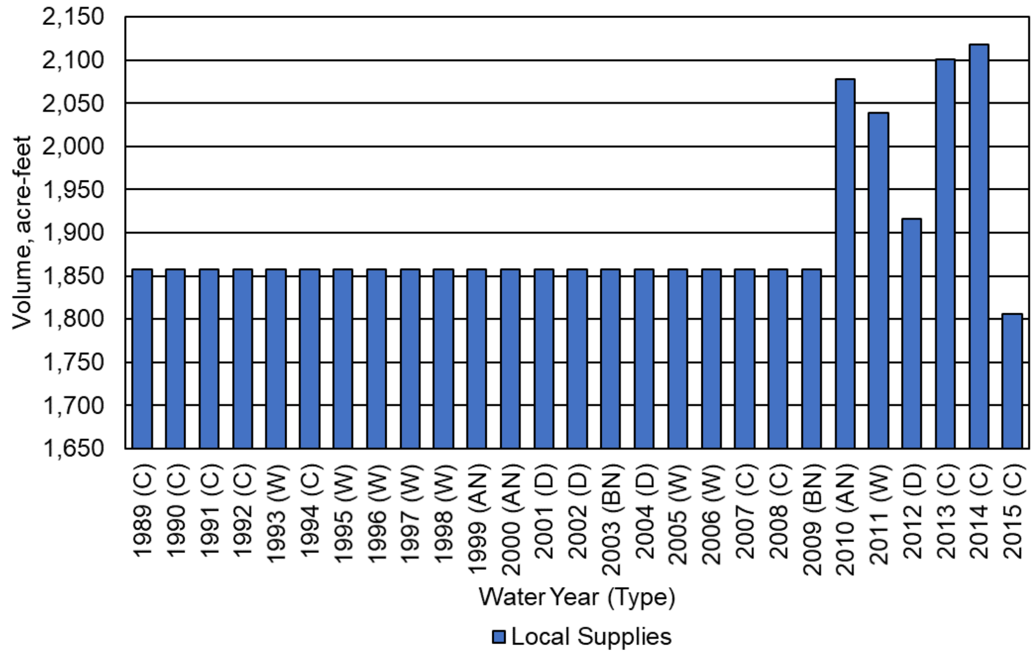

Figure A2.F.g-5. Root Creek Water District GSA Surface Water Inflows by Water Source Type.

Table A2.F.g-3. Root Creek Water District GSA Surface Water Inflows by Water Source Type (Acre-Feet).

Water Year (Type)	Local Supply	CVP Supply[1]	Total
1989 (C)	1,860	0	1,860
1990 (C)	1,860	0	1,860
1991 (C)	1,860	0	1,860
1992 (C)	1,860	0	1,860
1993 (W)	1,860	0	1,860
1994 (C)	1,860	0	1,860
1995 (W)	1,860	0	1,860
1996 (W)	1,860	0	1,860
1997 (W)	1,860	0	1,860
1998 (W)	1,860	0	1,860
1999 (AN)	1,860	0	1,860
2000 (AN)	1,860	0	1,860
2001 (D)	1,860	0	1,860
2002 (D)	1,860	0	1,860
2003 (BN)	1,860	0	1,860
2004 (D)	1,860	0	1,860

Water Year (Type)	Local Supply	CVP Supply[1]	Total
2005 (W)	1,860	0	1,860
2006 (W)	1,860	0	1,860
2007 (C)	1,860	0	1,860
2008 (C)	1,860	0	1,860
2009 (BN)	1,860	0	1,860
2010 (AN)	2,080	0	2,080
2011 (W)	2,040	0	2,040
2012 (D)	1,920	0	1,920
2013 (C)	2,100	0	2,100
2014 (C)	2,120	0	2,120
2015 (C)	1,810	0	1,810
Average (1989-2014)	1,890	0	1,890
Average (1989-2014) W	1,880	0	1,880
Average (1989-2014) AN	1,930	0	1,930
Average (1989-2014) BN	1,860	0	1,860
Average (1989-2014) D	1,870	0	1,870
Average (1989-2014) C	1,910	0	1,910

[1]CVP Supply is considered as all water supply released from CVP storage facilities. The volume of CVP Supply includes CVP deliveries to CVP contractors/water users, and flood releases from CVP facilities that largely pass through the subbasin.

3.2.1.2 Precipitation

Precipitation estimates for the RCWD GSA are provided in Figure A2.F.g-6 and Table A2.F.g-4. Precipitation estimates are reported by water use sector.

Total precipitation is variable between years in the study area, ranging from approximately 7 taf (8.6 inches) during critical years to 11 taf (14.4 inches) during wet years.

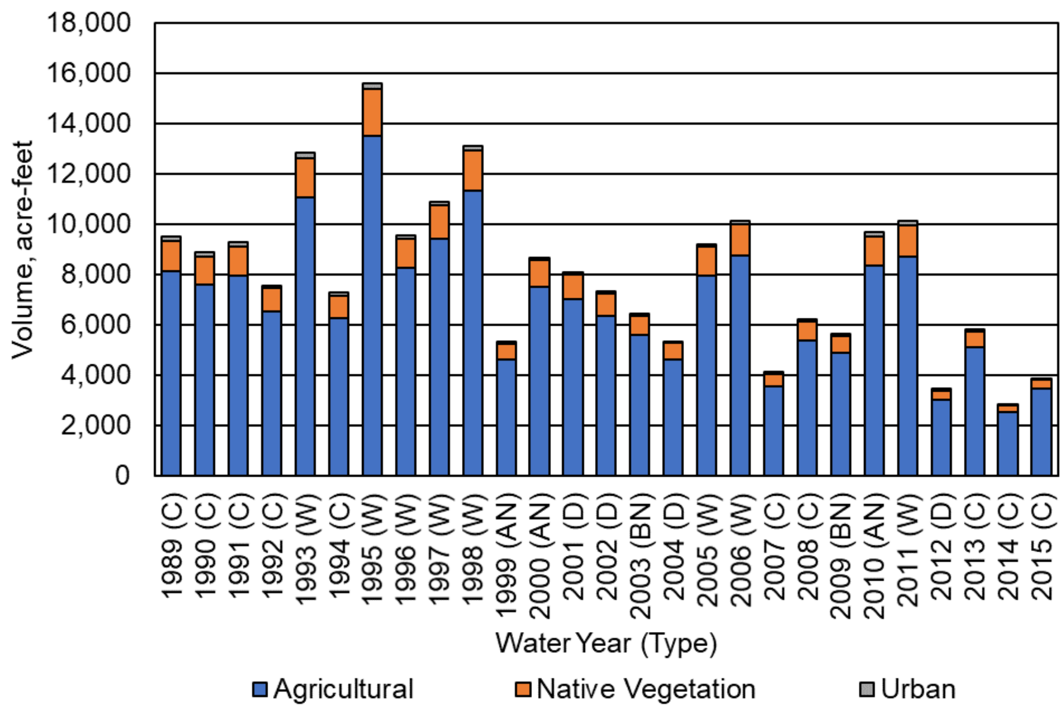

Figure A2.F.g-6. Root Creek Water District GSA Precipitation by Water Use Sector.

Table A2.F.g-4. Root Creek Water District GSA Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	8,130	1,190	180	9,500
1990 (C)	7,590	1,100	160	8,860
1991 (C)	7,950	1,140	170	9,260
1992 (C)	6,510	920	130	7,560
1993 (W)	11,050	1,560	210	12,810
1994 (C)	6,270	880	110	7,260
1995 (W)	13,470	1,890	230	15,590
1996 (W)	8,240	1,160	130	9,520
1997 (W)	9,420	1,330	130	10,880
1998 (W)	11,330	1,600	140	13,080
1999 (AN)	4,600	650	50	5,300
2000 (AN)	7,500	1,070	70	8,640
2001 (D)	7,000	1,000	60	8,060
2002 (D)	6,350	900	60	7,310
2003 (BN)	5,570	790	60	6,420
2004 (D)	4,620	660	60	5,330
2005 (W)	7,960	1,130	100	9,200
2006 (W)	8,760	1,240	130	10,130
2007 (C)	3,550	500	50	4,100
2008 (C)	5,380	760	90	6,230
2009 (BN)	4,860	690	90	5,630
2010 (AN)	8,330	1,170	160	9,650
2011 (W)	8,710	1,220	170	10,100

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2012 (D)	3,000	380	60	3,440
2013 (C)	5,120	590	110	5,810
2014 (C)	2,530	260	50	2,840
2015 (C)	3,470	330	80	3,870
Average (1989-2014)	7,070	990	110	8,170
Average (1989-2014) W	9,870	1,390	150	11,410
Average (1989-2014) AN	6,810	960	90	7,870
Average (1989-2014) BN	5,210	740	70	6,020
Average (1989-2014) D	5,240	740	60	6,040
Average (1989-2014) C	5,890	810	120	6,820

3.2.1.3 Groundwater Extraction by Water Use Sector

Estimates of groundwater extraction by water use sector are provided in Figure A2.F.g-7 and Table A2.F.g-5. For agricultural and urban (urban, semi-agricultural, industrial) lands, groundwater extraction represents pumping, while for native lands, groundwater extraction by riparian vegetation was considered to be negligible. For all water use sectors, groundwater extraction served as the water budget closure term. Groundwater extraction varies between years depending on surface water supplies and crop water demands or urban land consumptive use requirements. Between 1989 and 2014, average total groundwater extraction was approximately 22 taf per year.

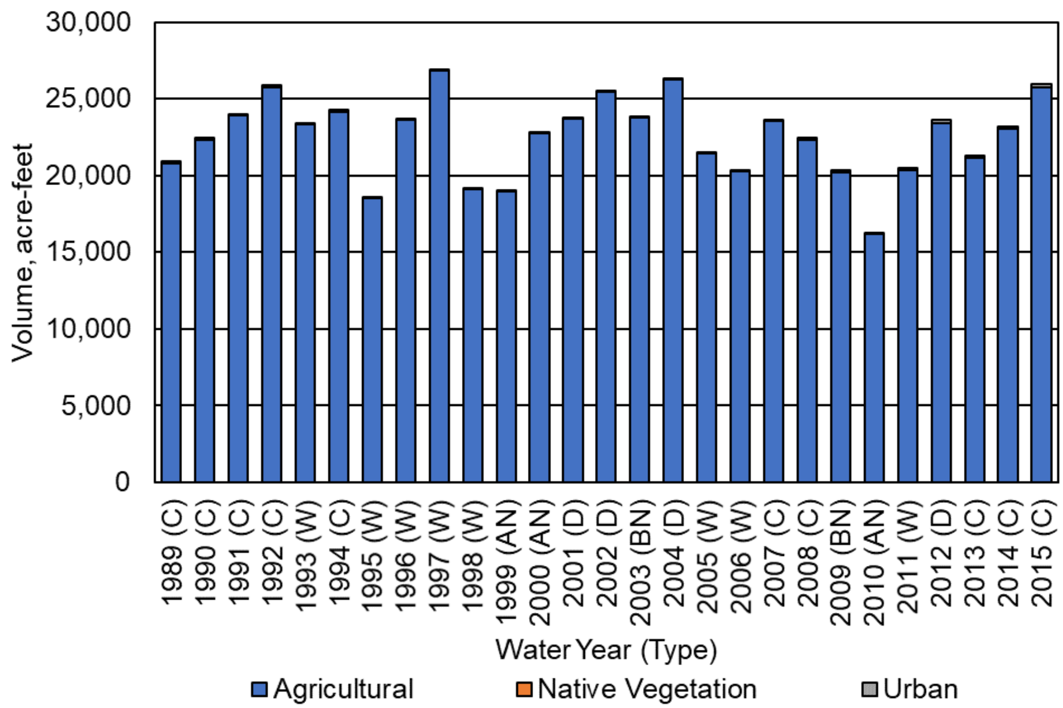

Figure A2.F.g-7. Root Creek Water District GSA Groundwater Extraction by Water Use Sector.

Table A2.F.g-5. Root Creek Water District GSA Groundwater Extraction by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	20,790	0	130	20,920
1990 (C)	22,340	0	130	22,470
1991 (C)	23,910	0	110	24,020
1992 (C)	25,750	0	150	25,890
1993 (W)	23,290	0	110	23,400
1994 (C)	24,120	0	120	24,250
1995 (W)	18,510	0	50	18,560
1996 (W)	23,590	0	80	23,670
1997 (W)	26,810	0	120	26,930
1998 (W)	19,100	0	60	19,160
1999 (AN)	18,980	0	70	19,060
2000 (AN)	22,740	0	60	22,800
2001 (D)	23,710	0	50	23,760
2002 (D)	25,460	0	70	25,530
2003 (BN)	23,760	0	80	23,830
2004 (D)	26,260	0	100	26,350
2005 (W)	21,400	0	70	21,470
2006 (W)	20,280	0	70	20,350
2007 (C)	23,530	0	120	23,650
2008 (C)	22,290	0	130	22,420
2009 (BN)	20,190	0	130	20,310
2010 (AN)	16,160	0	70	16,230
2011 (W)	20,350	0	90	20,450
2012 (D)	23,430	0	150	23,580
2013 (C)	21,130	0	170	21,300
2014 (C)	23,040	0	160	23,200
2015 (C)	25,770	0	190	25,960
Average (1989-2014)	22,340	0	100	22,440
Average (1989-2014) W	21,670	0	80	21,750
Average (1989-2014) AN	19,290	0	70	19,360
Average (1989-2014) BN	21,970	0	100	22,070
Average (1989-2014) D	24,710	0	90	24,810
Average (1989-2014) C	22,990	0	130	23,120

3.2.1.4 Groundwater Discharge to Surface Water Sources

The depth to groundwater is greater than 100-200 ft across much of the Madera Subbasin. Given the depth to the water table in the Madera Subbasin, groundwater discharge to surface water sources is negligible.

3.2.2 Outflows

3.2.2.1 Evapotranspiration by Water Use Sector

Evapotranspiration (ET) by water use sector is reported in Figures A2.F.g-8 to A2.F.g-10 and Tables A2.F.g-6 to A2.F.g-8. First, total ET is reported, followed by ET from applied water and ET from precipitation.

Total ET varies between years but has remained generally steady over time. Total ET ranges from a low of approximately 22 taf in 1999 to a high of 29 taf in 1992.

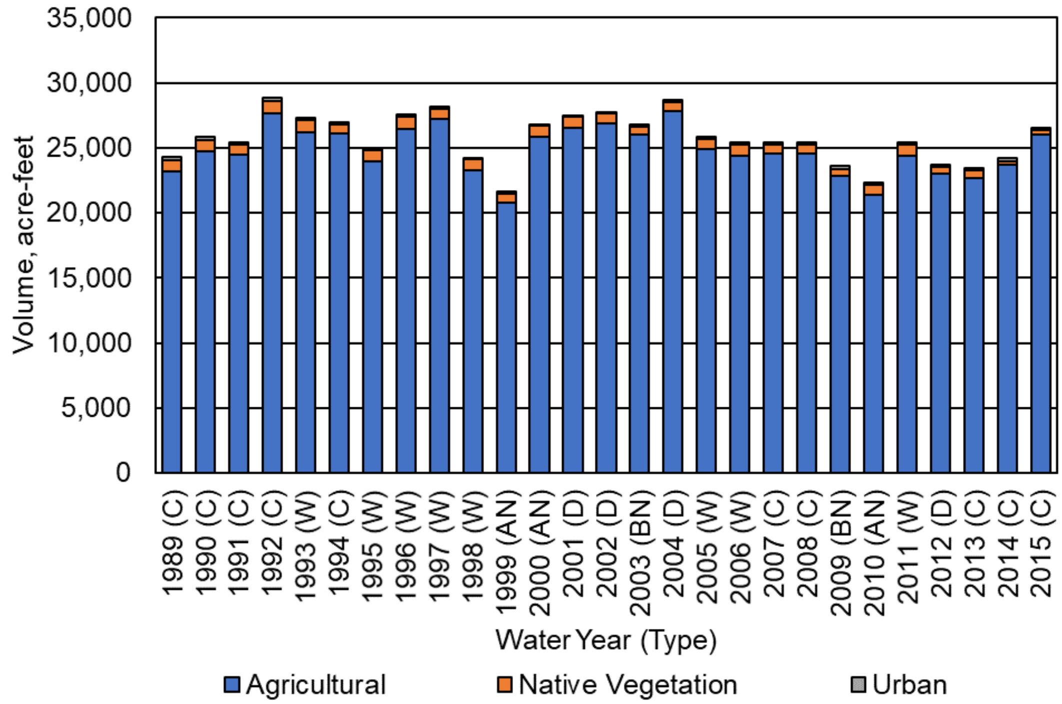

Figure A2.F.g-8. Root Creek Water District GSA Evapotranspiration by Water Use Sector.

Table A2.F.g-6. Root Creek Water District GSA Evapotranspiration by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	23,150	910	220	24,280
1990 (C)	24,720	880	210	25,810
1991 (C)	24,460	790	190	25,440
1992 (C)	27,680	950	210	28,840
1993 (W)	26,180	930	190	27,300
1994 (C)	26,090	730	180	27,000
1995 (W)	23,970	890	160	25,020
1996 (W)	26,480	950	150	27,580
1997 (W)	27,190	840	150	28,180
1998 (W)	23,300	790	120	24,210
1999 (AN)	20,810	700	110	21,620
2000 (AN)	25,860	810	100	26,770

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2001 (D)	26,510	870	90	27,470
2002 (D)	26,840	830	100	27,770
2003 (BN)	26,000	660	110	26,770
2004 (D)	27,810	730	130	28,670
2005 (W)	24,900	800	130	25,830
2006 (W)	24,380	870	140	25,390
2007 (C)	24,570	660	150	25,380
2008 (C)	24,580	690	170	25,440
2009 (BN)	22,840	560	180	23,580
2010 (AN)	21,360	780	170	22,310
2011 (W)	24,370	860	180	25,410
2012 (D)	23,050	460	170	23,680
2013 (C)	22,700	540	210	23,450
2014 (C)	23,740	260	180	24,180
2015 (C)	26,050	280	220	26,550
Average (1989-2014)	24,750	760	160	25,670
Average (1989-2014) W	25,100	870	150	26,120
Average (1989-2014) AN	22,680	760	130	23,570
Average (1989-2014) BN	24,420	610	150	25,180
Average (1989-2014) D	26,060	720	120	26,900
Average (1989-2014) C	24,640	710	190	25,540

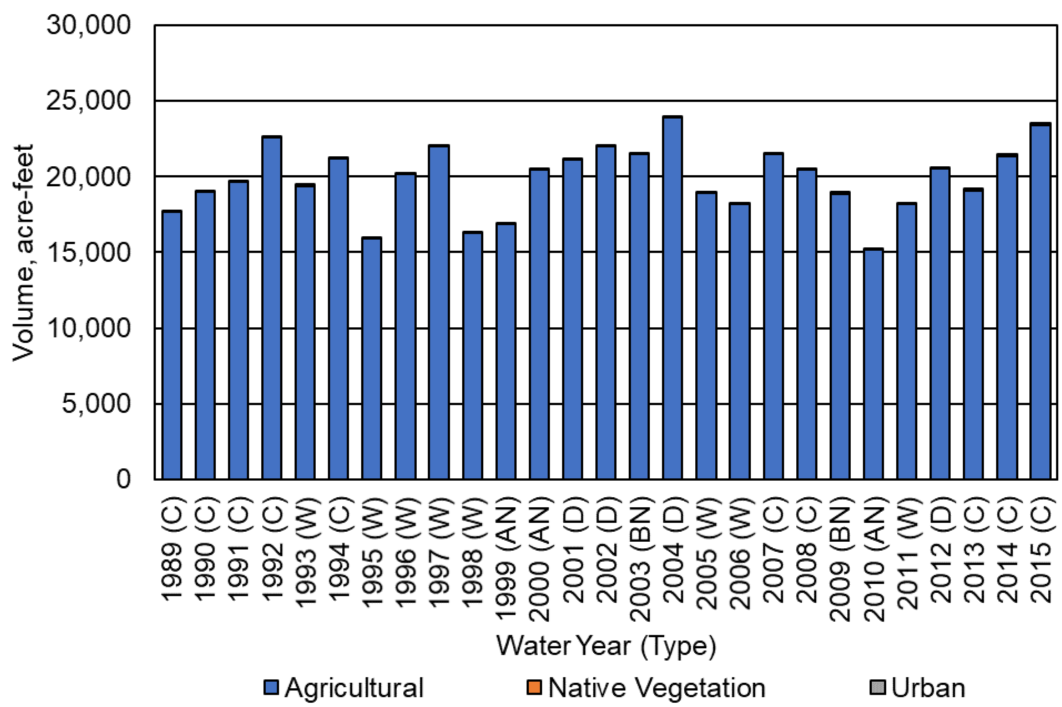

Figure A2.F.g-9. Root Creek Water District GSA Evapotranspiration of Applied Water by Water Use Sector.

Table A2.F.g-7. Root Creek Water District GSA Evapotranspiration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	17,670	0	100	17,770
1990 (C)	18,960	0	90	19,050
1991 (C)	19,620	0	90	19,710
1992 (C)	22,580	0	100	22,680
1993 (W)	19,390	0	80	19,470
1994 (C)	21,190	0	90	21,280
1995 (W)	15,890	0	50	15,940
1996 (W)	20,140	0	50	20,190
1997 (W)	22,010	0	70	22,080
1998 (W)	16,270	0	50	16,320
1999 (AN)	16,860	0	50	16,910
2000 (AN)	20,440	0	50	20,490
2001 (D)	21,110	0	40	21,150
2002 (D)	22,020	0	50	22,070
2003 (BN)	21,480	0	60	21,540
2004 (D)	23,900	0	80	23,980
2005 (W)	18,910	0	60	18,970
2006 (W)	18,160	0	60	18,220
2007 (C)	21,470	0	80	21,550
2008 (C)	20,440	0	100	20,540
2009 (BN)	18,860	0	110	18,970
2010 (AN)	15,160	0	80	15,240
2011 (W)	18,190	0	70	18,260
2012 (D)	20,520	0	100	20,620
2013 (C)	19,100	0	130	19,230
2014 (C)	21,370	0	130	21,500
2015 (C)	23,380	0	160	23,540
Average (1989-2014)	19,680	0	80	19,760
Average (1989-2014) W	18,620	0	60	18,680
Average (1989-2014) AN	17,490	0	60	17,550
Average (1989-2014) BN	20,170	0	90	20,260
Average (1989-2014) D	21,890	0	70	21,960
Average (1989-2014) C	20,270	0	100	20,370

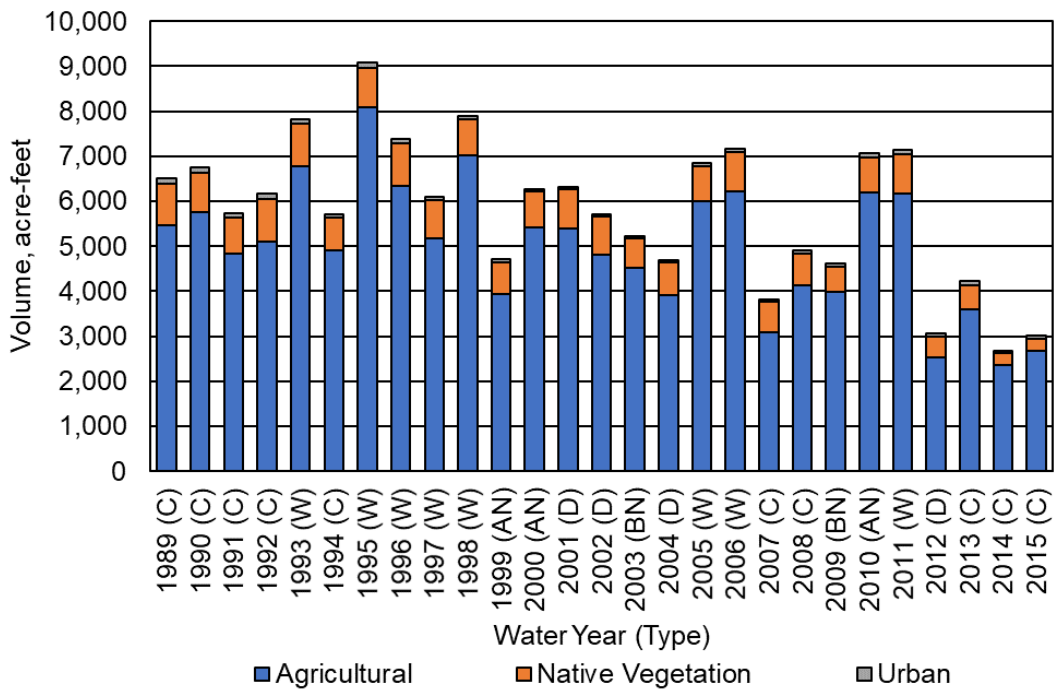

Figure A2.F.g-10. Root Creek Water District GSA Evapotranspiration of Precipitation by Water Use Sector.

Table A2.F.g-8. Root Creek Water District GSA Evapotranspiration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	5,480	910	120	6,510
1990 (C)	5,760	880	120	6,760
1991 (C)	4,840	790	100	5,730
1992 (C)	5,100	950	110	6,160
1993 (W)	6,790	930	110	7,830
1994 (C)	4,900	730	90	5,720
1995 (W)	8,080	890	110	9,080
1996 (W)	6,340	950	100	7,390
1997 (W)	5,180	840	80	6,100
1998 (W)	7,030	790	70	7,890
1999 (AN)	3,950	700	60	4,710
2000 (AN)	5,420	810	50	6,280
2001 (D)	5,400	870	50	6,320
2002 (D)	4,820	830	50	5,700
2003 (BN)	4,520	660	50	5,230
2004 (D)	3,910	730	50	4,690
2005 (W)	5,990	800	70	6,860
2006 (W)	6,220	870	80	7,170
2007 (C)	3,100	660	70	3,830
2008 (C)	4,140	690	70	4,900
2009 (BN)	3,980	560	70	4,610
2010 (AN)	6,200	780	90	7,070

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2011 (W)	6,180	860	110	7,150
2012 (D)	2,530	460	70	3,060
2013 (C)	3,600	540	80	4,220
2014 (C)	2,370	260	50	2,680
2015 (C)	2,670	280	60	3,010
Average (1989-2014)	5,070	760	80	5,910
Average (1989-2014) W	6,480	870	90	7,440
Average (1989-2014) AN	5,190	760	70	6,020
Average (1989-2014) BN	4,250	610	60	4,920
Average (1989-2014) D	4,170	720	50	4,940
Average (1989-2014) C	4,370	710	90	5,170

In addition to ET from land surfaces, estimates of evaporation from rivers and streams are reported in Figure A2.F.g-11 and Table A2.F.g-9. Evaporation from the Rivers and Streams System includes evaporation of both surface inflows and of precipitation runoff within local sloughs and depressions. Evaporation is highest in wet years when precipitation runoff is typically higher, though in all years evaporation averages less than 0.1 taf.

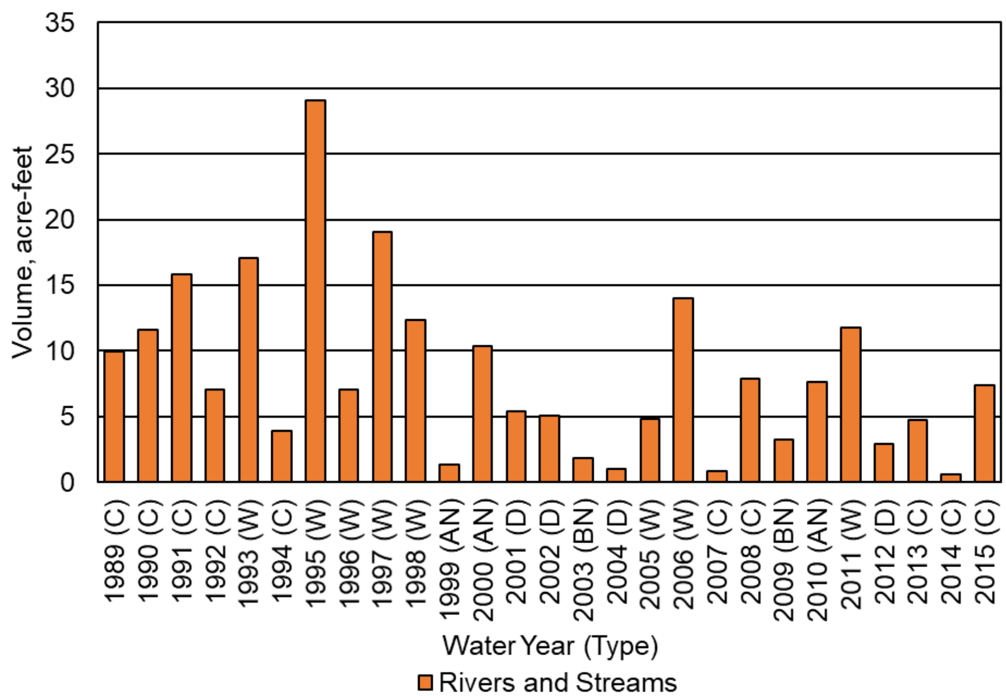

Figure A2.F.g-11. Root Creek Water District GSA Evaporation from the Surface Water System.

Table A2.F.g-9. Root Creek Water District GSA Evaporation from the Surface Water System (Acre-Feet).

Water Year (Type)	Rivers and Streams[1]
1989 (C)	10
1990 (C)	12
1991 (C)	16
1992 (C)	7
1993 (W)	17
1994 (C)	4
1995 (W)	29
1996 (W)	7
1997 (W)	19
1998 (W)	12
1999 (AN)	1
2000 (AN)	10
2001 (D)	5
2002 (D)	5
2003 (BN)	2
2004 (D)	1
2005 (W)	5
2006 (W)	14
2007 (C)	1
2008 (C)	8
2009 (BN)	3
2010 (AN)	8
2011 (W)	12
2012 (D)	3
2013 (C)	5
2014 (C)	1
2015 (C)	7
Average (1989-2014)	8
Average (1989-2014) W	14
Average (1989-2014) AN	6
Average (1989-2014) BN	3
Average (1989-2014) D	4
Average (1989-2014) C	7

[1] Includes evaporation of surface inflows and of precipitation runoff.

3.2.2.2 Surface Water Outflow by Water Source Type

No significant surface water sources are considered to enter or leave RCWD GSA. Runoff of applied water is assumed negligible and runoff of precipitation is expected to reenter the groundwater system through infiltration within the GSA boundaries.

3.2.2.3 Infiltration of Precipitation

Estimated infiltration of precipitation (deep percolation of precipitation) by water use sector is provided in Figure A2.F.g-12 and Table A2.F.g-10. Infiltration of precipitation to the groundwater system is highly variable from year to year due to variation in the timing and amount of precipitation, ranging from over 3.3 taf on average during wet years to less than 1.6 taf annually during dry and critical year types.

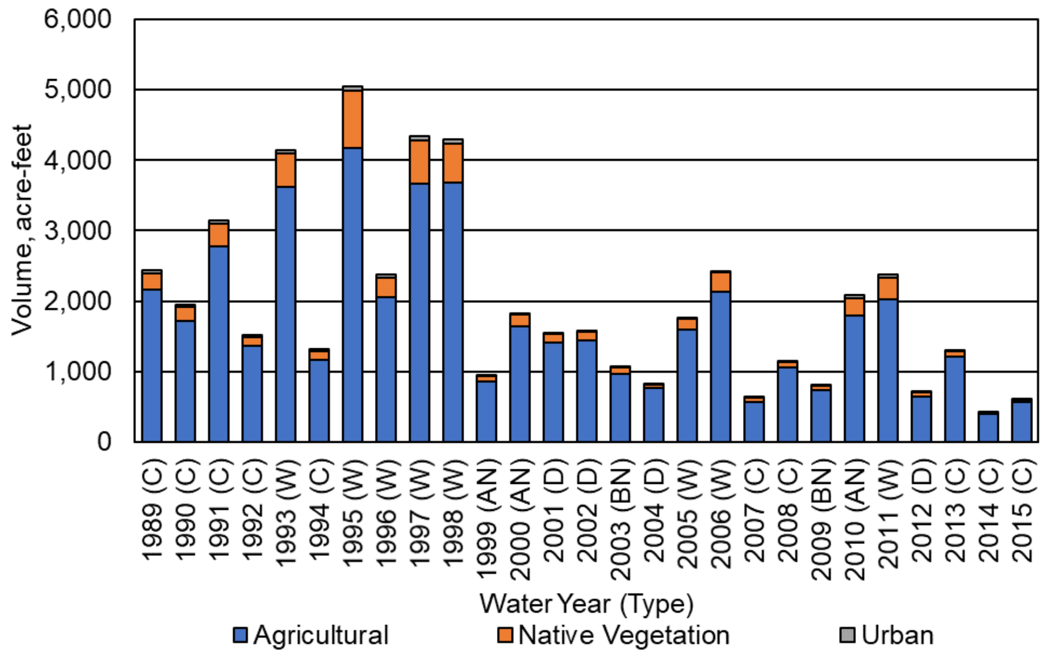

Figure A2.F.g-12. Root Creek Water District GSA Infiltration of Precipitation by Water Use Sector.

Table A2.F.g-10. Root Creek Water District GSA Infiltration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	2,160	230	50	2,440
1990 (C)	1,720	190	40	1,950
1991 (C)	2,770	330	50	3,150
1992 (C)	1,360	120	30	1,510
1993 (W)	3,620	470	60	4,150
1994 (C)	1,170	120	20	1,310
1995 (W)	4,180	800	70	5,050
1996 (W)	2,050	280	40	2,370
1997 (W)	3,670	610	60	4,340
1998 (W)	3,680	560	50	4,290
1999 (AN)	860	80	10	950
2000 (AN)	1,640	170	20	1,830
2001 (D)	1,410	130	10	1,550
2002 (D)	1,440	120	10	1,570
2003 (BN)	970	90	10	1,070
2004 (D)	760	50	10	820
2005 (W)	1,600	150	20	1,770
2006 (W)	2,130	270	30	2,430
2007 (C)	570	60	10	640
2008 (C)	1,050	80	20	1,150
2009 (BN)	740	50	10	800
2010 (AN)	1,790	250	40	2,080

2011 (W)	2,020	310	50	2,380
2012 (D)	640	60	10	710
2013 (C)	1,210	70	20	1,300
2014 (C)	390	20	10	420
2015 (C)	560	30	10	600
Average (1989-2014)	1,750	220	30	2,000
Average (1989-2014) W	2,870	430	50	3,350
Average (1989-2014) AN	1,430	170	20	1,620
Average (1989-2014) BN	860	70	10	940
Average (1989-2014) D	1,060	90	10	1,160
Average (1989-2014) C	1,380	140	30	1,550

3.2.2.4 Infiltration of Surface Water

Estimated infiltration of surface water (seepage) by source is provided in Figure A2.F.g-13 and Table A2.F.g-11. Seepage from the Rivers and Streams System includes seepage of both surface inflows and of precipitation runoff into local sloughs and depressions. Seepage from rivers and streams within the GSA boundaries is attributed to precipitation runoff and thus follows the same pattern as runoff. While flows in the San Joaquin River were not accounted directly as water budget components[3], boundary seepage from the San Joaquin River contributes an additional 2 taf per year on average to net recharge in RCWD GSA.

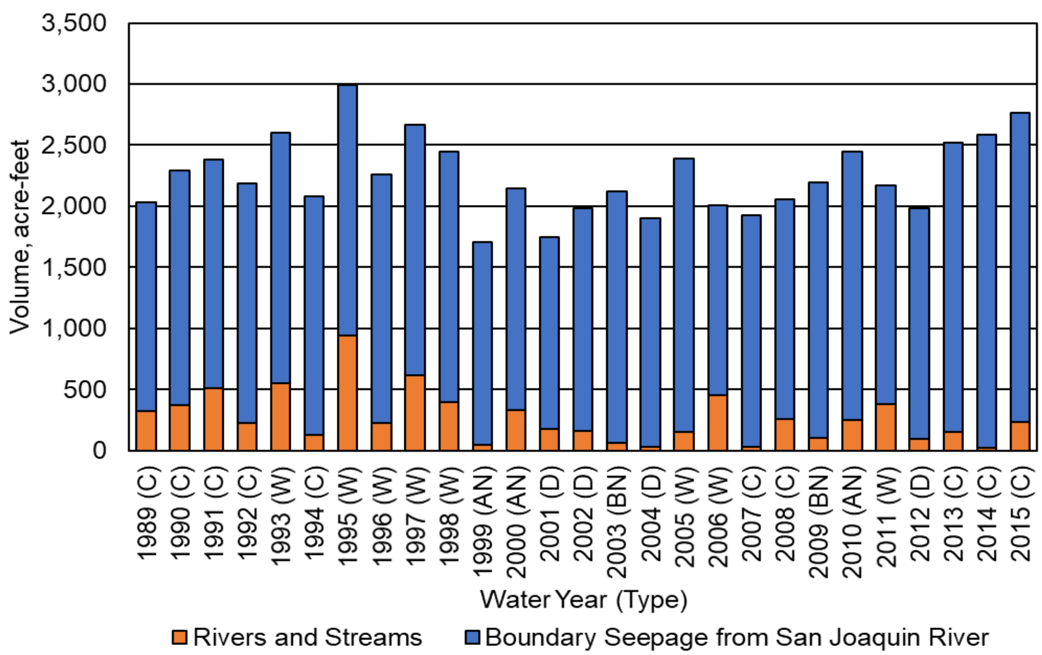

Figure A2.F.g-13. Root Creek Water District GSA Infiltration of Surface Water.

[3] The San Joaquin River does not cross the lateral boundaries of the Madera Subbasin, as defined above. Thus, San Joaquin River flows are not considered surface water inflows within this water budget. A portion of infiltration of surface water from the San Joaquin River is considered to cross the subbasin boundaries into the groundwater system and is included in the calculation of the subbasin estimates of overdraft and net recharge from SWS.

Table A2.F.g-11. Root Creek Water District GSA Infiltration of Surface Water (Acre-Feet).

Water Year (Type)	Rivers and Streams[1]	Boundary Seepage from San Joaquin River	Total
1989 (C)	330	1,710	2,040
1990 (C)	380	1,920	2,300
1991 (C)	530	1,870	2,400
1992 (C)	230	1,960	2,190
1993 (W)	570	2,050	2,620
1994 (C)	130	1,960	2,090
1995 (W)	970	2,050	3,020
1996 (W)	230	2,030	2,260
1997 (W)	630	2,050	2,680
1998 (W)	410	2,050	2,460
1999 (AN)	40	1,660	1,700
2000 (AN)	340	1,810	2,150
2001 (D)	180	1,570	1,750
2002 (D)	170	1,820	1,990
2003 (BN)	60	2,060	2,120
2004 (D)	30	1,870	1,900
2005 (W)	160	2,240	2,400
2006 (W)	460	1,550	2,010
2007 (C)	30	1,900	1,930
2008 (C)	260	1,800	2,060
2009 (BN)	110	2,090	2,200
2010 (AN)	250	2,200	2,450
2011 (W)	380	1,790	2,170
2012 (D)	100	1,890	1,990
2013 (C)	160	2,370	2,530
2014 (C)	20	2,560	2,580
2015 (C)	240	2,530	2,770
Average (1989-2014)	280	1,960	2,230
Average (1989-2014) W	480	1,980	2,450
Average (1989-2014) AN	210	1,890	2,100
Average (1989-2014) BN	90	2,080	2,160
Average (1989-2014) D	120	1,790	1,910
Average (1989-2014) C	230	2,010	2,240

[1] Includes infiltration of surface inflows and of precipitation runoff.

3.2.2.5 Infiltration of Applied Water

Estimated infiltration of applied water (deep percolation of applied water) by water use sector is provided in Figure A2.F.g-14 and Table A2.F.g-12. During all years, infiltration of applied water was dominated by agricultural irrigation, which generally decreased from the mid-1990s through 2014 following gradual increases in orchard crops. Between 1989 and 2014, agricultural applied water provided an average of approximately 4.6 taf per year to the groundwater system.

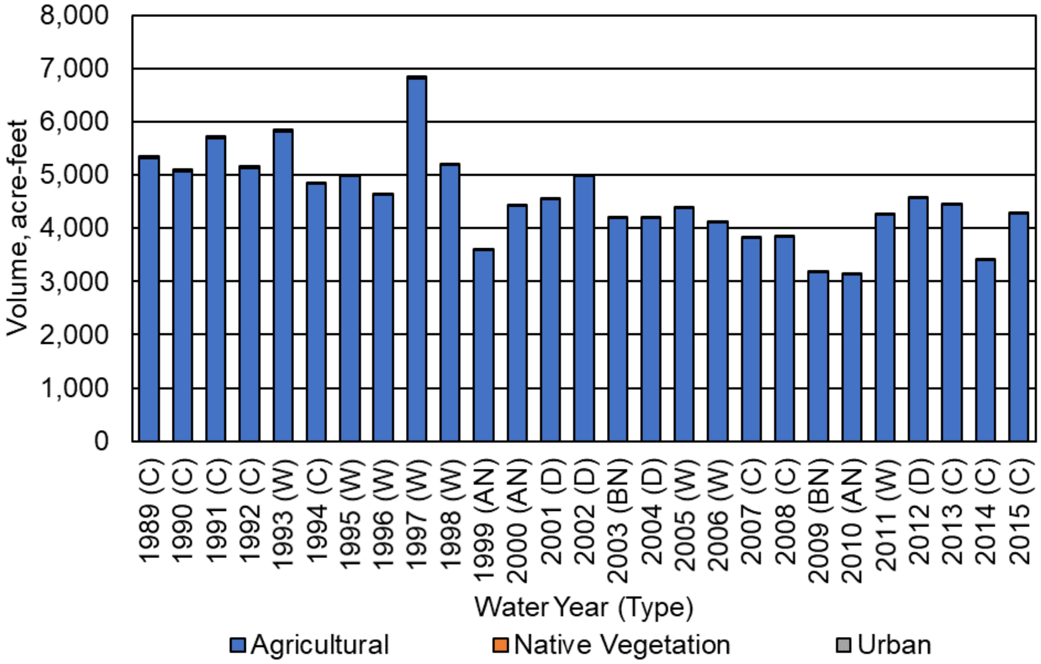

Figure A2.F.g-14. Root Creek Water District GSA Infiltration of Applied Water by Water Use Sector.

Table A2.F.g-12. Root Creek Water District GSA Infiltration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	5,310	0	40	5,350
1990 (C)	5,070	0	30	5,100
1991 (C)	5,690	0	30	5,720
1992 (C)	5,130	0	30	5,160
1993 (W)	5,820	0	40	5,860
1994 (C)	4,830	0	20	4,850
1995 (W)	4,970	0	30	5,000
1996 (W)	4,620	0	10	4,630
1997 (W)	6,810	0	30	6,840
1998 (W)	5,180	0	30	5,210
1999 (AN)	3,580	0	10	3,590
2000 (AN)	4,410	0	10	4,420
2001 (D)	4,550	0	10	4,560
2002 (D)	4,980	0	10	4,990
2003 (BN)	4,200	0	10	4,210
2004 (D)	4,190	0	10	4,200
2005 (W)	4,370	0	20	4,390
2006 (W)	4,100	0	20	4,120
2007 (C)	3,810	0	20	3,830
2008 (C)	3,830	0	20	3,850
2009 (BN)	3,170	0	20	3,190
2010 (AN)	3,130	0	20	3,150
2011 (W)	4,250	0	20	4,270
2012 (D)	4,570	0	20	4,590
2013 (C)	4,440	0	30	4,470
2014 (C)	3,400	0	30	3,430
2015 (C)	4,270	0	30	4,300
Average (1989-2014)	4,550	0	20	4,570
Average (1989-2014) W	5,020	0	30	5,050
Average (1989-2014) AN	3,710	0	10	3,720
Average (1989-2014) BN	3,690	0	20	3,710
Average (1989-2014) D	4,570	0	10	4,580
Average (1989-2014) C	4,610	0	30	4,640

3.2.3 Change in Surface Water System Storage

Estimates of change in SWS storage are provided in Figure A2.F.g-15 and Table A2.F.g-13. Inter-annual changes in storage within the surface water system consist primarily of root zone soil moisture storage changes, are relatively small, and tend to average near zero over many years.

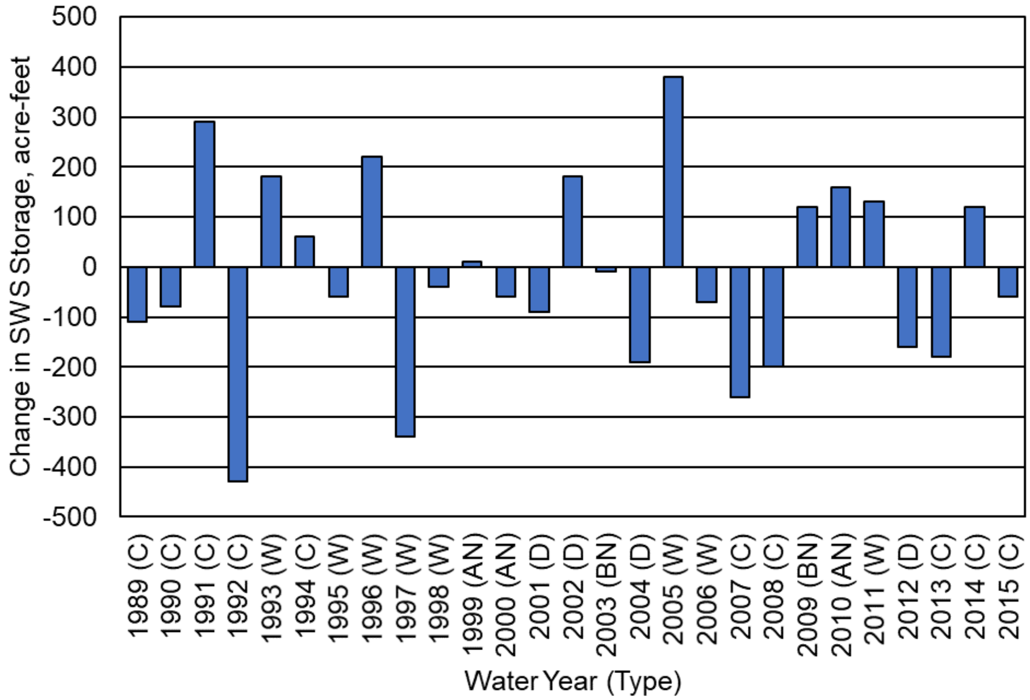

Figure A2.F.g-15. Root Creek Water District GSA Change in Surface Water System Storage.

Table A2.F.g-13. Root Creek Water District GSA Change in Surface Water System Storage (Acre-Feet).

Water Year (Type)	Change in SWS Storage
1989 (C)	-110
1990 (C)	-80
1991 (C)	290
1992 (C)	-430
1993 (W)	180
1994 (C)	60
1995 (W)	-60
1996 (W)	220
1997 (W)	-340
1998 (W)	-40
1999 (AN)	10
2000 (AN)	-60
2001 (D)	-90
2002 (D)	180
2003 (BN)	-10
2004 (D)	-190
2005 (W)	380
2006 (W)	-70
2007 (C)	-260
2008 (C)	-200
2009 (BN)	120
2010 (AN)	160

Water Year (Type)	Change in SWS Storage
2011 (W)	130
2012 (D)	-160
2013 (C)	-180
2014 (C)	120
2015 (C)	-60
Average (1989-2014)	-20
Average (1989-2014) W	50
Average (1989-2014) AN	40
Average (1989-2014) BN	60
Average (1989-2014) D	-70
Average (1989-2014) C	-90

3.3 Historical Water Budget Summary

Annual inflows, outflows, and change in SWS storage during the historical water budget period (1989-2014) are summarized in Figure A2.F.g-16 and Table A2.F.g-14. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values. Review of the variability in component volumes across years provides insight into the impacts of hydrology on the surface water system water budget.

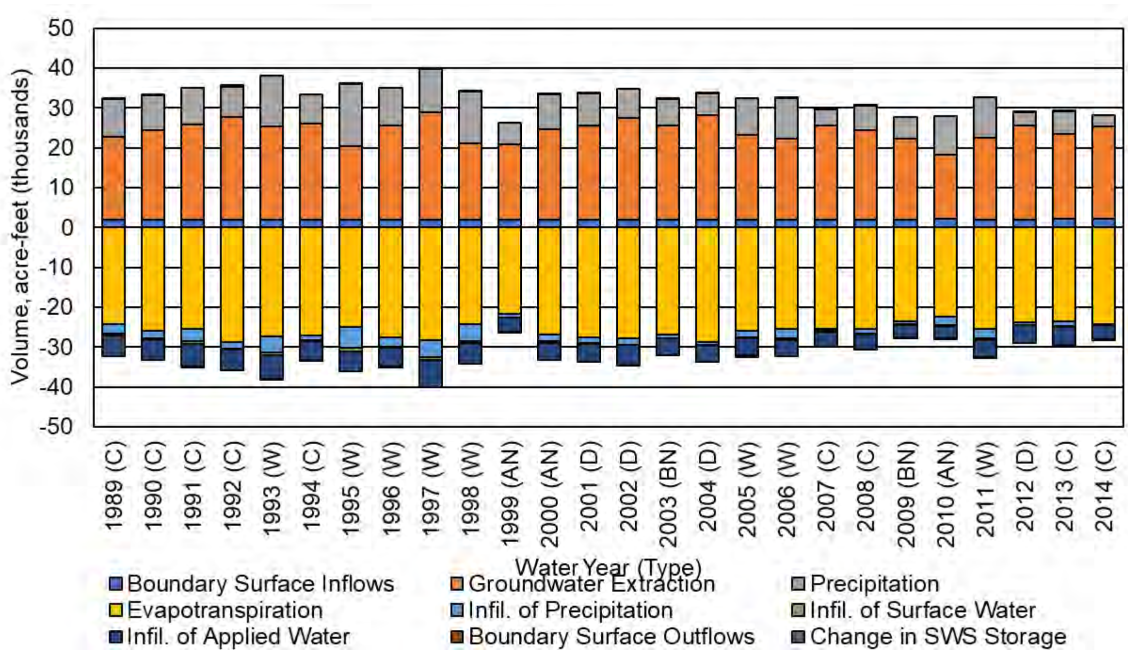

Figure A2.F.g-16. Root Creek Water District GSA Surface Water System Historical Water Budget, 1989-2014.

Table A2.F.g-14. Root Creek Water District GSA Surface Water System Historical Water Budget, 1989-2014 (Acre-Feet).

Water Year (Type)	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Evapo-transpiration[1]	Infil. of Precipitation	Infil. of Surface Water	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	1,860	20,920	9,500	-24,290	-2,430	-330	-5,340	0	110
1990 (C)	1,860	22,470	8,860	-25,830	-1,950	-380	-5,100	0	80
1991 (C)	1,860	24,010	9,260	-25,440	-3,150	-530	-5,720	0	-290
1992 (C)	1,860	25,890	7,560	-28,850	-1,510	-230	-5,160	0	430
1993 (W)	1,860	23,400	12,810	-27,320	-4,150	-570	-5,860	0	-180
1994 (C)	1,860	24,250	7,260	-27,000	-1,310	-130	-4,860	0	-60
1995 (W)	1,860	18,560	15,590	-25,050	-5,050	-970	-5,000	0	60
1996 (W)	1,860	23,670	9,520	-27,590	-2,370	-230	-4,640	0	-220
1997 (W)	1,860	26,930	10,880	-28,200	-4,330	-630	-6,840	0	340
1998 (W)	1,860	19,160	13,080	-24,220	-4,290	-410	-5,210	0	40
1999 (AN)	1,860	19,050	5,300	-21,610	-960	-40	-3,590	0	-10
2000 (AN)	1,860	22,800	8,640	-26,770	-1,820	-340	-4,420	0	60
2001 (D)	1,860	23,760	8,060	-27,480	-1,560	-180	-4,560	0	90
2002 (D)	1,860	25,530	7,310	-27,780	-1,570	-170	-5,000	0	-180
2003 (BN)	1,860	23,830	6,420	-26,780	-1,070	-60	-4,210	0	10
2004 (D)	1,860	26,350	5,330	-28,670	-830	-30	-4,200	0	190
2005 (W)	1,860	21,470	9,200	-25,840	-1,760	-160	-4,390	0	-380
2006 (W)	1,860	20,360	10,130	-25,400	-2,430	-460	-4,110	0	70
2007 (C)	1,860	23,650	4,100	-25,380	-640	-30	-3,830	0	260
2008 (C)	1,860	22,420	6,230	-25,450	-1,150	-260	-3,850	0	200
2009 (BN)	1,860	20,310	5,630	-23,580	-800	-110	-3,190	0	-120
2010 (AN)	2,080	16,230	9,650	-22,320	-2,070	-250	-3,150	0	-160
2011 (W)	2,040	20,450	10,100	-25,430	-2,380	-380	-4,270	0	-130
2012 (D)	1,920	23,580	3,440	-23,690	-710	-100	-4,600	0	160
2013 (C)	2,100	21,290	5,810	-23,450	-1,310	-160	-4,470	0	180
2014 (C)	2,120	23,200	2,840	-24,180	-410	-20	-3,420	0	-120
Average (1989-2014)	1,890	22,440	8,170	-25,680	-2,000	-280	-4,580	0	20
Average (1989-2014) W	1,880	21,750	11,410	-26,130	-3,340	-480	-5,040	0	-50
Average (1989-2014) AN	1,930	19,360	7,870	-23,570	-1,620	-210	-3,720	0	-40
Average (1989-2014) BN	1,860	22,070	6,020	-25,180	-930	-80	-3,700	0	-50
Average (1989-2014) D	1,870	24,800	6,040	-26,900	-1,170	-120	-4,590	0	60
Average (1989-2014) C	1,910	23,120	6,820	-25,540	-1,540	-230	-4,640	0	90

[1]Includes ET of applied water, ET of precipitation, and evaporation from rivers and streams.

3.4 Current Water Budget Summary

The current water budget was developed following a similar process to the historical water budget using the 2015 land use in Table 1 and the same 1989-2014 average hydrologic conditions of the historical base period, including surface water flows, precipitation, and weather parameters. This allowed quantification of groundwater inflows and outflows for current consumptive use in the context of average water supply conditions.

Annual inflows, outflows, and change in SWS storage from the current water budget are summarized in Figure A2.F.g-17 and Table A2.F.g-15. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values.

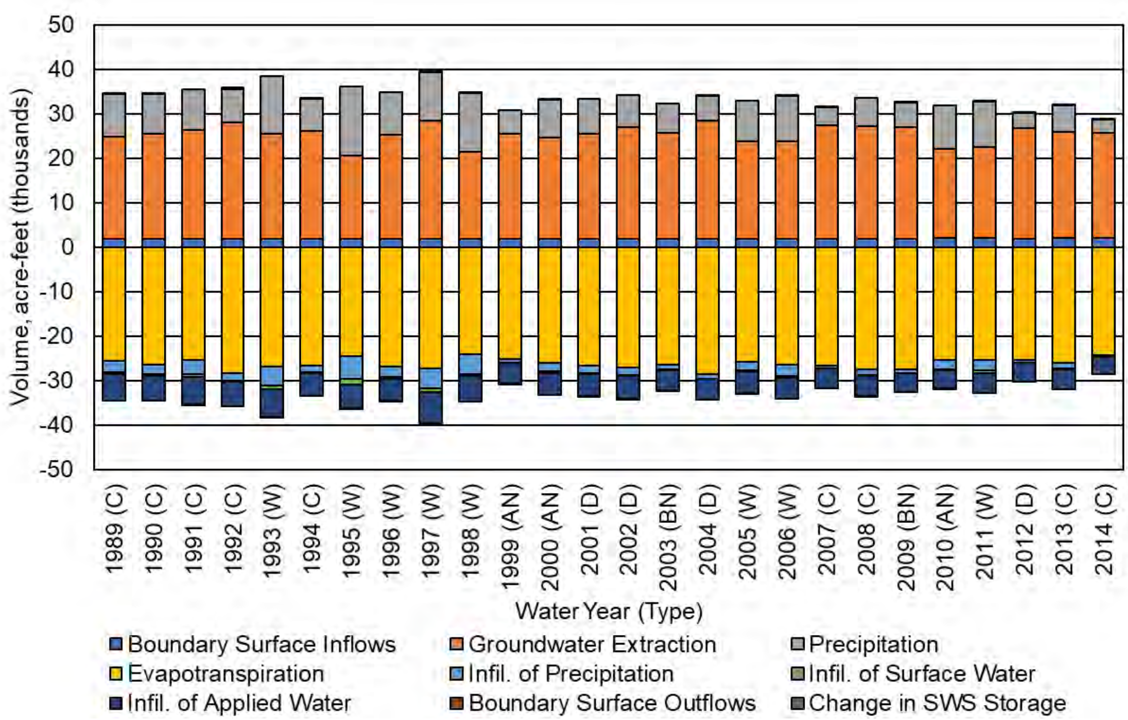

Figure A2.F.g-17. Root Creek Water District GSA Surface Water System Current Water Budget, 1989-2014.

Table A2.F.g-15. Root Creek Water District GSA Surface Water System Current Water Budget, 1989-2014 (Acre-Feet).

Water Year (Type)	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Evapo-transpiration[1]	Infil. of Precipitation	Infil. of Surface Water	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	1,860	23,090	9,520	-25,630	-2,500	-340	-6,060	0	70
1990 (C)	1,860	23,740	8,870	-26,450	-2,040	-450	-5,600	0	70
1991 (C)	1,860	24,470	9,270	-25,390	-3,220	-670	-6,190	0	-130
1992 (C)	1,860	26,170	7,580	-28,440	-1,600	-330	-5,480	0	260
1993 (W)	1,860	23,710	12,840	-26,950	-4,220	-720	-6,170	0	-340
1994 (C)	1,860	24,250	7,270	-26,670	-1,410	-180	-5,290	0	160
1995 (W)	1,860	18,700	15,610	-24,560	-5,100	-1,180	-5,310	0	-20
1996 (W)	1,860	23,370	9,540	-26,790	-2,480	-350	-4,920	0	-230
1997 (W)	1,860	26,540	10,900	-27,360	-4,360	-820	-7,060	0	300
1998 (W)	1,860	19,680	13,110	-24,070	-4,410	-530	-5,700	0	70
1999 (AN)	1,860	23,700	5,320	-25,090	-1,040	-20	-4,660	0	-70
2000 (AN)	1,860	22,700	8,670	-26,030	-1,940	-490	-4,860	0	100
2001 (D)	1,860	23,540	8,090	-26,670	-1,670	-290	-4,830	0	-10
2002 (D)	1,860	25,120	7,340	-27,060	-1,650	-260	-5,230	0	-110
2003 (BN)	1,860	23,950	6,450	-26,370	-1,150	-110	-4,550	0	-80
2004 (D)	1,860	26,710	5,360	-28,670	-900	-60	-4,620	0	330
2005 (W)	1,860	21,940	9,240	-25,880	-1,870	-220	-4,760	0	-310
2006 (W)	1,860	21,960	10,180	-26,460	-2,470	-480	-4,640	0	50
2007 (C)	1,860	25,530	4,120	-26,640	-680	-30	-4,370	0	220
2008 (C)	1,860	25,370	6,260	-27,500	-1,210	-250	-4,510	0	-20
2009 (BN)	1,860	25,030	5,660	-27,430	-870	-60	-4,240	0	50
2010 (AN)	2,080	20,090	9,720	-25,410	-2,140	-150	-4,040	0	-140
2011 (W)	2,040	20,500	10,170	-25,340	-2,430	-500	-4,490	0	50
2012 (D)	1,920	24,790	3,460	-25,380	-620	-80	-4,150	0	50
2013 (C)	2,100	23,910	5,850	-26,100	-1,210	-100	-4,540	0	100
2014 (C)	2,120	23,660	2,860	-24,240	-470	-20	-3,930	0	20
Average (1989-2014)	1,890	23,550	8,200	-26,250	-2,060	-330	-5,010	0	20
Average (1989-2014) W	1,880	22,050	11,450	-25,930	-3,420	-600	-5,380	0	-50
Average (1989-2014) AN	1,930	22,160	7,900	-25,510	-1,700	-220	-4,520	0	-40
Average (1989-2014) BN	1,860	24,490	6,050	-26,900	-1,010	-80	-4,390	0	-10
Average (1989-2014) D	1,870	25,040	6,060	-26,950	-1,210	-170	-4,710	0	70
Average (1989-2014) C	1,910	24,460	6,850	-26,340	-1,590	-260	-5,110	0	80

[1]Includes ET of applied water, ET of precipitation, and evaporation from rivers and streams.

3.5 Net Recharge from SWS

Overdraft is defined in DWR Bulletin 118 as "the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions" (DWR 2003). The Madera Subbasin water budget indicates that overdraft conditions occurred during the 1989-2014 historical base period. Per 23 CCR Section 354.18(b)(5), the subbasin overdraft has been quantified for this base period. The evaluation of overdraft conditions includes estimates of recharge from subsurface flows. However, estimates of recharge from subsurface flows are less accurate when estimated for areas less that an entire subbasin. Thus, for estimates of GSA level contribution to overdraft, the term net recharge from the SWS is defined as groundwater recharge minus groundwater extraction. Net recharge from the SWS is useful for understanding and analyzing the combined effects of land surface processes on the underlying GWS.

When calculated from the historical water budget, average net recharge from the SWS represents the average recharge (when positive) or shortage of recharge (when negative) based on historical cropping, land use practices, and average hydrologic conditions. When calculated from the current land use water budget, average net recharge represents the average recharge or shortage (negative net recharge) based on current cropping, land use practices, and average hydrologic conditions.

Average net recharge from the SWS is presented below for the RCWD GSA portion of the Madera Subbasin. Table A2.F.g-16 shows the average net recharge from the SWS for 1989-2014 based on the historical water budget, and Table A2.F.g-17 shows the same for the current water budget. Under historical and current land use conditions, average annual shortage from RCWD GSA is approximately 13 to 14 taf.

Table A2.F.g-16. Historical Water Budget: Average Net Recharge from SWS by Water Year Type, 1989-2014 (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water[1] (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	5,040	3,340	2,450	21,750	-10,920
AN	3	3,720	1,620	2,100	19,360	-11,920
BN	2	3,700	930	2,160	22,070	-15,280
D	4	4,590	1,170	1,910	24,800	-17,130
C	9	4,640	1,540	2,240	23,120	-14,700
Annual Average (1989-2014)	26	4,580	2,000	2,230	22,440	-13,630

[1] Includes infiltration from the Rivers and Streams System and boundary seepage from San Joaquin River.

Table A2.F.g-17. Current Water Budget: Average Net Recharge from SWS by Water Year Type (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water[1] (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	5,380	3,420	2,580	22,050	-10,670
AN	3	4,520	1,700	2,110	22,160	-13,830
BN	2	4,390	1,010	2,160	24,490	-16,930
D	4	4,710	1,210	1,960	25,040	-17,160
C	9	5,110	1,590	2,260	24,460	-15,500
Annual Average (1989-2014)	26	5,010	2,060	2,280	23,550	-14,200

[1] Includes infiltration from the Rivers and Streams System and boundary seepage from San Joaquin River.

3.6 Uncertainties in Water Budget Components

Uncertainties associated with each water budget component were estimated as a percentage representing approximately a 95% confidence interval following the procedure described by Clemmens and Burt (1997). Uncertainties for all independently measured or estimated water budget components were estimated based on the measurement accuracy, typical values reported in technical literature, typical values calculated in other water budgets, and professional judgement.

Table A2.F.g-18 provides a summary of typical uncertainty values associated with major SWS inflow and outflow components. These uncertainties provide a basis for evaluating confidence in water budget results and help to identify data needs that may be addressed during GSP implementation.

Table A2.F.g-18. Estimated Uncertainty of GSA Water Budget Components.

Flowpath Direction (SWS Boundary)	Water Budget Component	Data Source	Estimated Uncertainty (%)	Source
Inflows	Riparian Deliveries	Measurement	10%	Estimated measurement accuracy.
	Precipitation	Calculation	30%	Clemmens, A.J. and C.M. Burt, 1997.
	Groundwater Extraction	Closure	20%	Typical uncertainty calculated for Land Surface System water balance closure.
Outflows	Evaporation	Calculation	20%	Estimated accuracy of calculation based on CIMIS reference ET and free water surface evaporation coefficient.
	ET of Applied Water	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, estimated crop coefficients from SEBAL energy balance, and annual land use.
	ET of Precipitation	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, precipitation, estimated crop coefficients from SEBAL energy balance, and annual land use.
	Infiltration of Applied Water	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use and NRCS soils characteristics.
	Infiltration of Precipitation	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use, NRCS soils characteristics, and CIMIS precipitation.
	Infiltration of Surface Water	Calculation	15%	Estimated accuracy of daily seepage calculation using NRCS soils characteristics and calculated runoff of precipitation.
	Change in SWS Storage	Calculation	50%	Professional Judgment.
Net Recharge from SWS		Calculation	25%	Estimated water budget accuracy; typical value calculated for GSA-level net recharge from SWS.

3.7 Comparison of Historical Water Budget with RCWD GSA Individual GSP

RCWD GSA is among the three GSAs that are each separately satisfying the requirements of SGMA by preparing individual GSPs. These individual GSPs have been prepared separately from this joint plan. A coordination agreement is being developed by all seven GSAs in the Madera Subbasin detailing required GSA and GSP cooperation and coordination.

To maintain consistent estimates of subbasin groundwater storage and overdraft conditions between the joint and individual GSPs, comparisons of historical surface water-groundwater exchanges have been prepared between the GSA-level historical water budgets from this coordinated plan and the historical water budgets from each of the three individual GSPs.

Table A2.F.g-19 provides a comparison between the RCWD GSA historical water budget developed as part of this coordinated plan and the RCWD GSA historical water budget developed by the District for its individual GSP. During the historical water budget period of 1989-2014, the total estimated groundwater recharge between the two water budgets is within 500 AF/yr. The net difference in water supplies and nonrecoverable losses is within 3,000 AF/yr, as the individual GSP water budget estimates greater supply (7000 AF/yr greater than coordinated GSP), but also greater nonrecoverable losses (3,630 AF/yr).

The net recharge from the SWS within the District was estimated to be approximately -10,800 AF/yr and -13,600 AF/yr, as calculated in the RCWD GSA individual GSP and this coordinated GSP, respectively. This translates to a difference of approximately 2,800 AF/yr, which is within the estimated range of the coordinated GSP net recharge estimate. These values indicate fairly close correspondence between the plans, particularly in the context of the estimated total net recharge from SWS across the entire subbasin, which exceeds -100,000 AF/yr.

Table A2.F.g-19. Comparison of Historical Water Budget Results between RCWD GSA Individual GSP and Joint GSP.

Root Creek Water District

Water Budget - Average Annual Values

Period of Record: (1989-2014)

	RCWD GSA, Individual GSP			RCWD GSA, Joint GSP					
	Estim. Irrig. Eff.	83%		Summary from WY 1989-2014, rounded to nearest 10 acre-feet					
Flow Path*	**Symbol**	**Volume (AF/yr)**	**Source**	**Volume (AF/yr)**	**Estimated Uncertainty (%)**	**Volume, Lower Estimate Bound (AF/yr)**	**Volume, Upper Estimate Bound (AF/yr)**	**Difference (Coordinated - Individual)**	**Coordinated GSP Source**
Supply									
Surface Water - Irrigation	Qirr	4,900	Measured	1,890	10%	1,700	2,100	-3,010	Measured/Estimated (diversions to holding contract land, riparian parcels)
Groundwater Pumping - Irrigation (Private Wells)	Gwirrp	19,900	Residual	22,340	20%	17,800	26,900	2,440	Residual
Groundwater Pumping - M&I (Private Wells)	Gwmip	0	Calculated	100	20%	0	200	100	Residual
Precipitation	P	8,400	Measured	8,170	30%	5,700	10,700	-230	Measured (Fresno/Madera/ Madera II CIMIS)
Total Supply		**33,200**		**32,500**				**-700**	
Demand								0	
Consumptive Use								0	
Evapotranspiration - Applied Water	ETc	24,900	Calculated	19,680	10%	17,700	21,700	-5,220	Calculated (IDC)
Evapotranspiration - Effective Precipitation	ETp	4,400	Calculated	5,910	10%	5,300	6,600	1,510	Calculated (IDC)
Evapotranspiration - M&I	ETmi	0	Calculated	80	10%	0	100	80	Calculated (IDC)
Consumptive Use Subtotal		**29,300**		**25,670**				**-3,630**	
Groundwater Recharge								0	
Deep Percolation - Irrigation	PRCirr	4,300	Calculated	4,550	20%	3,600	5,500	250	Calculated (IDC)
Deep Percolation - Precipitation	PRCp	1,100	Calculated	2,000	20%	1,600	2,400	900	Calculated (IDC)
Deep Percolation - M&I	PRCmi	0	Calculated	20	20%	0	100	20	Calculated (IDC)
Local Streams/Rivers - Recharge	Rst	3,700	Calculated	2,230	15%	1,800	2,600	-1,470	Calculated (seepage of runoff, San Joaquin River boundary seepage)
Groundwater Recharge Subtotal		**9,100**		**8,800**				**-300**	
Nonrecoverable Losses								0	
Precipitation - Evaporation and Runoff	Ep	2,900	Residual	10	20%	0	100	-2,890	Calculated (evaporation of runoff)
Nonrecoverable Subtotal		**2,900**		**10**				**-2,890**	
Net Recharge from SWS**		**-10,800**	Calculated	**-13,640**	**25%**	-10,200	-17,100	**-2,840**	

***List excludes subsurface groundwater inflows/outflows and flow paths with zero volume.**

****Calculated as the sum of groundwater recharge minus the sum of groundwater pumping; excludes subsurface groundwater inflows/outflows.**

APPENDIX 2.F. WATER BUDGET INFORMATION

2.F.h. Daily Reference Evapotranspiration and Precipitation Quality Control

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

January 2020

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1 PURPOSE

The purpose of this report is to describe the development of daily reference evapotranspiration (ET_{ref}) and precipitation values for water years 1989 through 2015 for use to determine consumptive use of irrigation water. The Study Area is the Madera groundwater basin.

This report describes the methodology for developing ET_{ref} and precipitation records, the results and the findings.

2 METHODOLOGY

Scientifically sound and widely accepted methods for determining consumptive use of irrigation water utilize daily ET_{ref} determined using the standardized Penman-Monteith (PM) method as described by the ASCE Task Committee Report on the Standardized Reference Evapotranspiration Equation (ASCE-EWRI, 2005). The PM method requires measurements of incoming solar radiation (R_s), air temperature (T_a), relative humidity (RH) and wind speed (W_s) at hourly or daily time steps. The task committee report standardizes the ASCE PM method for application to a full-cover alfalfa reference (ET_r) and to a clipped cool season grass reference (ET_o). The clipped cool season grass reference is widely used throughout the western United States and was selected for this application. Additionally, the Task Committee Report provides recommended methods for estimating required inputs to the standardized equation when measured data are unavailable. The remainder of this section describes an inventory of weather stations and available data, weather data quality control (QC), and the methods used to estimate ET_o.

2.1 Weather Data Inventory

Weather data from irrigated areas are needed to develop estimates of consumptive use of irrigation water. Automatic Weather Stations (AWS) provide measurements of R_s, T_a, RH and W_s over hourly or shorter periods used to compute ET_o. AWS data are often available from state extension services and weather station networks. Prior to the advent of the AWS, National Oceanic and Atmospheric Administration (NOAA) stations recorded daily minimum and maximum air temperatures and daily precipitation. Data from these NOAA stations are available from the National Centers for Environmental Information (NCEI) formerly National Climatic Data Center (NCDC).

In recent years, several gridded climate data sets have become available for public use. Daymet and PRISM (Parameter-elevation Relationships on Independent Slopes Model) are two of the more well-known data sets. The gridded estimates are developed by a collection of algorithms that interpolate and extrapolate from daily meteorological observations at available weather stations. Generally, the gridded estimates do not include all necessary parameters to calculate ET_o. PRISM[1] provides estimates for precipitation, daily maximum air temperature, daily minimum air temperature and daily average dewpoint temperature by interpolating between weather stations based on the physiographic similarity of the station to the grid cell.

For developing ET_o values to use in determining crop water depletions, the weather data used must represent irrigated agriculture. This is because ET from irrigated areas in arid regions is generally lower than that from surrounding not irrigated areas. The evaporation process tends to both cool and humidify the near-surface boundary layer over irrigated fields. This cooling and humidifying effect tends to reduce ET rates, including the reference ET estimate, and should be considered when calculating reference ET.

[1] http://www.prism.oregonstate.edu/ accessed on May 18, 2014.

Weather stations used to develop the gridded data are from both irrigated and not irrigated areas. For this reason, AWS inside the irrigated area are the preferred source for weather data to calculate ET_o for use in determining consumptive use of irrigation water.

A complete inventory of weather stations both inside and near irrigated areas was conducted to select the most appropriate weather station, or stations, for the historical crop water consumptive use analysis.

2.2 Weather Data Quality Control

Accurate estimation of consumptive use of irrigation water requires accurate and representative weather data. Weather data from each station were reviewed and corrected when necessary, following accepted, scientific procedures (Allen, et al 1996, Allen, et al, 1998, ASCE-EWRI, 2005 and ASCE, 2016). Daily data obtained for the AWS stations were quality checked using spreadsheets and graphs of weather data parameters for analysis and application of quality control methods according to the guidelines specified in Appendix-D of the ASCE Task Committee Report on the Standardized Reference Evapotranspiration Equation (ASCE-EWRI, 2005). Quality control procedures applied to R_s, T_a, RH and W_s are briefly described in the following sections.

2.2.1 Solar Radiation

Solar radiation data were quality controlled by plotting measured R_s and computed clear sky envelopes of solar radiation on cloudless days (R_{so}) for hourly or daily time steps (Allen, et al 1996, Allen, et al, 1998, ASCE-EWRI, 2005 and ASCE, 2016). Recommended equations for R_{so} that include the influence of sun angle, turbidity, atmospheric thickness, and precipitable water were used. The measured R_s should reach the clear sky envelope on cloud-free days. On cloudy or hazy days, the measured R_s will not reach the clear sky envelope. Measured R_s values that consistently fall above or below the curve indicate improper calibration or other problems, such as the presence of dust, bird droppings or something else on the sensor. Values for R_s that were found to be consistently above or below R_{so} on clear days were adjusted by dividing R_s by the average value of R_s/R_{so} on clear days at intervals of 60-day groupings for daily data and 30-day periods for hourly data. The values resulting from these adjustments were carefully reviewed for reasonableness of the adjustments.

2.2.2 Air Temperature

Air temperature is the simplest weather parameter to measure and the parameter most likely to be of high quality (Allen, et al 1996, Allen, et al, 1998, ASCE-EWRI, 2005 and ASCE, 2016). Nevertheless, daily maximum and minimum air temperatures were plotted together vs. time, and the extreme values were compared against historical extremes. Temperatures that consistently exceed the recorded extremes for a region may indicate a problem with the sensor or environment and may need to be adjusted based on air temperatures collected at a nearby station.

2.2.3 Relative Humidity

Daily maximum and minimum relative humidity values were plotted and examined for values chronically lower than five to ten percent and values that were consistently over 100 percent (Allen, et al 1996, Allen, et al, 1998, ASCE-EWRI, 2005 and ASCE, 2016). Additionally, relative humidity was checked on days having recorded rainfall to confirm that the measured maximum RH values approached 90 to 100 percent. Where necessary, reasonable adjustments such as setting all values above 100 percent equal to 100 percent were made.

2.2.4 Wind Speed

Wind speed records were plotted and visually inspected for consistently low wind speed values (Allen, et al 1996, Allen, et al, 1998, ASCE-EWRI, 2005 and ASCE, 2016). Low wind speeds can indicate dirty or worn anemometer bearings that lead to failure of the anemometer. Any period of more than thirty days with wind speeds below 1.0 meters per second was compared to available nearby stations and, if the wind speed at the nearby station did not indicate a period of unusually low wind speeds, adjusted based on the nearby station.

3 RESULTS

This section describes the results of an inventory of weather stations and available data, weather data quality control, and ET_o estimates.

3.1 Weather Station Inventory

Table 2A.F.h-1 lists the stations and time periods used for the Madera Subbasin weather data.

Table 2A.F.h-1. Madera Subbasin Weather Data Time Series Summary for the period 1989 – 2015.

Weather Station	Start Date	End Date	Comment
Fresno State (#80)	Oct. 2, 1988	May 12, 1998	AWS. Before Madera was installed.
Madera (#145)	May 13, 1998	Apr. 2, 2013	AWS. Moved East 2 miles and renamed “Madera II”
Madera II (#188)	Apr. 3, 2013	Dec. 31, 2015	AWS

3.2 Weather Data Quality Control

Hourly checks and necessary adjustments performed on AWS station data and daily checks are described in the following sections. However, the following sections only include examples of common data adjustments observed in the quality-controlling process. A complete list of adjustments can be found in Attachment A.

3.2.1 Solar Radiation

CIMIS AWS solar radiation data were generally of good quality, but it was apparent that some records required adjustment to fall within reasonable bounds. Two different types of quality control were performed on the solar radiation data. First, there are time periods in certain years where there is an obvious drop or rise in solar radiation values which cause them to fall significantly above or below the expected values. One instance of an unreasonable, sudden drop in solar radiation occurred in 1996 at the Madera CIMIS station. This is displayed in Figure 2A.F.h-1 below. This data was then adjusted up by a factor of 1.08, and the calibrated data is displayed in Figure 2A.F.h-2 below.

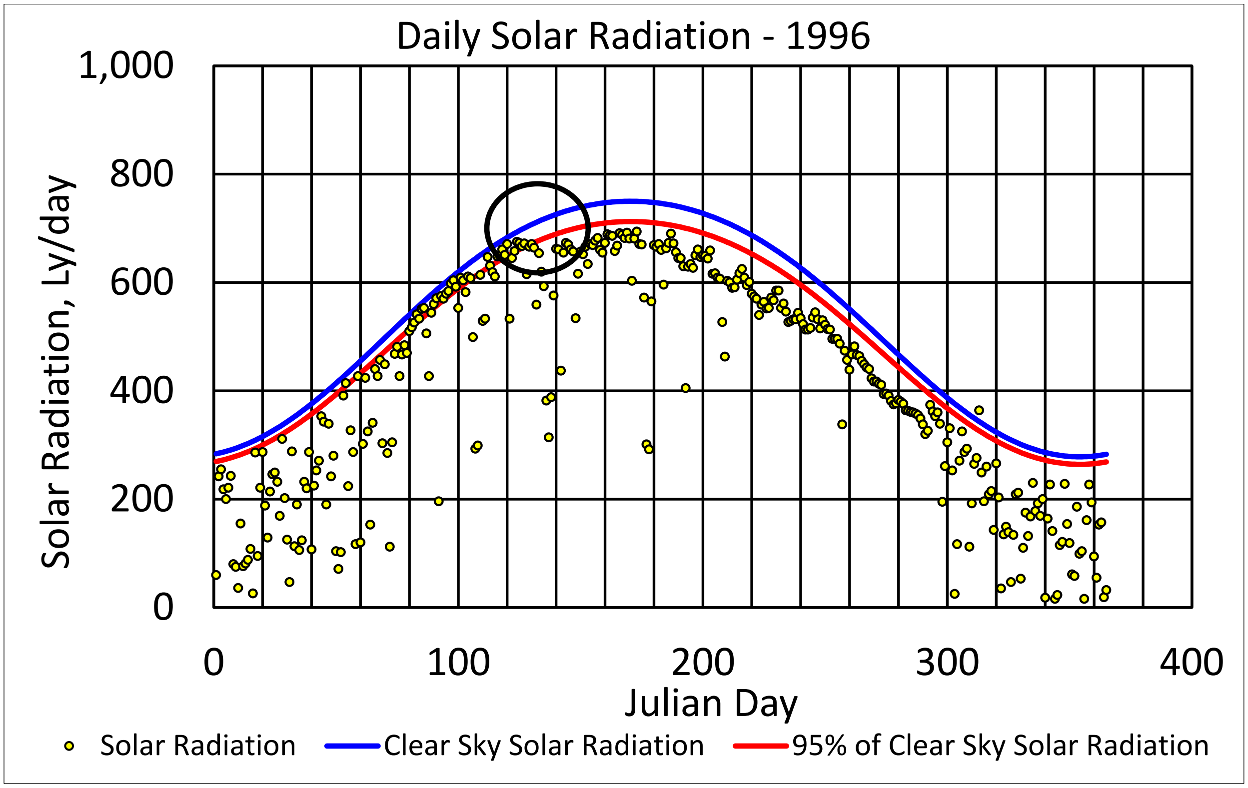

Figure 2A.F.h-1: Daily Solar Radiation (Ly/day) for Madera CIMIS station (#145) for 1996 before QC.

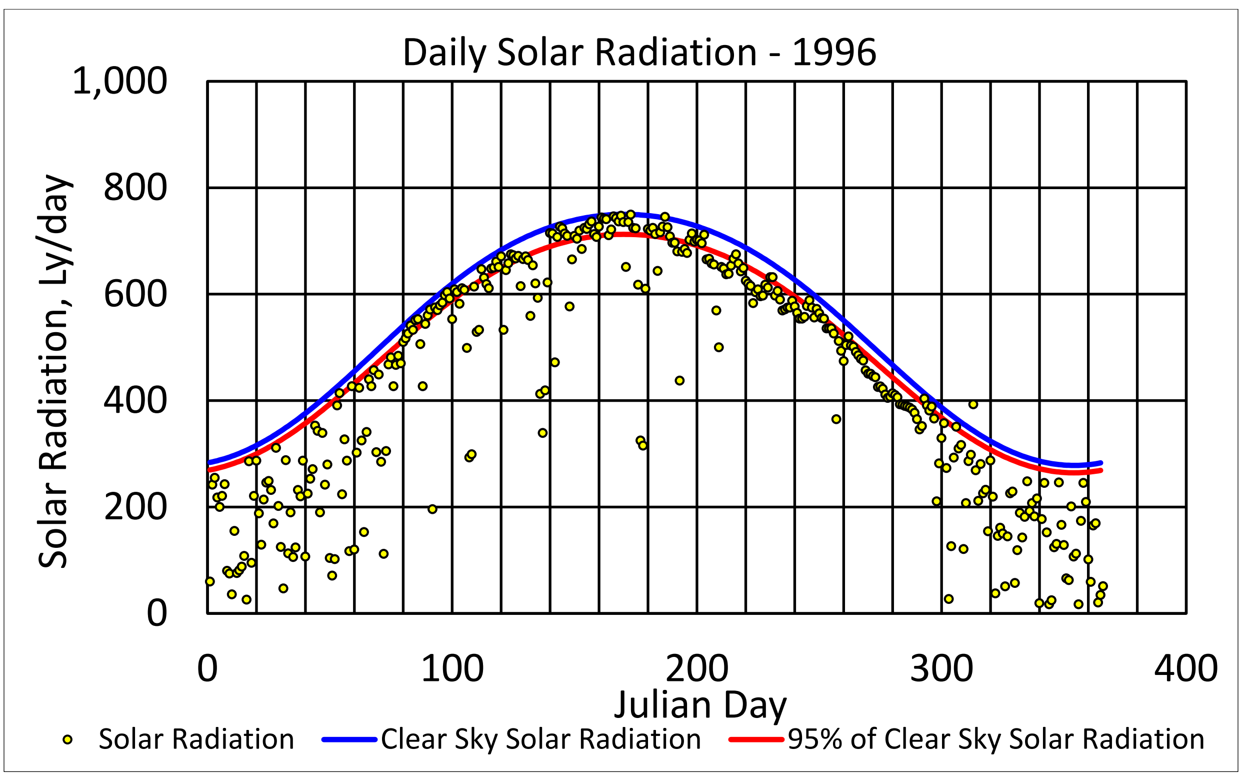

Figure 2A.F.h-2: Daily Solar Radiation (Ly/day) for Madera CIMIS station (#145) for 1996 after QC.

3.2.2 Air Temperature

For the most part, CIMIS AWS air temperature data were consistent and followed expected values and behavior. However, adjustments were applied to some data points to more closely reflect the expected temperatures within the seasons for each year. There were two common problems observed within this parameter: missing data points and minimum temperatures automatically being assigned a value of 32 degrees Fahrenheit. The latter is made obvious by the season in which the data points reside, and the difference between this point and those immediately before and after. Examples of both issues are displayed in Figure 2A.F.h-3. Missing data points were filled in with a value of the corresponding parameter from a nearby CIMIS station. The same process was applied to the points that were automatically set to 32 degrees Fahrenheit. The adjusted data can be observed in Figure 2A.F.h-4.

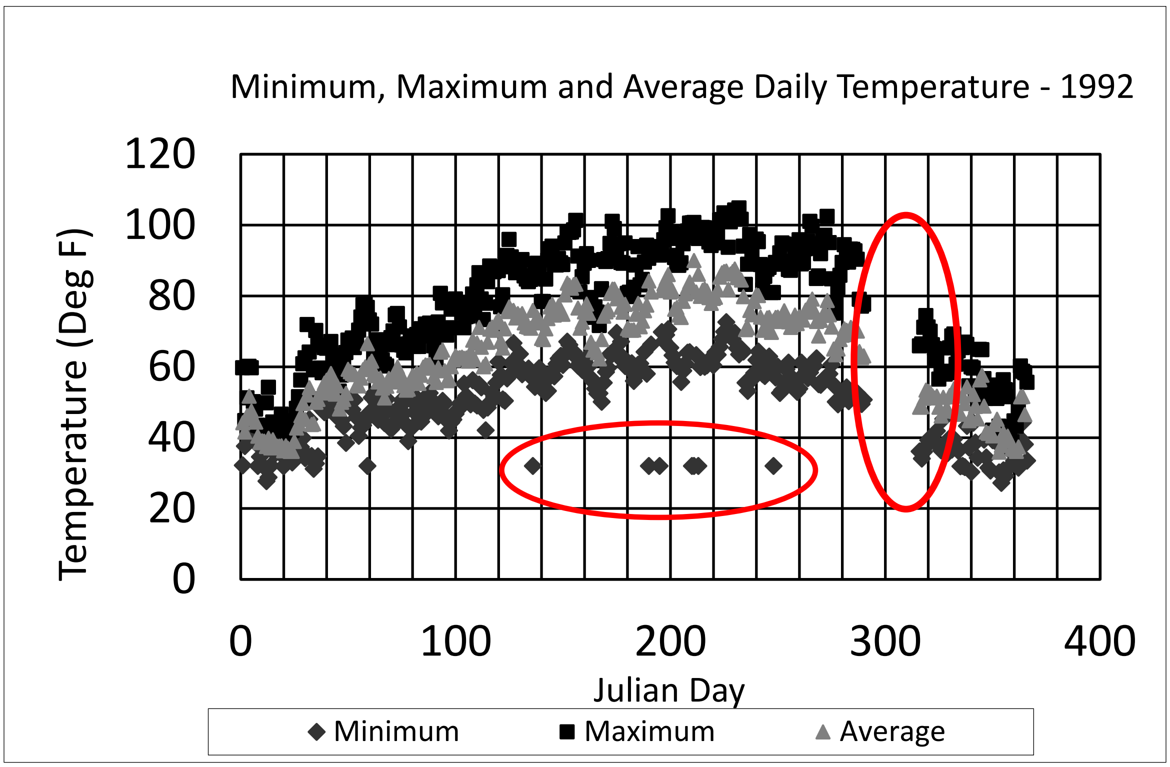

Figure 2A.F.h-3: Average, Maximum, and Minimum Daily Temperatures (DegF) for Fresno State CIMIS station (#80) for 1992 before QC.

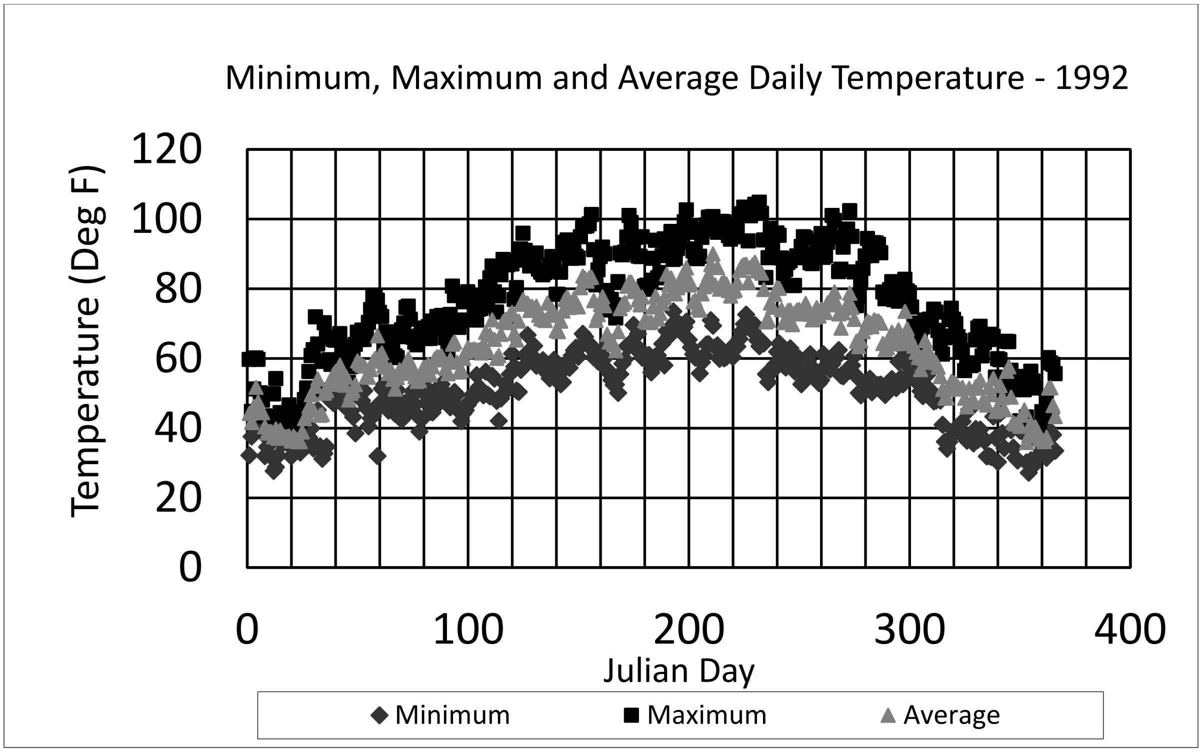

Figure 2A.F.h-4: Average, Maximum, and Minimum Daily Temperatures (DegF) for Fresno State CIMIS station (#80) for 1992 after QC.

3.2.3 Relative Humidity

CIMIS AWS Relative Humidity (RH) data was analyzed for all of the time period and station combinations listed in Table 2A.F.h-1 above and the necessary adjustments were made. Maximum RH at night commonly approaches 60% during the summer period and 100% during the winter period. When values fall significantly below this expected range of values (Figure 2A.F.h-5), it can be concluded that the RH sensor is in need of calibration or to be replaced and the data need to be adjusted. In years when this trend was observed, such as for the Madera station in 2005, the data was adjusted (Figure 2A.F.h-6).

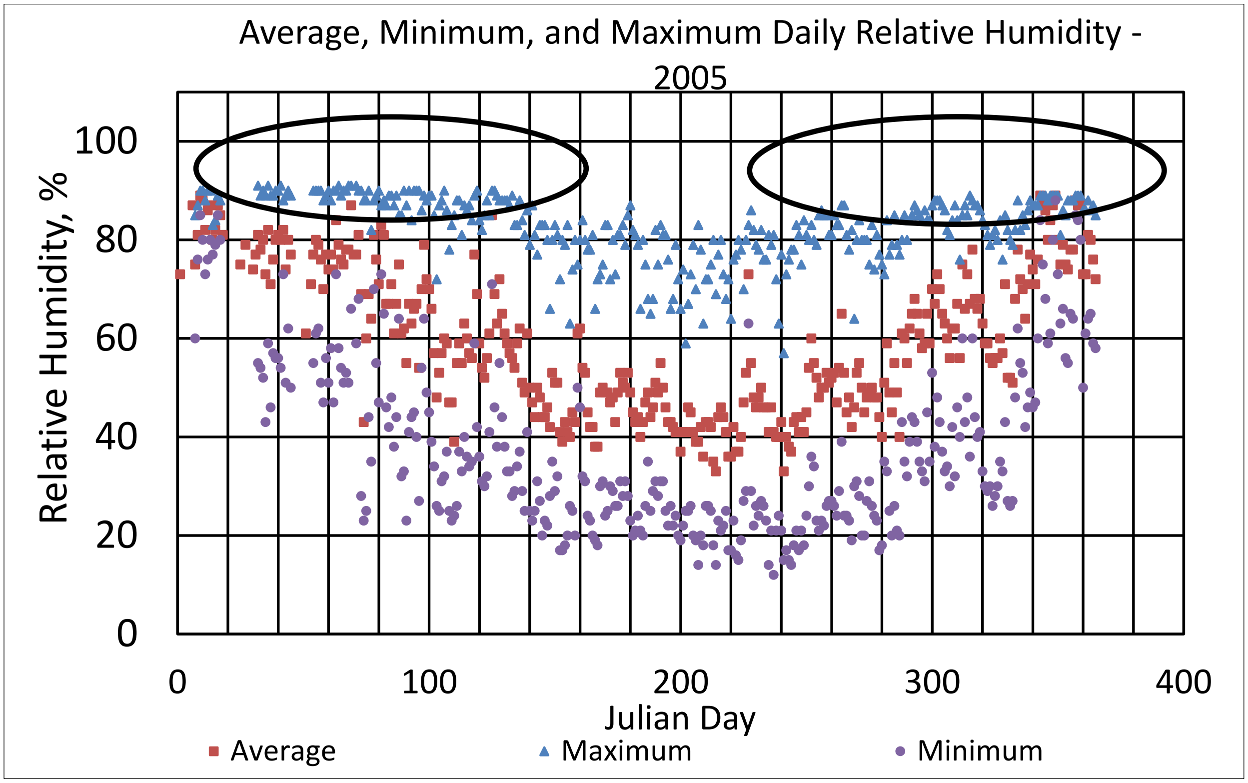

Figure 2A.F.h-5: Average, Maximum, and Minimum Daily Temperature (DegF) for Madera CIMIS station (#145) for 2005 before QC.

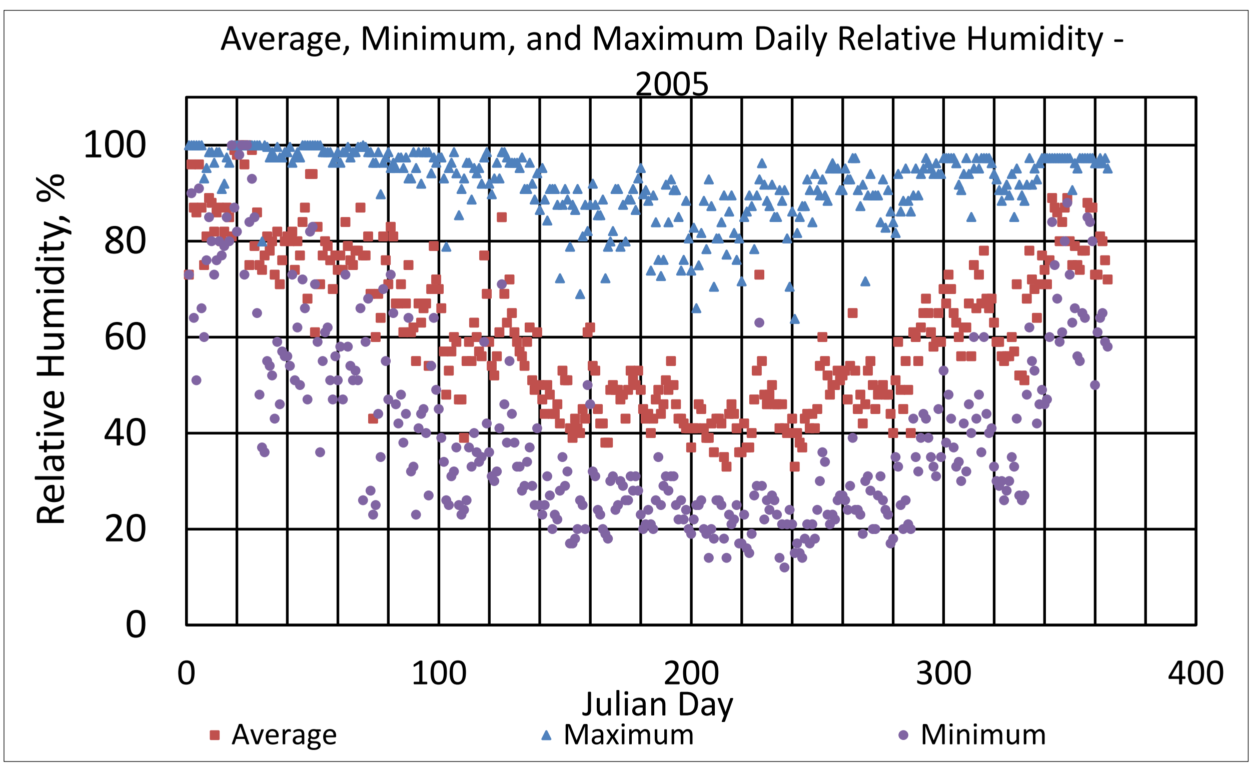

Figure 2A.F.h-6: Average, Maximum, and Minimum Daily Temperature (DegF) for Madera CIMIS station (#145) for 2005 after QC.

3.2.4 Wind Speed

CIMIS AWS wind speed data were generally reasonable and usually followed expected ranges and patterns, with lower values during nighttime and higher values during the day. To calculate ET_o, all hourly wind speed values less than 0.5 m/s were set to 0.5 m/s, following the recommendation in ASCE-EWRI (2005), Appendix E, to represent a floor on wind movement and equilibrium boundary layer stability effects in the Penman-Monteith equation. A graphical example of this quality-control as it is applied to Madera windspeed data in the year 2000, can be observed in Figures 2A.F.h-7 (unadjusted data) and 2A.F.h-8 (adjusted data).

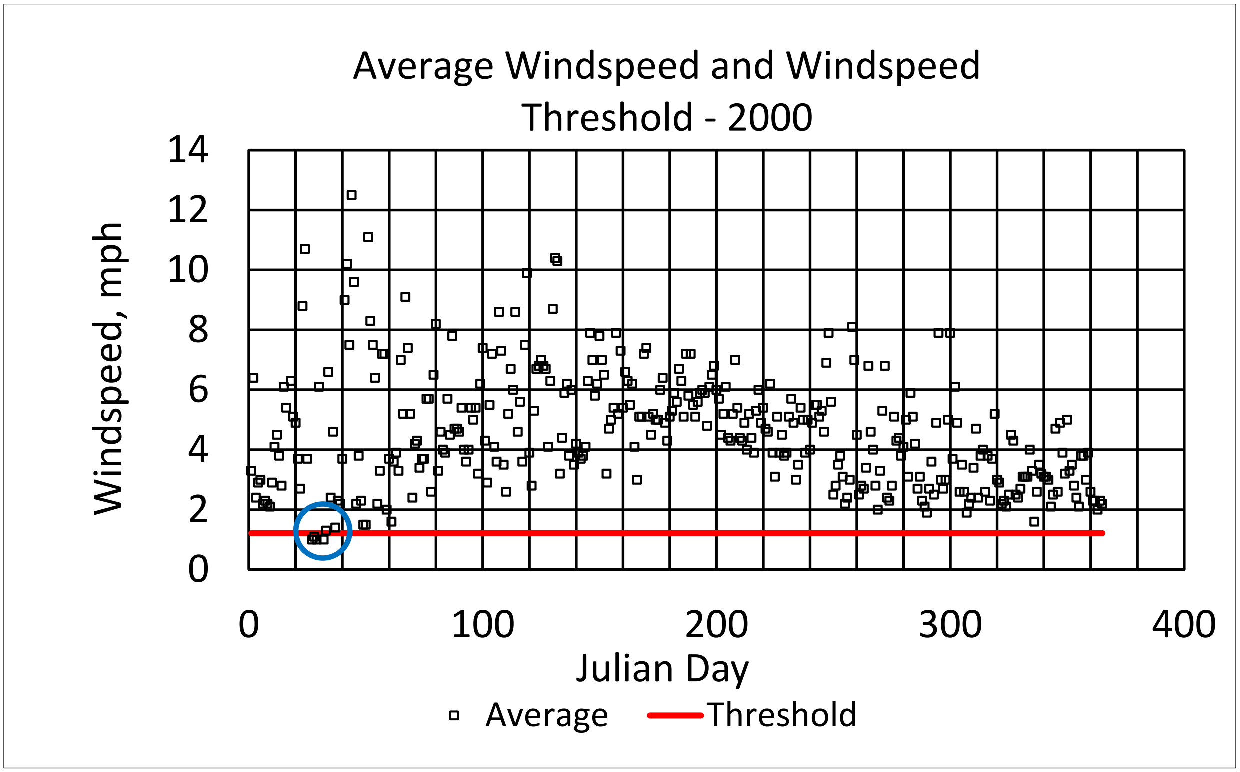

Figure 2A.F.h-7: Average Windspeed (mph) for Madera CIMIS station (#145) for 2000 before quality-controlling.

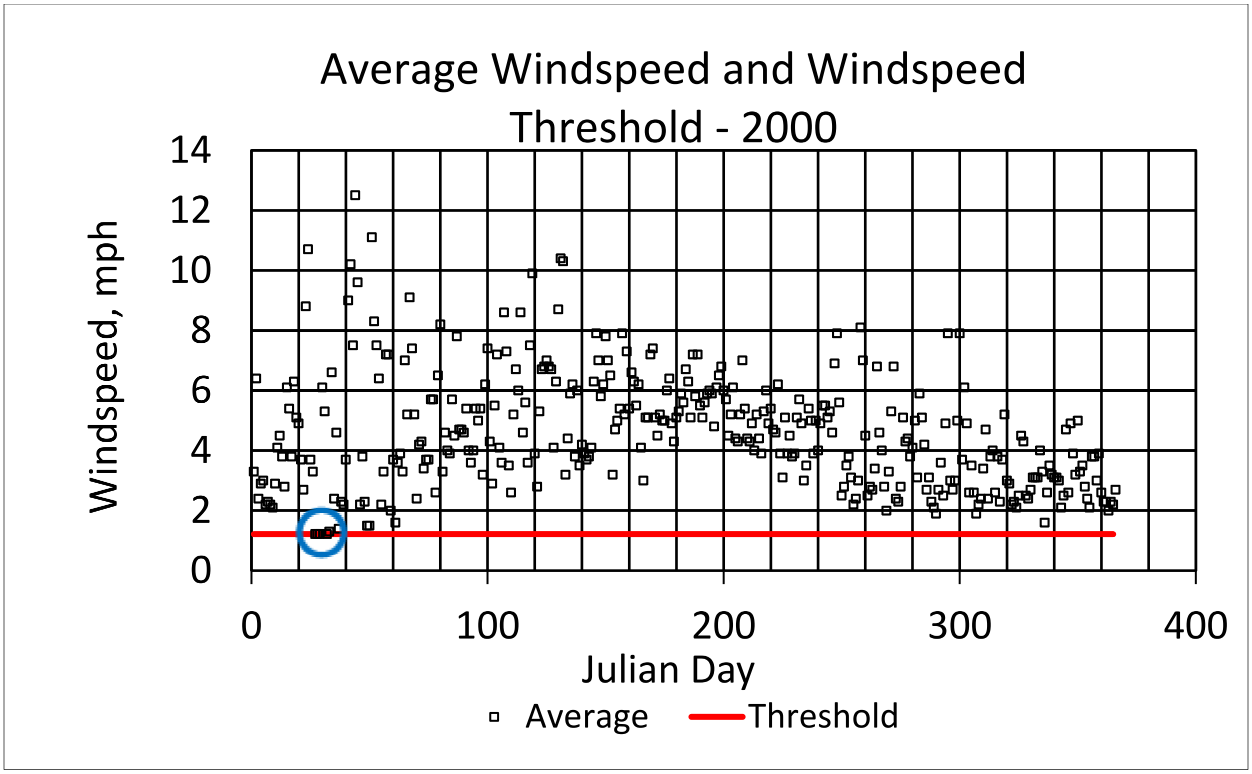

Figure 2A.F.h-8: Average Windspeed (mph) for Madera CIMIS station (#145) for 2000 after quality-controlling.

3.2.5 ET$_o$ Results Summary

The average water year ET$_o$ for 1989 – 2015 was 55.34 inches and ranged from 50.64 inches in 1995 to 59.79 inches in 2004. This indicates that the differences in the average ET$_o$ values computed from the weather data collected at the various stations (Table 2A.F.h-2) is most likely due to natural and expected variability in the record.

Table2A.F.h- 2. Weather Data Time Series Summary for the period 1989 – 2015.

Weather Station	Start Date	End Date	Average Water Year ET$_o$, inches	Minimum Water Year ET$_o$, inches	Maximum Water Year ET$_o$, inches
Fresno State	Oct. 1, 1988	May 12, 1998	55.13	50.64 (1995)	59.27 (1992)
Madera	May 13, 1998	Apr. 2, 2013	55.67	52.56 (2011)	59.79 (2004)
Madera II	Apr. 3, 2013	Dec. 31, 2015	55.51	53.79 (2014)	57.24 (2015)
Overall	Oct. 2, 1988	Dec. 31, 2015	55.34	50.64	59.79

Water year ET$_o$ totals for the complete 1989 to 2015 period are included in Attachment 2A.F.h-A.

3.2.6 Precipitation Results Summary

The 26-year average water year precipitation from 1989 to 2015, was 10.11 inches, varying from 3.59 inches in 2014 to 19.62 inches in 1995 (Table 2A.F.h-3).

Table2A.F.h-3. Water Year Precipitation Statistics for 1989-2015.

Weather Station	Start Date	End Date	Average Water Year Rainfall, inches	Minimum Water Year Rainfall, inches	Maximum Water Year Rainfall, inches
Fresno State	Oct. 1, 1988	May 12, 1998	12.76	9.14 (1994)	19.62 (1995)
Madera	May 13, 1998	Apr. 2, 2013	8.98	4.35 (2012	12.79 (2006)
Madera II	Apr. 3, 2013	Dec. 31, 2015	4.25	3.59 (2014)	4.90 (2015)
Overall	Oct. 2, 1988	Dec. 31, 2015	10.11	3.59 (2014)	19.62 (1995)

Water year rainfall totals for the complete 1989 to 2015 period are included in Attachment 2A.F.h-B.

4 FINDINGS

All weather stations in the Madera Subbasin are located in agricultural areas. Quality control and quality assessment protocols were followed with review of hourly data and necessary adjustments performed on AWS data and daily checks and necessary adjustments performed on NOAA data. In conclusion, the time period was of such duration that at some point each parameter needed some adjustment. Minor adjustments to short periods of the wind data were necessary at all three sites. Air temperature data were mostly acceptable with the exception of multiple errors in the minimum temperature values for individual points within each site. Regarding both solar radiation and relative humidity for each site, erroneous trends were noticed and corrected, though the adjustment factors generally remained minimal (under 5%).

The average water year ET_o for 1989 – 2015 was 55.34 inches. The 26-year average precipitation from 1989 to 2015, was 10.11 inches.

5 REFERENCES

Allen, R.G. 1996. *“Assessing integrity of weather data for use in reference evapotranspiration estimation.” J. Irrig. And Drain. Engrg.*, ASCE. 122(2):97-106.

Allen, R.G., L.S. Pereira, D. Raes and M Smith. 1998. *"Crop Evapotranspiration: Guidelines for computing crop water requirements."* Irrig. And Drain. Paper 56, Food and Agriculture Organization of the United Nations, Rome, 300 pp.

Allen, R.G., Walter. I. A., Elliot, R., Howell, T., Itenfisu, D., Jensen, M. 2005. *"The ASCE Standardized Reference Evapotranspiration Equation."* Publication, American Society of Civil Engineers.

Attachment 2A.F.h-A. List of Quality Control Adjustments Completed

Madera II Weather Station data:

Air Temperature:

2013: bad minimum temperature for 4-2, 10-7, 11-12,

2014: bad minimum temperature on 3-10, 4-7, 11-10, 11-12,

2015: bad minimum temperature on 3-9, 12-8,

2016: bad minimum temperature on 2-26, 5-27, 10-18,

Solar Radiation:

2013: data values need replacement on 4-2, 7-2, 7-5, 8-12, 9-4, 9-11, 9-17,

2014: 1% increase until 6-29, 4% increase the rest of the year, data values need replacement on 3-10, 4-3, 4-7, 6-4, 6-6, 8-12, 9-4, 9-8, 10-22, 11-10, 11-14

2015: 2% increase all year, data values need replacement on 2-9, 3-9, 7-8, 8-17, 9-16, 11-13

Relative Humidity:

2013: increase data up 3% all year (from 4-2 when station starts through the end of year)

2014: apply 3% increase for first half of year

2015: good

Windspeed*:

2013-2015: Good

Fresno State Weather Station data:

Air Temperature:

1989: missing average air temperature for 1-1 and 1-2, 10-13, missing all data for 10-12

1990: missing/bad data for 3-26 and 3-27, missing all data from 8-20 through 9-1

1991: bad data point on 3-8, missing data on 10-18 through 10-21 and 12-23

1992: missing data from 7-10 through 7-13 and from 10-17 through 11-10, data points need replacement on 5-15, 7-8, 7-13, 7-28, 7-29, 7-31, 9-4, 11-6, and 12-1

1993: bad minimum temperature readings on 2-1, 3-23, 4-21, 5-21, 6-25, 7-2, 9-10, and 10-29

1994: bad minimum temperature readings on 5-20, 7-18, 9-9, missing average temperature on 1-3

1995: all good

1996: bad minimum temperature on 4-30, 11-8, 12-31

1997: bad minimum temperature on 7-29, 4-1, 4-18, 10-2, and 10-10

1998: bad minimum temperature on 7-17, 8-17, bad average temp on 9-4

1999: bad minimum temperature on 4-10, 10-15, missing minimum temperature on 6-11, 7-23, 9-22, bad average temperature on 2-25, 3-1

2000: bad minimum temperature values on 4-12, 5-2, 5-16, 10-20,

2001: bad minimum temperature values on 4-10, 5-31, and 10-12

2002: bad minimum temperature values on 2-25, 4-30, 5-28,

2003: bad minimum temperature values on 3-11,

Solar Radiation:

1989: Good

1990: Good

1991: Adjust data down 9% from 5-30 through 6-7

1992: data points need replacement on 5-15, 7-13, 7-29, 7-31, 9-4, 12-1; adjust all data for this year up 2.5%

1993: data points need replacement on 2-1, 5-21, 6-25, 7-2, 9-10, 10-29

1994: data points need replacement on 7-18

1995: adjust data down 1%

1996: Adjust data up 8% from 5-15 on

1997: Adjust data up 8% until 4-1, then no adjustment; data points need replacement on 4-1, 4-18, 7-29

1998: data points need replacement on 5-1, 7-17, 11-25, adjust data down 2% from 5-9 through 7-1

1999: data points need replacement for 4-23, 6-11, 7-23, moved data up 5% from beginning until 8-10, move data up 7% from 8-10 until 9-2, then move data up 12% for the rest of the year

Relative Humidity:

1989: good

1990: move data up 1% for the whole year

1991: move data up 4% from 9-21 through end of the year

1992: move data up 1% all year

1993: Good

1994: Good

1995: Good

1996: Good

1997: Good

1998: Good

1999: Good

Windspeed*:

1989-1999: Good

Madera Weather Station Data:

Air temperature:

1998: Bad minimum temperature on 10-1,

1999: bad minimum temperature on 4-23,

2000: bad minimum temperature on 3-7, 10-2,

2001: bad minimum temperature on 10-11,

2002: bad minimum temperature on 4-15, 4-22, 2-27,

2003: bad minimum temperature on 3-2, 4-8, 5-12, 10-29,

2004: bad minimum temperature on 4-21, 12-5, 12-9,

2005: bad minimum temperature on 1-6, 1-12, 1-31, 4-20,

2006: bad minimum temperature on 2-6,

2007: bad average temperature on 1-1,

2008: bad minimum temperature on 4-14,

2009: bad minimum temperature on 1-16, 3-13,

2010: bad minimum temperature on 1-27,

2011: bad minimum temperatures on 1-22 through 2-1, 2-16, 3-17, 4-14, bad average temperature on 11-29,

2012: bad minimum temperature on 5-9, 2-6, 2-28, 1-23,

2013: good through 4-2 (end of record)

Solar Radiation:

1998: Data points need replacement on 8-26, 12-23, 12-31,

1999: Data points need replacement on 4-2, 4-23, 6-11, 7-2, 9-7, move all data up 3.5%,

2000: move data down 1% until 6-6, and then move data up 1% through the rest of the year

2001: data points need replacement on 7-20, 8-13, 8-15, 9-10, move data up 3% until 5-10, then move data up 4% until 7-11, then unadjusted data through the end of the year

2002: move all data down 1.5%, data points need replacement on 8-21, 8-24, 8-25,

2003: From 7-15 on, move data up 3.5%, data points need replacement on 3-10, 4-8, 5-12, 7-10, 8-14,

2004: data points need replacement on 6-18, 7-19, 8-18, move all data up 2.5%,

2005: data points need replacement on 2-22, 3-15, move all data up 4%

2006: move data up 10% until 6-19, and then move data up 14% through the end of the year

2007: data points need replacement on 8-16, move data down 3% until 5-2, and then move data down 8% until 8-14, then move data up 3% for the rest of the year,

2008: move data up 13% until 4-13, then move data down 12% through the end of the year, 2009: move data down 6% until 6-7, then move data down 2% for the rest of the year, data points need replacement on 6-16, 6-19, 8-7, 8-10,

2010: move data up 2% for the year, data points need replacement on 1-27, 11-24,

2011: move data up 3.5% until 5-25, then move data down 6% until end of year, data points need replacement on 7-18, 9-7, 11-2,

2012: replace data from 4-29 through 5-7, and on 3-19, 5-9, 6-5, 6-6, move data up 5% from 5-14 through the end of the year,

2013: data points need replacement from 3-29 through 4-2

Relative Humidity:

1998: good

1999: apply 2% increase to the second half of the year

2000: apply 2% increase to first half of year, and 3% increase to second half of year

2001: apply 3% increase to first half of year, and 4% increase to second half of year

2002: apply 4% increase all year

2003: apply 4% increase to first half of year, and 6.5% increase to second half of year

2004: apply 7% increase to first half of year, and 8.5% increase to second half of year

2005: apply 9.5% increase to first half of year, and 12% increase to second half of year

2006: apply % increase until 6-9, then no adjustment factor

2007: good

2008: good

2009: apply 2% increase all year

2010: apply 2% increase all year

2011: apply 2% increase all year

2012: apply 1% increase all year

2013: Good

Windspeed*:

1998-2013: Good

*Windspeed values that fell below the threshold may have been replaced with replacement stations data but are not listed here because they were not replaced in the manual review QC process.

Attachment 2A.F.h-B. Annual ET_o and Precipitation Results

Table 2A.F.h-B-1. Water Year ET_o and Precipitation Results

Water Year	ETo, inches	Precip, inches
1989	52.68	11.96
1990	55.16	11.15
1991	54.96	11.65
1992	59.27	9.52
1993	55.29	16.13
1994	55.75	9.14
1995	50.64	19.62
1996	55.76	11.99
1997	56.63	13.70
1998	53.05	16.55
1999	52.63	6.68
2000	55.02	10.89
2001	56.16	10.16
2002	56.07	9.22
2003	55.42	8.10
2004	59.79	6.73
2005	53.94	11.61
2006	55.44	12.79
2007	57.25	5.18
2008	57.36	7.87
2009	57.62	7.11
2010	53.24	12.21
2011	52.56	12.78
2012	56.89	4.35
2013	54.50	7.35
2014	53.79	3.59
2015	57.24	4.90

APPENDIX 2.F. WATER BUDGET INFORMATION

2.F.i. Development of Daily Time Step IDC Root Zone Water Budget Model

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

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1 OVERVIEW

The Madera Subbasin water budget uses available data and estimates to develop an accurate accounting of all water inflows and outflows from the Madera Subbasin. As part of water budget development, flows through the root zone and land surface were modeled using the root zone water budget modeling tool known as the Integrated Water Flow Model (IWFM) Demand Calculator, or IDC. IDC uses weather data and information regarding crops, soil properties, and irrigation methods to compute the balance of inflows and outflows from the Land Surface System.

IDC can be used as a stand-alone tool, or it can be integrated for use with IWFM. Both tools are developed and maintained by the California Department of Water Resources (DWR). For developing the Madera Subbasin Surface Water System (SWS) water budgets, a daily IDC application was used as a stand-alone root zone model independent of IWFM. For developing the integrated SWS and Groundwater System (GWS) water budgets, this daily IDC application was converted to a monthly application, recalibrated to match the monthly inflows and outflows in the SWS water budgets, and then integrated with the California Central Valley Groundwater-Surface Water Simulation Model (C2VSim) application modified for modeling the Madera Subbasin SWS and GWS, known as MCSim. The IDC application thus served as the foundation for coupling the SWS water budget to the groundwater model used in GSP development.

For the Madera Subbasin water budget, IDC was used to develop time series estimates for the following outputs which were then combined with surface water delivery and groundwater pumping information to complete the subbasin boundary water budget: and to provide estimates of the infiltration of precipitation and runoff of precipitation:

- ET of precipitation (ET_{pr})
- ET of applied water (ET_{aw})
- Infiltration of precipitation, also called deep percolation of precipitation (DP_{pr})
- Infiltration of applied water, also called deep percolation of applied water (DP_{aw})
- Uncollected surface runoff of precipitation (RO_{pr})
- Uncollected surface runoff of applied water (RO_{aw}; estimated as negligible in the Madera Subbasin)
- Change in root zone storage

IDC files were developed for a stand-alone, daily time step IDC application and these inputs were later adapted into IDC files used to simulate root zone soil moisture within IWFM. Thus, the IWFM results for the surface layer of the Madera Subbasin area should be carefully reviewed and IDC Model parameters may require some adjustment to align the results with the agricultural lands water budget results.

Inputs provided to the IDC root zone model include:

- Daily crop evapotranspiration (ET_c) representing actual ET (as compared to potential ET) for each crop or land use class from January 1, 1985 through December 31, 2015 developed by multiplying reference ET (ET_o) by the appropriate crop coefficient (developed from a 2009 SEBAL (remotely sensed energy balance analysis)).
- Daily precipitation (P_r) from January 1, 1985 through December 31, 2015.
- Soil properties for each soil texture simulated
- Rooting depth for each crop or land use class
- Other model parameters for the land use classes and soil texture combinations simulated, including soil moisture parameters and runoff curve numbers

2 IDC MODEL SETUP

The IDC Model was used as a stand-alone root zone modeling tool to develop a surface layer water budget for the Madera Subbasin to provide preliminary information regarding subbasin water overdraft prior to the development of the groundwater model. The IDC Model was then linked with IWFM to develop a groundwater model for the Chowchilla and Madera Subbasins.

The stand-alone IDC Model uses a daily time step to accurately parse ET_c into ET_{aw} and ET_{pr} for the Madera Subbasin agricultural water budget between January 1, 1985 and December 31, 2015. The model is set up as a unitized model (as compared to a spatial model) that provides per acre results by specifying one unique land use class-soil-runoff combination per element with the area of each element set to 10,000 acres. A total of 17 land use classes and 16 soil textures were evaluated with one specified curve number representing runoff conditions for each. To allow land use class-soil-runoff combinations to be added in future years, 50 elements comprised of 114 nodes were configured in the model. The land use class-soil-runoff combinations are described in the following sections. The provided input files were used with the IWFM Version 2015.0.0036, Root Zone Component Version 4.0 (DWR, 2015). All land use classes were modeled as non-ponded crops except the urban land use class, which was modeled using the IDC urban module.

The linked IDC Model uses a monthly time step to link with the IWFM groundwater model. The monthly linked model results should match daily model results summed to monthly and annual time steps. Because of the differing time steps, some of the IDC parameters in the daily model must be revised. Those revisions are described in the appropriate sections below.

2.1 Weather Inputs

2.1.1 Evapotranspiration Inputs

Daily reference ET (ET_o) values used for 1985 through 2015 were based on measured weather data from three California Irrigation Management Information System (CIMIS) stations (Table 2A.F.i-1). Measured weather parameters supporting daily ET_o calculations were quality controlled following standard procedures (ASCE-EWRI, 2005) to produce a high quality daily ET_o time series for use with crop coefficients to develop the ET time series for each land use class as described in Appendix 2.F.h.

Table 1. Madera Subbasin Weather Data Time Series Summary for the period 1989 – 2015.

Weather Station	Start Date	End Date	Comment
Fresno State (#80)	Jan. 1, 1985	May 12, 1998	CIMIS. Before Madera was installed.
Madera (#145)	May 13, 1998	Apr. 2, 2013	CIMIS. Moved East 2 miles and renamed “Madera II”
Madera II (#188)	Apr. 3, 2013	Dec. 31, 2015	CIMIS.

Crop coefficients were derived using ET_o values described in the previous paragraph and actual ET (ET_a) estimates based on remotely sensed surface energy balance results from Surface Energy Balance Algorithm for Land (SEBAL) (Bastiaanssen, et al. 2005). Spatially distributed ET_a results were available with spatial cropping data for 2009. SEBAL results account for effects of salinity, deficit irrigation, disease, fertilization, immature permanent crops, crop canopy structure, and any other factors resulting in differences between potential and actual crop ET. Studies by Bastiaanssen et al. (2005), Allen et al. (2007, 2011), Thoreson et al. (2009), and others have found that when performed by an expert analyst, seasonal

ET_a estimates by these models are expected to be within five percent of actual ET determined using other, reliable methods. For crops grown in the Madera Subbasin, annual ET_a computed using the quality controlled CIMIS ET_o and crop coefficients are provided in Table 2A.F.i-2.

Table 2A.F.i-2. Average Acreages and Annual Evapotranspiration Rates for Madera Subbasin, 1989 to 2015.

Crop	ET_c (in)	ET_{pr} (in)	ET_{aw} (in)
Alfalfa	38.6	7.5	31.0
Almonds	41.6	7.1	34.5
Citrus and Subtropical	40.3	7.6	32.7
Corn (double cropped)	34.3	5.6	28.7
Grain and Hay Crops	7.7	7.7	0.0
Grapes	26.7	6.6	20.0
Idle	6.5	6.5	0.0
Miscellaneous Deciduous	30.4	8.3	22.1
Miscellaneous Field Crops	30.9	6.4	24.5
Miscellaneous Truck Crops	30.4	5.2	25.2
Mixed Pasture	28.7	6.7	22.0
Native	7.5	7.5	0.0
Pistachios	32.3	7.5	24.8
Semi-agricultural	13.9	6.7	7.2
Urban	14.1	6.7	7.4
Walnuts	33.9	7.2	26.7
Water	48.5	6.5	42.0

2.1.2 Precipitation Inputs

Precipitation values were obtained from the three CIMIS stations (Table 2A.F.i-1) for 1985 through 2015 and averaged 10.1 inches per water year during the 1989 through 2015 period. The precipitation records were carefully reviewed and standard quality control procedures (ASCE-EWRI, 2005) were applied as described in Appendix 2.F.h.

2.2 Land Use Inputs and Parameters

2.2.1 Land Use

Annual land use was estimated based primarily on spatially distributed land use information from DWR Land Use surveys in 1995, 2001 and 2011 and Land IQ[1] remote sensing-based land use identification for 2014. County Agriculture Commission land use areas were used to interpolate between years with available spatial land use information. Lands in the District were assigned to one of 17 land use classes. These land use classes along with average acres over the 1989 through 2015 period are listed in Table 2A.F.i-2.

The Madera Subbasin underlies land within Madera County. The following five steps were used to develop the Madera County-wide annual, spatial land use dataset.

1.) Developed spatial land use coverages for 1995, 2001, 2011, and 2014. Made adjustments to the spatial coverage, including:
    a) Filled missing area from LandIQ coverage with 2011 DWR coverage (native, semi-agricultural, urban, and water account for 86% of the missing area)
    b) Used the water area from 2001 for the 1995 DWR survey (water surfaces were not included in the 1995 DWR survey).

2.) Calculated agricultural area:
    a) Assumed county data does not include idle land (county data has idle equal to zero for all years)
    b) Excluded idle land from DWR agricultural totals to be consistent with county totals
    c) Calculated the ratio of the DWR agricultural total area (not including idle lands) to county agricultural production area for years with DWR (or Land IQ) land use data
    d) Estimated agricultural area for missing years between the first and last available county data by interpolating the ratio calculated in step (c)
    e) Estimated agricultural area for missing years outside the available county data by extending the annual trend or estimating as equal to the nearest available county data

3.) Multiplied county agricultural acres for each crop by the ratio calculated in in step 2 (c) to adjust county agricultural areas for each crop scaling each crop area in each year by an estimate of the difference between the areas in the DWR land use surveys and County Commissioner reports. This procedure assumes DWR areas are the most accurate.
    a) Interpolated native, semi-agricultural, urban, and water land uses between DWR years.
    b) Calculated idle area as the remaining area (total DWR land use minus total cropped area)

4.) Reviewed calculated idle and crop area graphs and adjusted individual annual cropped areas with abnormal crop area shifts based on professional judgement to eliminate calculated negative idle areas
    a) 1996 adjustments--replaced high miscellaneous truck areas with interpolated values between 1995 and 1997
    b) 2002, 2003, 2004 and 2005 adjustments--replaced high areas for mixed pasture and alfalfa between 2001 and 2011 DWR areas by interpolating areas between 2001 and 2011.
    c) 2012 adjustments--replaced high miscellaneous deciduous, field and truck with interpolated value between 2011 and 2013

5.) Implemented the DWR Land Use interpolation tool to create annual spatial cropping data sets.

[1] Land IQ is a firm that was contracted by DWR to use remote sensing methodologies to identify crops in fields.

Complete land use areas for the entire subbasin for 1989 through 2015 are provided in Section 2 of the GSP.

2.2.2 Root Depth

The IDC model was set up to simulate the aforementioned land use classes. Root depths for each land use class were estimated primarily from ASCE (2016) with consideration given for local conditions. A list of the land use classes and their associated rooting depths are provided in Table 2A.F.i-3. IDC provides an option that models changing root growth as the season progresses for annual crops. For this application, all land use classes were modeled with constant root depths.

Table 2A.F.i-3. Root Depths Used in IDC Model by Land Use Class.

Land Use Class	Root Depth, ft
Alfalfa	6.0
Almonds	4.0
Citrus and Subtropical	4.0
Corn (double crop)	3.5
Grain and Hay Crops	3.5
Grapes	4.0
Idle	3.0
Miscellaneous Deciduous	4.0
Miscellaneous Field Crops	3.5
Miscellaneous Truck Crops	2.5
Mixed Pasture	3.0
Native	6.0
Pistachios	4.0
Semi-agricultural	4.0
Urban	4.0
Walnuts	6.0
Water	4.0

2.2.3 Runoff Curve Numbers

The IDC uses a modified version of the SCS curve number (SCS-CN) method to compute runoff of precipitation. A curve number for each land use class and soil type is required as input to the model. Curve numbers are used as described in the National Engineering Handbook Part 630[2] (USDA, 2004, 2007) based on land use or cover type, treatments (straight rows, bare soil, etc.), hydrologic condition, and hydrologic soil group. An area weighted average curve number for each land use-soil texture combination was calculated based on the area in each hydrologic soil group assuming good hydrologic conditions (Table 2A.F.i-4). The total area of each soil group within the Madera Subbasin was estimated from the NRCS SSURGO database and is described in a later section.

[2] Table 1. Runoff curve numbers for agricultural lands.

Table 2A.F.i-4. Curve Number Used to Represent Runoff Conditions in Madera Subbasin.

Soil Texture (% Sand,% Silt, % Clay)	Alfalfa	Almonds	Citrus and Subtropical	Corn	Grain and Hay Crops	Grapes	Idle	Miscellaneous Deciduous	Miscellaneous Field Crops	Miscellaneous Truck Crops	Mixed Pasture	Native	Pistachios	Semi-agricultural	Walnuts	Water	Urban
clay - clay loam (30, 30, 40)	78	79	79	89	87	79	94	79	89	89	78	78	79	86	79	89	69
clay (20, 30, 50)	78	79	79	89	87	79	94	79	89	89	78	78	79	86	79	89	
clay (30, 20, 50)	78	79	79	89	87	79	94	79	89	89	78	78	79	86	79	89	
clay loam (30, 40, 30)	74	75	75	87	84	75	92	75	87	87	74	74	75	83	75	87	
clay loam (40, 30, 30)	77	78	78	88	86	78	94	78	88	88	77	77	78	85	78	88	
loam (40, 40, 20)	69	70	70	84	82	70	90	70	84	84	69	69	70	81	70	84	
loam (50, 30, 20)	73	74	74	86	84	74	92	74	86	86	73	73	74	83	74	86	
loamy sand (80, 20, 0)	31	33	33	67	63	33	77	33	67	67	31	31	33	59	33	67	
sand (100, 0, 0)	60	61	61	80	77	61	87	61	80	80	60	60	61	76	61	80	
sandy clay loam (50, 20, 30)	78	79	79	89	87	79	94	79	89	89	78	78	79	86	79	89	
sandy clay loam (60, 10, 30)	78	79	79	89	87	79	94	79	89	89	78	78	79	86	79	89	
sandy loam - sandy clay loam (60, 20, 20)	64	65	65	81	79	65	89	65	81	81	64	64	65	78	65	81	
sandy loam - sandy clay loam (70, 10, 20)	77	78	78	88	86	78	93	78	88	88	77	77	78	85	78	88	
sandy loam (70, 20, 10)	61	61	61	80	77	61	87	61	80	80	61	61	61	76	61	80	
sandy loam (80, 10, 10)	41	42	42	71	68	42	80	42	71	71	41	41	42	65	42	71	
silty clay loam (20, 50, 30)	58	58	58	78	75	58	86	58	78	78	58	58	58	74	58	78	

When IDC is run on a monthly time step, if the curve number used for the daily model is used, greater volumes of runoff of precipitation result. Thus, the curve number values were adjusted to result in runoff of precipitation volumes consistent with the daily model results.

2.2.4 Irrigation Period

The irrigation period determines the cropped and non-cropped periods for each crop. A value of one represents a cropped period, during which IDC calculates applied water demand for the crop. A value of zero represents a non-cropped period, during which IDC does not compute applied water for the crop. Different irrigation periods can be defined for different land use types if necessary. In this application the irrigation period was set to one between March and October for all land use classes except idle lands, and roughly corresponded with the irrigation season in the Madera Subbasin. For idle lands, the irrigation period was set to zero for all months.

2.2.5 Minimum Soil Moisture

The minimum soil moisture value for each crop corresponds to the moisture content at the Management Allowable Depletion (MAD) specified for that crop. Management Allowed Depletion (MAD) is defined as the desired soil water deficit at the time of irrigation and can vary with growth stage (ASABE, 2007). The MAD is often set as the percent of total available moisture that the crop can withdraw without suffering stress or yield loss. Water stress is estimated within the IDC model when the percent of total available moisture exceeds 50 percent. The IDC Model allows different values to be input for different crops and different growth stages. Values for the minimum soil moisture were set to 50 percent for all land use classes at all growth stages to prevent stress from occurring in the simulation. It is important to note here that the crop coefficients, as described previously, are developed from remotely sensed energy balance ET data and thus already include ET reductions that may have occurred due to water stress or other factors.

2.2.6 Agricultural Water Supply Requirement (Target Soil Moisture Fraction)

Water supplied to each crop is estimated within the simulation. The target soil moisture data file allows the user to specify irrigation target soil moisture as a fraction of field capacity. When simulating an irrigation event, the IDC model will apply water until the soil reaches the specified percent of field capacity. Target soil moisture fractions were estimated as 1.0 for all land use classes based on common irrigation methods and scheduling practices in the Madera Subbasin, where growers typically irrigate to field capacity.

When IDC is run on a monthly time step, if the TSMF used for the daily model is used, greater volumes of deep percolation results. This is because when the IDC equations are applied on a monthly basis, the TSMF values used for the daily model result in greater values of soil moisture in the equation computing deep percolation. Thus, the TSMF values was adjusted to result in deep percolation of applied water volumes consistent with the daily model results. The revised TSMF values were also adjusted to simulate the increase in consumptive use fraction that occurs when over time flood irrigation systems are converted to pressurized systems.

2.2.7 Reuse and Return Flow

The return flow fraction determines the proportion of applied water that can leave the land use cell as runoff, while the reuse fraction determines the proportion of applied water that is captured and reused for irrigation. A value of one each indicates that all applied water can leave as runoff, but that all applied water is captured and reused for irrigation. A value of zero each indicates that no applied water leaves the land use cell or is reused for irrigation. For this simulation, irrigation water return flow and reuse fractions have been set to zero in the IDC model. Return flow and reuse are internal flow paths and thus not included in the Subbasin boundary water budget.

2.2.8 Minimum Deep Percolation Fraction

The minimum deep percolation fraction, defined as a fraction of "infiltrated" applied water, is used to simulate the practice of applying additional water to leach salts from the root zone. Because of the high-quality water and soil in the study area, applying additional water to leach salts is not a common practice, so the minimum deep percolation factor was set equal to zero for all crops.

2.2.9 Initial Soil Moisture

In many years, sufficient precipitation occurs during the winter months to fill the root zone to field capacity. Thus, the initial soil moisture at the IDC model start date (January 1, 1985) was set to field capacity. The IDC model runs for the Subbasin water budget were started, four years before the first year in the water budget period (1989) to minimize any potential effect from incorrectly specifying the initial soil moisture value.

2.3 Soil Inputs

2.3.1 Soil Textural Classes and Calibrated Model Parameters

Soil textural classes and associated soil hydraulic parameters were estimated from the Soil Survey Geographic (SSURGO) database (Soil Survey Staff, 2014) for use in IDC. The SSURGO database contains information collected by the National Cooperative Soil Survey (NCSS) about soils in the United States. The United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS), formerly known as the Soil Conservation Service (SCS), organizes the NCSS and publishes soil surveys. The IDC model includes sixteen soil textures representing approximately 98 percent of the Madera Subbasin area (Table 2A.F.i-5). Sandy clay loam and sandy loam textured soils together underlie nearly 77 percent of the area inside the Madera Subbasin.

The following five soil parameters are inputs to the IDC Model:

1. Permanent Wilting Point (PWP), dimensionless
2. Field Capacity (FC), dimensionless
3. Total Porosity (ϕ), dimensionless
4. Pore Size Distribution Index (λ) , dimensionless
5. Saturated Hydraulic Conductivity (K_{sat}) in feet per day (ft/day)

Table 2A.F.i-5. Soil Textures by Area.

Soil Texture (% Sand, % Silt, % Clay)	Acres	% of Area	Represented in IDC Model
sandy loam (70, 20, 10)	63,719	18.3%	×
sandy loam - sandy clay loam (60, 20, 20)	57,912	16.7%	×
sandy clay loam (50, 20, 30)	57,242	16.5%	×
sandy loam - sandy clay loam (70, 10, 20)	40,910	11.8%	×
sandy clay loam (60, 10, 30)	40,235	11.6%	×
loam (50, 30, 20)	34,360	9.9%	×
loamy sand (80, 20, 0)	13,067	3.8%	×
silty clay loam (20, 50, 30)	6,866	2.0%	×
sandy loam (80, 10, 10)	6,812	2.0%	×
clay loam (40, 30, 30)	5,533	1.6%	×
clay loam (30, 40, 30)	3,452	1.0%	×
clay (20, 30, 50)	2,462	0.7%	×
loam (40, 40, 20)	2,399	0.7%	×
sand (100, 0, 0)	2,203	0.6%	×
clay - clay loam (30, 30, 40)	1,681	0.5%	×
clay (30, 20, 50)*	1,043	0.3%	×
sand (90, 10, 0)	670	0.2%	
sandy loam (60, 30, 10)	639	0.2%	
sandy clay (50, 10, 40)	521	0.1%	
silt loam - loam (40, 50, 10)	430	0.1%	
loamy sand (90, 0, 10)	421	0.1%	
silt loam - loam (30, 50, 20)	253	0.1%	
clay - clay loam (40, 20, 40)	107	0.0%	
silt loam (30, 60, 10)	92	0.0%	
Other (i.e., water, urban, etc.)	4,432	1.3%	
Total	347,461	100%	

For each soil texture class derived from SSURGO, initial soil hydraulic properties were estimated based on pedotransfer functions reported by Saxton and Rawls (2006) and refined to provide drainage from saturation to field capacity within a reasonable amount of time, as determined from the percentage of drainage after 3 days (general exceeding 60-80%), and to predict minimal gravitational drainage once field capacity was reached (Table 2A.F.i-6).

Table 2A.F.i-6. Soil Texture with IDC Model Soil Parameters.

Soil Group	PWP	FC	φ	λ	Ksat (ft/d)
sandy loam (70, 20, 10)	0.07	0.15	0.38	0.42	19.00
sandy loam - sandy clay loam (60, 20, 20)	0.11	0.20	0.38	0.26	14.00
sandy clay loam (50, 20, 30)	0.16	0.27	0.40	0.17	4.00
sandy loam - sandy clay loam (70, 10, 20)	0.09	0.17	0.38	0.33	16.00
sandy clay loam (60, 10, 30)	0.15	0.24	0.39	0.20	6.00
loam (50, 30, 20)	0.11	0.23	0.39	0.22	7.20
loamy sand (80, 20, 0)	0.01	0.07	0.40	1.20	31.00
silty clay loam (20, 50, 30)	0.16	0.32	0.42	0.14	0.80
sandy loam (80, 10, 10)	0.03	0.10	0.39	0.74	25.50
clay loam (40, 30, 30)	0.18	0.30	0.41	0.19	0.60
clay loam (30, 40, 30)	0.19	0.33	0.42	0.16	0.49
loam (40, 40, 20)	0.13	0.26	0.40	0.18	3.50
sand (100, 0, 0)	0.01	0.04	0.42	4.50	35.50
clay (20, 30, 50)	0.30	0.43	0.49	0.13	0.08
clay - clay loam (30, 30, 40)	0.24	0.37	0.45	0.13	0.24
clay (30, 20, 50)	0.27	0.40	0.47	0.12	0.13

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APPENDIX 2.G. MADERA SUBBASIN DOMESTIC WELL INVENTORY

Prepared as part of the

Joint Groundwater Sustainability Plan
Madera Subbasin

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Technical Memorandum:

Domestic Well Inventory for the Madera Subbasin

Prepared for Madera County and the
Madera Subbasin Groundwater Sustainability Agencies

April 2022

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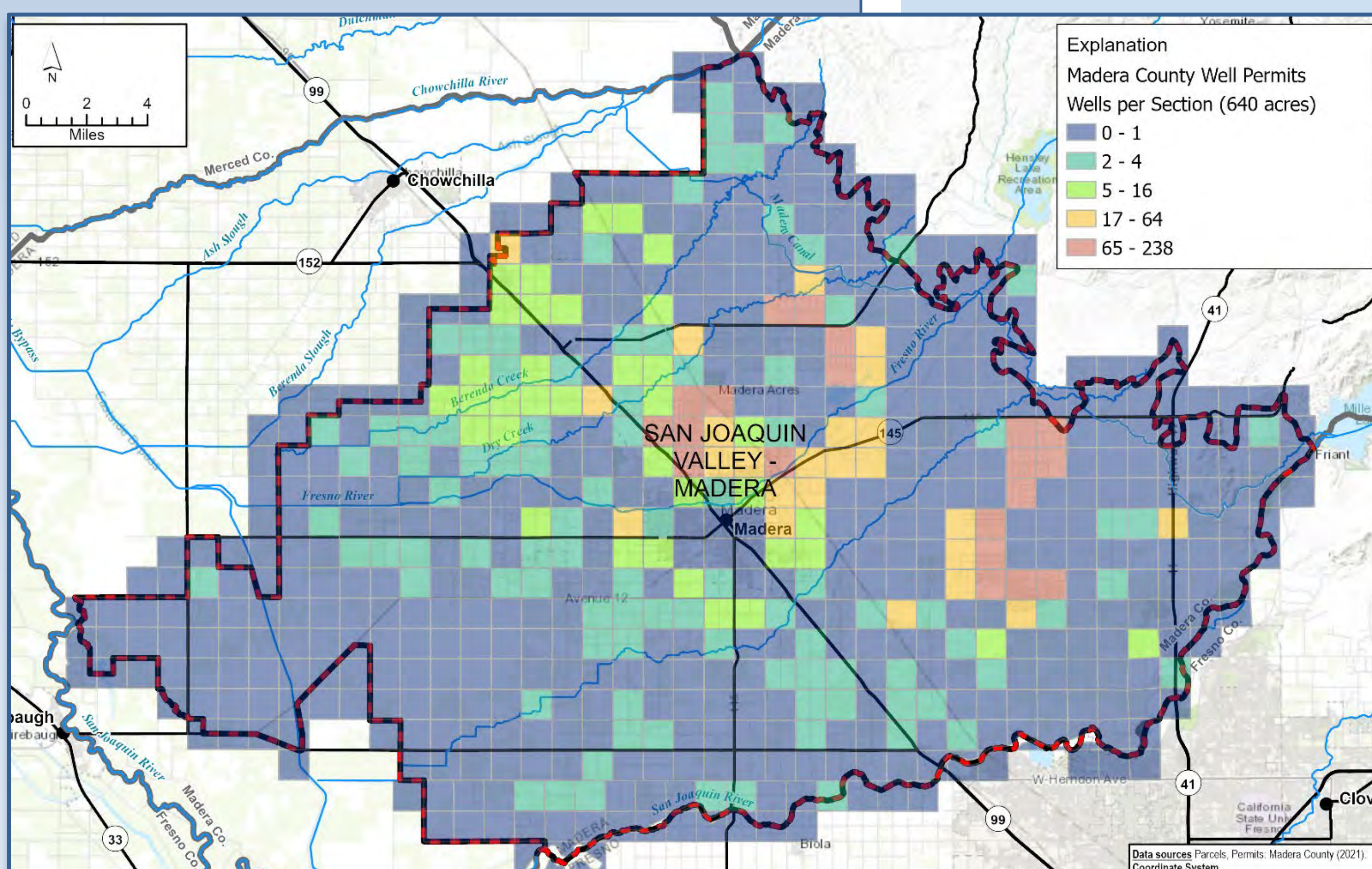

Technical Memorandum:

Domestic Well Inventory for the Madera Subbasin

This memorandum was prepared for Madera County and the Madera Subbasin Groundwater Sustainability Agencies to support implementation of the Madera Subbasin Groundwater Sustainability Plan.

Luhdorff and Scalmanini Consulting Engineers conducted the Domestic Well Inventory project for the Madera Subbasin and prepared this technical memorandum with assistance from ERA Economics.

Madera County and the Madera Subbasin Groundwater Sustainability Agencies appreciate and acknowledge funding received from the California Department of Water Resources under the Sustainable Groundwater Planning Grant Program, authorized by the California Drought, Parks, Climate, Coastal Protection, and Outdoor Access for All Act of 2018 (Proposition 68). This grant funding supported the completion of the Madera Subbasin Domestic Well Inventory project.

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2. Madera Subbasin – Evaluation of DWR Household Water Supply Shortage Reports and Self-Help Enterprises Tank Water Participants

LIST OF ABBREVIATIONS & ACRONYMS

Acronym	Meaning
APN	Assessor Parcel Number
CDP	Census-Designated Place
CDWR	California Department of Water Resources
CEHTP	California Environmental Health Tracking Program
DAC	Disadvantaged Communities
DDW	Division of Drinking Water
DTW	depth to water
GPS	Global Positioning Satellite
GSP	Groundwater Sustainability Plan
LSCE	Luhdorff & Scalmanini, Consulting Engineers
LSWS	Local Small Water System
MCSIM	groundwater model
MD	Maintenance District
MHI	median household income
OSWCR	Online System for WCRs
PLSS	Public Land Survey System
PWS	Public Water System
SDAC	Severely Disadvantaged Communities
SDWIS	Safe Drinking Water Information System
SGMA	Sustainable Groundwater Management Act
SHE	Self-Help Enterprises
SSWS	State Small Water System
SSWS	State Small Water System
SWRCB	State Water Resources Control Board
TM	Technical Memorandum
WCR	Well Completion Report

1 INTRODUCTION

The Madera Subbasin Groundwater Sustainability Plan (GSP) includes maps, figures, analysis, and discussion of domestic wells and potential impacts from continued decline in regional groundwater levels during the GSP Implementation Period. The GSP provided the background and data analyses to illustrate the need for a Domestic Well Mitigation Program in Madera Subbasin and described how it is the most economically viable way to transition from current overdraft conditions to sustainable conditions in 2040. However, there was insufficient time during GSP development to conduct the more thorough inventory of domestic wells and the potential range of impacts to domestic wells under various scenarios of future groundwater conditions. This study supplements domestic well information provided in the GSP and provides an updated analysis that includes anticipated impacts to domestic wells during the GSP Implementation Period.

Madera County was successful in applying for a DWR grant under Prop 68 to conduct a more detailed well inventory, which is documented in this Technical Memorandum (TM). In addition, the grant funding provides for drilling and installation of nested monitoring wells at two sites in proximity to clusters of domestic wells to provide monitoring of current and future groundwater levels and groundwater quality. This TM includes recommendations for locations of these two nested well sites.

To prepare this domestic well inventory, approximations of the number, depths, and locations of domestic wells were developed from multiple available data sources. The total number of domestic wells indicated to be present according to the various data sources were reviewed and compared. Domestic well depths were then compared to historical, current, and predicted future local groundwater depths based on observed and modeled data from the groundwater model (MCSIM) developed for and described in the 2020 Madera Subbasin GSP. Due to the uncertainty in future climatic conditions for the GSP Implementation Period; two primary scenarios were evaluated to bracket the range of domestic wells that are estimated to go dry during the GSP Implementation Period. Estimated costs to replace domestic wells are also included in this TM.

This TM documents the available data sources for estimating numbers and locations of domestic wells, domestic well construction details, occurrence of domestic wells inside and outside of public and small community water systems, analyses to estimate the number of domestic wells that may go dry through 2040 based on two different climatic sequences, and sensitivity analyses to evaluate how various assumptions impact estimates of the number of dry wells. Using the results from the domestic well inventory and analysis, an updated economic analysis was also conducted comparing the tradeoffs of implementing a Domestic Well Mitigation Program during the Implementation Period versus immediately implementing demand reduction in the Subbasin to avoid significant and unreasonable adverse impacts on domestic well users. This economic analysis is included as **Attachment 1** (Domestic Well Replacement Economic Analysis) and provides an update to Appendix 3.D of the Madera Subbasin GSP. **Attachment 1** incorporates the latest results from the domestic well inventory relative to the total number of domestic wells estimated to go dry during the GSP Implementation Period. The economic analysis evaluated the difference in costs for implementing a Domestic Well Mitigation Program concurrent with gradual reductions in groundwater pumping over the twenty-year Implementation Period compared to not having a Domestic Well Mitigation Program and immediately implementing demand management and other PMAs to eliminate the overdraft in the Subbasin.

2 DOMESTIC WELL INVENTORY DATA SOURCES AND COMPILATION

Data from a variety of public agencies were assembled for consideration in the project. Compiled datasets included the following.

- Well Completion Report (WCR) Database from California Department of Water Resources (CDWR) Online System for WCRs (OSWCR)
- Madera County well permit database (records since 1990)
- Madera County Assessor's Parcel data
- Public Water System (PWS) service area boundaries and PWS well locations from State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW)
- State Small Water System (SSWS) service area boundaries from Madera County
- Census block-level household counts from the US Census Bureau
- Disadvantaged Community boundaries from DWR

With the exception of the Madera County well permit database, all of the above-listed datasets were available in geospatial (e.g., GIS) formats. The well permit database was provided as tabular data, which was converted to geospatial information as described below.

2.1 DWR WCR Database

The primary source for well construction data in the subbasin is the CDWR WCR database (CDWR, 2020). Well drillers are required to submit a WCR to DWR for all wells drilled and constructed in the State of California. DWR has tabulated information from WCRs for the State, including data from WCRs dating as far back as the early 1900s. The tabulated WCR information include well type and construction characteristics such as the intended use of the well, well depths, and screened intervals along with location, construction date, permit information, and other details included on the WCR. Although completed WCRs commonly include additional notes on borehole lithology and a variety of other types of information, lithology and some other well information included on WCRs is not entered or maintained in the DWR WCR database. It is notable that many well attributes in the WCR database are blank or incomplete because of missing or illegible information provided on the WCRs. Additionally, well locations in the WCR database are commonly only provided to the center of the Public Land Survey System (PLSS) section in which it is located, which translates to a locational accuracy of approximately +/- 0.5 mile.

2.1.1 Domestic Well WCRs

As part of the project, initial quality checks were conducted on the WCR database to identify obvious inconsistencies in well data, including conflicting well locations (e.g., latitude, longitude, PLSS coordinates) and construction (e.g., well depths, top and bottom of screens). Such questionable information and records were flagged for additional consideration during subsequent analyses. For the purpose of this domestic well inventory project, only WCRs indicated to be domestic water supply wells were included in the analysis. To limit potential double counting of domestic wells, only WCRs for new well construction (i.e., not well repairs/modification or destruction) were included in the domestic well inventory.

The number of well records within the Madera Subbasin in the WCR database exhibit a notable increase starting in about 1970 as indicated by domestic WCR counts by decade presented in **Table 1**. This shift may be partly due to changes in the Water Code relating to well data collection methods and reporting requirements that were instituted in 1969. The number of WCRs for domestic wells in the Madera Subbasin increased by a factor of six times around 1970, from around 100 WCRs in the 1960s to over 600 in the 1970s.

2.1.2 WCR Dates

The typical lifespan of a small water well is estimated to be 30 to 50 years based on the durability and longevity of typical domestic well materials, which are commonly constructed of PVC casing. Wells drilled prior to 1970 are also unlikely to still be in operation because of long-term trends in groundwater levels in the Subbasin.

For these reasons, only WCRs for wells with dates on or after 1970, were included in the domestic well inventory and associated analyses. DWR's WCR database includes 265 domestic well new construction WCRs located in the Madera Subbasin that do not have any recorded installation or permit dates. For this well inventory and analysis, these 265 wells were included in the analysis even though some fraction of them may have been constructed prior to 1970. A total of 4,822 domestic wells constructed since 1970 were considered in the project based on WCR records.

2.1.3 WCR Locations

Wells with WCRs marked as domestic were selected and mapped based on one of four geolocation methods, depending on what information was available in the tabulated data. Only wells with installations in 1970 or later were considered, or those with no available date of installation. The geolocation methods, in order of priority, are as follows:

1. Global Positioning Satellite (GPS) – 4 wells
2. Assessor Parcel Number (APN) – 2387 wells
3. Address – 1397 wells
4. Public Land Survey System (PLSS) – 1034 wells

A total of 4,822 domestic wells were located within the Madera Subbasin using these methods (**Figure 1a**). Wells located by PLSS are typically placed at the center of the section in which they are located, and thus may be out of position by as much as about 0.5 mile (half the typical width of a section). Other sources of location error include changes in APNs over time; poorly matched addresses; and incorrect WCR entries for PLSS values, GPS coordinates, APNs, or addresses. Since many of the location dots for domestic wells plot on top of each other in **Figure 1a**, the locations of domestic wells in the Subbasin by Township/Range/Section mapping are displayed in **Figure 1b**.

2.2 Well Permit Records

Under county regulation, a well permit is required prior to drilling and constructing a domestic well. Records of well permits were provided by Madera County as a tabular dataset (Madera County Environmental Health, 2020); no GIS data were initially available for the well permits. The period of record for the well permits begins in 1990. Limited information on individual wells is available in the well permit dataset, although most well permits include APNs or well addresses, which can be used for locating wells. Well uses in the permit dataset were inconsistently entered and required considerable review and modification to standardize well uses for identifying likely domestic well permits.

2.2.1 Domestic Well Permits

A subset of 7,505 permits for all of Madera County was identified as likely domestic wells based on the indicated well use. The well uses retained as representative of likely domestic wells include the following:

1. Domestic (7300 permits),
2. Domestic Replacement (25 permits),
3. Shared (54 permits),
4. Dairy (36 permits),
5. No Use listed (90 permits).

“Shared” wells are typically domestic wells that are also used for irrigation. “Dairy” wells are typically used for semi-industrial, and irrigation uses on a dairy, but in some cases can also be used for domestic water supply. Wells without a listed use were included in an effort to be conservative in the domestic well inventory.

2.2.2 Locating Well Permits

Of the 7,505 domestic well permits (7,362 with APNs) for all of Madera County, the portion applicable to Madera Subbasin were identified based on APNs associated with them. Multiple permits refer to the same APN in some cases with only 6,498 unique APNs listed as having domestic well permits in the database. Domestic well permits in the County well permit database were located by matching the listed APN with the county parcel data when possible. Following this approach, 4,115 domestic well permits were matched to 3,605 unique parcels located within the Madera Subbasin. For the 143 well permits without APNs, 79 permits were expected to be located within the Subbasin based on the fraction of permits with APNs that were determined to be within the Subbasin.

In addition to APNs, the well permit database includes site addresses for most (7,323) of the wells. Through geocoding of addresses in the well permit database, 95 of the well permits without APNs were located within the Subbasin.

Though locating of well permits based on APNs and site addresses, approximate locations for all but one of the 7,505 domestic well permits were determined. Using these locations, the total number of domestic well permits in the Subbasin was determined to be 4,210 (at 3,700 unique locations) out of 7,505 domestic well permits in the database. A map of the domestic well permits located in the Madera Subbasin is presented in **Figure 2a**. Since many of the location dots for domestic wells plot on top of each other in **Figure 2a**, the count of domestic wells in the Subbasin by Township/Range/Section mapping is displayed in **Figure 2b**. The relationship between County well permits and WCRs is summarized in **Table 2** and described further in Section 3.2.3.3 Scaling Estimates.

2.3 County Assessor Parcel Data

County Assessor parcel GIS data were provided by Madera County (Madera County Assessor's Office, 2020), including land use and other characteristics for each APN indicating the presence of a dwelling. The parcels dataset includes 34,365 unique APNs within the Madera Subbasin. Of those, 24,192 are listed as having dwellings associated with them (**Figure 3**). Although the County parcel dataset does not include records related to the presence of domestic wells on parcels, the presence of a dwelling on a parcel is interpreted to suggest the presence of a drinking water supply, including in some areas the potential for a domestic well to exist. This includes parcels that are included within a public water system service area.

2.4 Water System Data

Public Water System, State Small Water System (SSWS), and Local Small Water System (LSWS) service area boundaries from State and local data sources were used to map and evaluate where and how many inferred well locations occur inside of a water system service area and therefore may not be supplied by a domestic well. Water system boundaries are a key dataset for comparing with potential domestic well locations identified through analysis of WCRs, parcels, and permits. The service area boundaries for water systems identified in the Subbasin are presented on **Figure 4** based on the evaluation of PWS, SSWS, and LSWS boundaries as described below.

2.4.1 State Regulated Systems

The PWS boundaries are part of an archived dataset developed by the California Environmental Health Tracking Program (CEHTP) and now maintained by the SWRCB DDW (SWRCB, 2021). This dataset is a publicly available GIS feature class of system boundaries provided voluntarily by water system operators over the period from 2012 to 2019. Previous assessments of this dataset suggest it includes approximately 85 percent of community water systems, although this can vary by region within the state. Of the state regulated PWS boundaries, 21 were identified to have service areas within Madera Subbasin.

2.4.2 County Regulated Systems

The PWS service area dataset from DDW is not intended to include county-regulated systems. Madera County Public Works representatives reviewed the PWS boundaries and provided additional service area boundary data for county-regulated water systems (Madera County Environmental Health, 2021). The County provided 12 water system boundaries that are within the Madera Subbasin. Of these, 8 were for water systems that already had boundaries in the CEHTP dataset. In cases where boundaries were available from DDW and Madera County, the union of the two boundaries was retained for use in the analysis. The resulting addition of four new systems increased the total number of water systems in the Subbasin to 25. County staff reviewed the combined water system boundaries and stated it appears complete.

2.4.3 Public Water System Wells

PWS well locations were downloaded from the SWRCB GAMA website (SWRCB, 2021) and used to check for any water system wells in areas not covered by the water systems service area boundaries data. All PWS wells were located within previously delineated water system service area boundaries.

2.5 Community Data

2.5.1 Census

United States Census data (US Census, 2016) were used for cross-checking and comparison with domestic well WCRs, domestic well permits, and parcels with dwellings in the Subbasin. The Census data include counts of households by Census area (e.g., block, tract, designated place). The Census data were evaluated to assess whether they could inform the count and locations of domestic wells in the Subbasin. To approximate the number of households that might have a domestic well, Census block area were converted to randomly located points within each block equal in number to the count of households per block. The resulting 28,695 points represent an estimate of the number of households within the Subbasin that might have a domestic well (**Figure 5**). This number is slightly higher than the number of parcels with dwellings in the Subbasin (24,192), a result which might be expected because multiple households can occupy a single parcel. This includes households that are included within a public water system service area.

2.5.2 Disadvantaged Communities

DWR defines Disadvantaged Communities (DACs) as communities with an annual median household income (MHI) less than 80 percent of the Statewide annual MHI (PRC Section 75005(g)), and SDACs as communities with an annual MHI less than 60 percent of the Statewide annual MHI. The statewide median household income (MHI) for the Census American Community Survey (ACS): 2014-2018 dataset is $71,228. Therefore, a community where the MHI is less than $56,982 meets the DAC threshold and a community where the MHI is less than $42,737 meets the SDAC threshold.

DWR provides a standardized GIS layer of Disadvantaged Communities and Severely Disadvantaged Communities (DACs, SDACs) (DWR, 2021). These data are available as Census Designated Places, Census Tracts, or Census Blockgroups. The Tract-level data are simply aggregated from the Blockgroup-level data and were not used in the current analysis. Place-level data are not congruent with Blockgroups or Tracts, typically following established neighborhood boundaries. Place-level data provide a more focused description of the regions that qualify as DAC or SDAC; however, the Place-level data is only available in Census-Designated Places (CDPs), and these do not capture more diffuse residential neighborhoods. DACs and SDACs are found in both urban and rural areas in Madera Subbasin. **Figure 6** shows the locations of the Census Designated Places identified as DACs or SDACs by the definition above.

3 ANALYSIS AND RESULTS

Estimates of domestic wells were developed through analysis and comparison of the data sources discussed above. Estimates of the number and locations of domestic wells in Madera Subbasin were made using four different sources of data and approaches: from WCRs, well permits, parcels with dwellings, and Census households. Domestic well WCRs and well permits provide a more direct indication of the existence (past or present) of a domestic well whereas the parcel data and Census data provide a basis for inferring the existence of domestic wells. The County well permit database is believed to provide the most accurate estimate of the numbers and locations of domestic wells constructed during the available data record (since 1990).

The completeness of the well records in County well permit data are expected to be greater than the WCR database because although regulations state that WCRs are required to be submitted to DWR for all constructed wells, there has historically been little or no verification at the County or State level that a well driller submits a WCR to DWR after a well is completed. In cases where a WCR is submitted, the time elapsed between when a well is drilled and when a WCR is submitted to DWR can be highly variable and information provided on WCRs may not be complete. There are also additional steps involved in entering WCRs into DWR's database after receiving a WCR, which may also introduce timing delays or data entry errors. In contrast, although there is generally no information about a given well's design provided in the County well permit database, there is a fee to obtain a well permit and permits are typically obtained by the driller immediately prior to starting work on a project. Therefore, it is believed that most permitted wells are constructed even if a corresponding WCR is never submitted to DWR by the well driller.

The locational accuracy of well permit records are also believed to be better because most well permit records include data on the parcel where the well is permitted. Many of the WCR records only indicate location by the PLSS section in which the well is located.

Although the well permit data are believed to be more complete and provide better locational accuracy of wells, only the WCR data have information on well depths and other well construction details (**Figure 7a**, **Figure 7b**). Additionally, while WCRs and well permits generally have a date associated with each record indicating the approximate date of well construction, the parcel and Census datasets do not. However, estimates of well counts based on parcel and Census data do provide a sense for the maximum possible number of domestic wells, and also a comparative check on the relative spatial density of domestic wells in the Subbasin.

Water system service area boundaries were used to refine domestic well estimates derived from parcel and Census household counts, with the expectation that all parcels and households within a water system boundary are served water by the water system and therefore do not rely on a domestic well. The locations and count of permits and WCRs were assumed to be correct, regardless of their location relative to a PWS service area.

With this information, estimated locations and counts of domestic wells in the Subbasin were developed and well depths were compared to historical groundwater levels and model-simulated future groundwater levels (based on the modeling conducted during GSP development) to evaluate potential impacts to domestic wells from changing groundwater levels in the Subbasin. The methods and results from these analyses are described below.

3.1 Analysis of Domestic Well Locations and Counts

3.1.1 Domestic Well WCRs

The domestic well WCRs since 1970 were compared with water system boundaries. Because the WCRs are records of actual wells that were constructed, those located within a water system service area are assumed to be correctly located. It is possible that wells that pre-existed the establishment of a water system in an area may remain in use after the water system is operational; however, the frequency of this occurring is not known.

Of the 4,822 domestic wells represented by WCRs in the Subbasin, 559 are located within the known water system boundaries (**Figure 8**). This represents approximately 11 percent of the domestic well WCRs in the Subbasin. Some of these domestic well WCRs may be associated with wells that no longer actively supply domestic drinking water. Nevertheless, WCRs within a water service area boundary were still considered in the domestic well inventory and analysis described below, which is a conservative assumption relative to likely domestic well counts.

3.1.2 Domestic Well Permits

Similar to the WCR estimate, permits are expected to accurately identify well locations, but domestic well permits may exist for wells drilled and constructed prior to the operation of a water system in an area. The use of such wells may have been discontinued when a residence was hooked up to a water system, although this may not always be the case and some domestic wells within water system service areas may still be operational.

In contrast to the WCR dataset, which relies on submittal and entry of a WCR in DWR's database, the County well permit dataset is expected to be a more comprehensive representation of the wells drilled in the County for the period over which it spans (1990 to present). Although the comparisons across different datasets described below highlight differences between data sources and the estimates of domestic wells derived from each, this study did not attempt to assess the accuracy of the well permit database in relation to actual domestic wells.

Of the 4,210 domestic well permits in the Subbasin, 333 are located within known water system boundaries. This represents approximately eight percent of the domestic well permits in the Subbasin. Some of these domestic well permits may be associated with wells that no longer actively supply domestic drinking water. Nevertheless, domestic well permits within a water service area boundary were still considered in the domestic well inventory and analysis described below.

3.1.3 Parcels with Dwellings

For the purpose of assessing the maximum possible number of domestic wells in the Subbasin, all parcels with a dwelling but not within a water system service area were counted. In this approach, a parcel is considered within a water system service area if its centroid is within the service area.

Based on these criteria, within the Madera Subbasin there are a total of 24,192 parcels with dwellings, 5,898 of which are outside of the service area boundaries of all 29 PWS and County-regulated systems serving residential parcels. These 5,898 parcels representing potential domestic well locations are presented on **Figure 9**. There are several areas within the Madera Subbasin with a high density of parcels with dwellings that are not covered by a water system boundary.

3.1.4 Census households

Due to the irregular shape of Census blocks and the inconsistent alignment of blocks with other important boundaries in the Subbasin (e.g., Subbasin, water service areas) the Census data provided limited utility for the inventorying of domestic wells, although they do provide an approximate check on the maximum overall number of potential domestic wells in the Subbasin. Conversion of the Census household counts to points and comparing to water system service areas provides estimates between 7,109 and 7,393 potential households outside of the water system service areas. Although the total number of parcels and total number of households within the Subbasin are reasonably consistent, the number of households estimated to be outside of the water system service areas is considerably higher than the number of parcels outside of the water system service areas and is not believed to be an accurate metric for inventorying domestic wells.

3.1.5 Comparisons of Domestic Well Location Information Sources

3.1.5.1 Domestic Wells Within PWS Service Areas

While most residences within a PWS service area are supplied with drinking water by that PWS, it is not unusual for wells that were drilled prior to the creation of the PWS to be retained and used for part, or all, of a residence's use, including for drinking water or landscape irrigation.

Of the 4,822 WCRs since 1970 located in the Madera Subbasin, 559 are located within a water system service area. Of the 4,210 permits (since 1990) located within the Madera Subbasin, 310 were located within a water system service area. These represent approximately 12 percent and seven percent, respectively, of the wells identified from these data sources.

Of the 24,192 parcels with dwellings noted in the APN dataset, 18,294 are within a water system boundary. Similarly, of the 28,708 households in the Subbasin indicated by the 2010 Census data, 21,503 are within a water system service area.

The count of known locations of permits and WCRs within water systems, when compared to the number of residences within those systems based on parcel and Census data, represent between one and three percent of the number of residences within those service areas. This suggests that the number of domestic well permits and WCRs located within water system boundaries is a small fraction of the number of likely residences within those water system areas. Accordingly, this comparison suggests that neither the WCR nor well permit data identify a large number of domestic wells within water system boundaries. Although this does not speak to the accuracy of the WCR and well permit data in locating wells in other areas of the Subbasin, they do not appear to identify an unreasonable number of domestic wells within areas covered by water systems.

3.1.5.2 Comparing WCR Locations to Well Permits

The Madera County well permits dataset is believed to be more complete in representing wells drilled in the County, but it only extends back to 1990. To provide an appropriate comparison between the WCR dataset and the well permit dataset, a subset of the WCRs since 1990 (those dated after 1989), were considered. In the Madera Subbasin, roughly two-thirds of domestic well WCRs have construction dates after 1989. For this analysis, WCR records without construction dates are assumed to be drilled in 1990.

The subset of domestic wells with WCRs since 1990 has many similar characteristics as the dataset for WCRs since 1970, with several noteworthy differences. As shown in **Table 3**, proportionally, the WCR dataset since 1990 has fewer WCR records located in water system service areas. This is reasonable, as it is consistent with the understanding that many of the domestic well WCRs located within water system service areas are for wells drilled prior to the creation or expansion of those water systems.

There is no direct linkage between WCRs and well permits on record (i.e., WCRs commonly do not indicate well permit numbers) for majority of the wells, and the available method for geolocating records for a given well present in both datasets may differ. However, it was determined that 2,691 of the parcels associated with permit locations coincided with WCR locations for domestic wells (**Figure 10**).

This relatively low rate of coincidence is most likely a function of poor accuracy of the WCR locations. The permit location error is generally related to the area of the parcel within which they are located and is commonly less than half the distance of the maximum parcel dimension. As parcel size decreases, the accuracy of the locating of well permits tends to increase. Many WCR locations have much higher error, especially those that rely on locations from the PLSS section centroid.

3.1.5.3 Comparing Domestic Well Permits with Parcel Characteristics

Of the 95 well permit locations produced by geocoding addresses in the well permit database, 62 did not fall within a parcel. Such locations generally occur between parcels on streets. For these locations, the attributes from the nearest parcel were used to compare. The parcel Use Codes for the 3,700 unique locations are summarized here:

1. One residence: 88%
2. Two residences: 7%
3. Urban Non-Residential: 3%
4. Agricultural: 2%

Of the 4,210 domestic well permits (at 3,700 unique locations), 3,672 permits (87 percent of permits) at 3,205 unique locations (87 percent of unique locations) were in parcels with dwellings, as indicated on the parcel dataset, suggesting that a residence is present on the parcel associated with the well permit (**Figures 11a** **and** **11b**).

3.1.5.4 Comparisons of Parcels with Dwellings and WCRs

Of the 5,898 parcels listed as having dwellings in the Madera Subbasin, and not within a water system boundary, 1,901 coincide with the location of WCRs located as described above. A total of 285 parcels with dwellings located within water systems also coincided with WCR locations (**Figure 12**). Nearly all the dwelling parcels within water system boundaries and also intersecting WCRs are located in the Maintenance District (MD) 10 – Madera Ranchos water system.

3.1.6 Final Domestic Well Count and Location Estimates

The County permit database includes 4,210 domestic (or considered domestic for this analysis) wells installed since 1990. For providing a direct comparison of the domestic well counts from the WCR database, the count of WCRs was limited to WCRs with dates since 1990 (3,446 domestic well WCRs) to allow for direct comparison to available County permits. This comparison yields a ratio of 1.22 between the domestic well permit count and the domestic well WCR count. Well permits are believed to provide a more complete representation of wells constructed in the Subbasin, but these permit records do not contain information on well perforations and depths and only date back to 1990. As a result, the ratio of well permits to WCRs for the period since 1990 provides a useful metric for scaling of results derived during the evaluation of potential impacts on domestic wells from changing water levels, an analysis which relies heavily on well construction information available only on WCRs. The domestic well impacts analysis is described below.

3.2 Evaluation of Potential Domestic Well Impacts

A key consideration in the implementation of the GSP for the Madera Subbasin is the potential occurrence of impacts to domestic well users due to declining water levels. As part of implementing the GSP, the Subbasin is in the process of evaluating and designing a Domestic Well Mitigation Program targeting domestic wells that may be impacted by future declines in groundwater levels. To support this effort, the effects of historical and future groundwater levels on domestic wells in the Subbasin were evaluated.

This analysis involved comparing domestic well perforation and depth information to historical groundwater levels and potential future groundwater levels, as simulated by the groundwater model (MCSIM) utilized during the GSP development. Simulated groundwater level conditions from MCSim were used to estimate the number of domestic wells that may go dry during the GSP implementation period from 2020 through 2040, the period during which the Subbasin will be working towards achieving sustainability as required by the Sustainable Groundwater Management Act (SGMA). WCR records for domestic wells (and the well construction information provided on WCRs) were used to estimate well depth information for evaluating impacts. The ratio of well permits to WCRs (1.22) was used to upscale the results derived from these analyses conducted using WCR data.

3.2.1 WCR Domestic Well Construction Information

Of the 4,822 domestic well WCRs in the Madera Subbasin, 4,524 included some information on perforated interval (top of bottom of perforations) or total depth. As mentioned earlier, several inconsistencies in construction information were noted in the initial WCR dataset (e.g., total well depth less than depth to top of perforations, depth to bottom of perforations less than top of perforations), so multiple levels of quality checks were conducted on the well construction data in the WCR database to assess the reliability of the information. Only WCR records determined to have sufficiently reliable well construction information (i.e., lack of obviously conflicting information on the well construction) were included in the summary and analyses relating to domestic well construction in the Subbasin. In analyses using well perforations (screens), where data for bottom of perforations was not available, the reported total well depth was used. A total of 3,834 WCRs included top of screened interval information. For wells lacking information for either bottom of perforations or top of perforations, the average values for wells in the same section were used. Where a section had fewer than three wells with reported depth or top of screen data, the average values from wells in the same section and the eight surrounding sections were used. This resulted in estimates of top and bottom of perforated Intervals for all 4,822 domestic well WCRs in the Subbasin. **Figure 7a** and **Figure 7b** show the depth of domestic wells in the Subbasin based on these estimates.

3.2.2 Domestic Well Impacts Analysis Methods

Simulated groundwater levels output from the MCSim model developed by Luhdorff & Scalmanini, Consulting Engineers (LSCE) and described in the 2020 GSP for Madera Subbasin were queried to produce depth to water (DTW) datasets for the Subbasin for the period from 1989 through 2070. MCSim is a multi-layered model and based on review of the well data and consideration of the hydrogeologic conceptual model and groundwater conditions described in the GSP, model layers 3 and 4 were determined to most appropriately correspond with the production zones for most domestic wells in the Subbasin. The simulated DTW datasets for model Layers 3 and 4 were used to extract DTW values for different time periods at all WCR locations; DTW values at each domestic well WCR location were compared with the top and bottom of perforations (screens) values for each WCR. Based on this comparison, the wells were assigned DTW values for either model Layer 3 or 4. If a well was screened at least 50 percent in Layer 4 or deeper, the well was assigned DTW values for Layer 4. If more than 50 percent of the screened interval was above Layer 4 (in Layer 3 or shallower) then Layer 3 DTW values were assigned to the well.

Simulated depth to water model output for Layers 3 and 4 for the years from 1989 to 2039 were then compared to the screened intervals for each domestic well (WCR) to assess if each well was wet or dry during each year. For each year, the fall simulated DTW (on October 31st) in layers 3 and 4 of the model were assessed for each well location.

The analysis was performed using different analysis periods and methods. Generally, the analysis was conducted using five-year analysis periods, with the first analysis period starting in 1989 and extending to 2014 or 2015 followed by shorter five-year intervals thereafter. Analyses included comparisons based on snapshots of DTW conditions at the end of each analysis interval (generally five-year analysis periods) and separate comparisons based on the maximum depth to water found during each analysis period. Variations of analyses were also performed using simulated model output from the projected model run used in the GSP and also separately on a model run utilizing a projected future hydrology that included drier conditions during the early years of the GSP Implementation Period, conditions that are more consistent with the recent hydrology experienced in the area. In all analyses, if the simulated DTW in the assigned model Layer at a well location falls below the required minimum level of saturation in relation to the depth of the well, either at the end of each analysis period (or in the year within each five-year period that generally had the lowest water levels) for the maximum DTW scenario), the well was considered to have gone dry during the analysis period. Once a well was concluded to have gone dry in an analysis scenario, it was removed from the pool of potential wells that could go dry in subsequent years. The sensitivity of model results to different assumptions, analysis periods, and WCR data restrictions were tested and evaluated.

The parameters used in the analysis are defined as follows:

P = the base year for the analysis periods. This defines the end of the initial historical analysis period (after 1989) during which wells were evaluated for historically having gone dry. This is generally Fall 2019, indicating a historical analysis period of 1989-2019, but 2018 was also used as the ending year for the historical period during sensitivity analyses (because groundwater levels in 2018 were generally lower than in 2019).

S = minimum saturation threshold above the well total depth for a well to remain wetted. This is assumed to be 10 feet in the baseline analysis, but the sensitivity of analysis results to varying this value was conducted to evaluate the influence of this parameter on analysis results.

E = the earliest year of installation for the WCRs considered. This reflects the cutoff year for the construction date on WCRs intended to reflect wells that may have been active at the time of the base year considered based on typical domestic well life expectancy.

Appropriate scaling of the results of these impacts analyses based on WCR was also considered based on the ratio (1.22) of domestic well permits to domestic well WCRs determined previously. This ratio is developed from a direct comparison of domestic well permits and WCRs with dates since 1990. The scaling ratio is developed for the entire Subbasin and is assumed to have limited spatial or temporal bias across the Subbasin or across the period since 1990. The potential for bias in the ratio has not been evaluated.

The baseline analysis scenario of potential domestic well impacts involved the parameters listed below.

- Snapshots of DTW at the end of each analysis period
- The ending year for historical analysis is 2019, with historical analysis period 1989-2019 (P = 2019). Corresponding analysis periods as follows:
  - 1989-2019
  - 2020-2024
  - 2025-2029
  - 2030-2034
  - 2035-2039

  The analysis periods were selected to correspond with the dates of the Interim Milestones and preparation of Five=Year Update Reports.

- Minimum well saturation threshold of 10 feet (S = 10).
- Using projected model run from GSP (without early sequence of dry years).
- Wells analyzed based on the WCR count of wells installed since 1970 (E = 1970).

Because the early years of the projected model period, including during the early GSP implementation period, have been dry, an alternative analysis scenario evaluated potential domestic well impacts based on simulated groundwater levels from a model run that starts with a drier sequence of years. This analysis involved the same parameters as the baseline analysis (described above) but used simulated groundwater levels from a different projected model run with an early dry period.

3.2.3 Results of Domestic Well Impacts Analyses for Baseline GSP Climate Scenario

In the baseline analysis scenario described above, a total of 739 of the 4,822 domestic wells (from WCRs) analyzed are indicated to have gone dry during years prior to 2020. A total of 772 wells are projected to go dry between 2020 and 2039 (**Table 4a**); the analysis suggests 287 dry wells of the total of 772 occurring during the period 2020-2024. **Table 5a** includes the results for this analysis when scaled up by a multiplier of 1.22 based on the ratio of well permits to WCRs.

3.2.3.1 Spatial Distribution of Dry Wells

Figures 13a to **13e** show the distribution of dry wells (and remaining wetted wells) in each of the analysis years for the baseline analysis. The predicted dry wells are clustered in the eastern parts of the Subbasin, with a greater number of dry wells predicted along and to the east of Highway 99. There are two higher-density clusters located north of the Fresno River and south of Dry Creek, and an especially large cluster in the Madera Ranchos area south of highway 145 and north of Avenue 12 in the southeastern part of the Subbasin.

Most of the domestic wells that are predicted to go dry over the 20-Year GSP Implementation Period in the Base Case occur in the 2020-2024 and 2030-2034 five-year intervals (**Tables 4a and 5a**). Groundwater levels stabilize and begin to recover after 2035 and no additional wells are predicted to go dry in the Base Case after 2035. The timing of domestic wells going dry is closely related to the assumed sequence of average, dry, and wet years applied for the Base Case, which is based on a historical sequence of years that represent overall average conditions for the 20-Year period.

3.2.3.2 Impacts on Disadvantaged Communities

Some dry domestic wells are predicted to occur in DAC and SDAC areas. The Fairmead area and City of Madera area SDACs are predicted to see significant numbers of wells going dry during the implementation period. In addition, the Valley Lake Ranchos, Lake Madera Country Estates, and Bonadelle Ranchos 5 neighborhoods, all located in Census blockgroups east of the City of Madera that qualify as DACs, are predicted to see significant numbers of wells going dry (**Figure 13f**).

Nonetheless, based on the analysis presented here, DACs and SDACs will not be disproportionately impacted by declining groundwater levels. Rather, these neighborhoods will see impacts proportional to the number of domestic wells and the depth of decline in water levels in their regions, as with any other wells examined in non-DAD/SDAC areas. DACs and SDACs in the Madera Subbasin are primarily located near urban centers, and thus near existing water system service areas. Opportunities for annexation or consolidation of DACs and SDACs into existing State- or County-regulated systems may provide better value than efforts to deepen existing wells in these areas.

3.2.3.3 Scaling Estimates

The previous analyses are all based on WCR counts of wells drilled since 1970 or 1990. A more accurate number of wells, however, is more likely the number of Permits in the permit database provided by Madera County.

Figure 14 shows that the spatial distributions of the two datasets are similar. As shown in that figure, the areas with large differences between the WCR and Permit datasets (shown as red and blue in the figure) are smaller areas that are peripheral in the Subbasin. The largest portion of the Subbasin is represented by ratios near 1:1 (from 0.8:1 to 1.2:1). The region of the Subbasin near the City of Madera and to the north has a higher ratio of permits to WCRs, and this is an expected outcome due to the denser population and presence of municipal water systems in that area. Therefore, simply scaling the count of wells up for each period should be adequate. The number of Permits for wells installed since 1990 is 122% of the number of WCRs for wells in the same period, averaged over the Subbasin (**Table 2**).

Scaling the results up to match the expected number of wells based on the Permits-to-WCRs ratio of 1.22:1 yields 942 wells going dry between 2020 and 2040 (**Table 5a**).

3.2.4 Results of Domestic Well Impacts Analyses for Alternative Dry-Start Climate Scenario

The same analysis was conducted as described above for the GSP Climate Scenario, but instead using an alternative climate sequence for the GSP Implementation Period with more dry years at the beginning of the 20-Year climate sequence. In the alternative analysis scenario, a total of 755 of the 4,822 domestic wells (from WCRs) analyzed are indicated to have gone dry during years prior to 2020. A total of 1,294 wells are projected to go dry between 2020 and 2039 (**Table 4b**); the analysis suggests 350 dry wells of the total of 1294 occurring during the period 2020-2024. **Table 5b** includes the results for this analysis when scaled up by a multiplier of 1.22 based on the ratio of well permits to WCRs.

3.2.5 Sensitivity Analyses on Potential Domestic Well Impacts

To understand influences from different analysis assumptions and parameters, sensitivity analyses were conducted on a number of aspects of the analysis. These sensitivity analyses evaluated different approaches to evaluating the DTW at well locations over each analysis period (e.g., DTW at end of period vs maximum DTW during analysis period), the required minimum saturation threshold for concluding a well is dry, and different cutoff dates for WCRs included in the analysis.

3.2.5.1 Snapshot of Depth at End of Reporting Period vs. Maximum Depth During Reporting Period

The baseline analysis described above compares domestic well depths to groundwater levels at the end of each Five-Year Update reporting period using the years 2019, 2024, 2029, 2034 and 2039. As noted previously, these baseline analysis periods were selected because the final year of each period aligns with the IM and Five-Year Update reporting periods. However, if the lowest groundwater levels do not align with the end of each analysis period, this method may not capture the full extent of potential impacts on domestic wells.

By choosing analysis period ending years as 2023, 2028, 2033, and 2038, the lowest groundwater levels in each five-year period will typically be captured along with the lowest pre-2020 groundwater levels (generally occurring in 2015 or 2018). Therefore, a separate analysis was performed using the maximum DTW in each five-year period. This analysis results in a small decrease (23 wells) in the total number of wells (749) expected to go dry between 2020 and 2040 compared to the Base Case (**Table 6**). The reason for the decrease of dry well occurrence between 2020 and 2040 is this analysis results in more wells going dry prior to the start of the GSP implementation period in 2020 due to the lowest pre-2020 groundwater levels occurring prior to Fall 2019, (which is the year used in the Base Case to determine well going dry prior to 2020). Therefore, the base case with a greater number of wells going dry between 2020 and 2040 is used for further sensitivity analyses described below because it is a more conservative estimate of dry wells.

3.2.5.2 Minimum Saturation Threshold

The baseline analysis comparing DTW and total well depths included a minimum well saturation threshold that a well is considered dry when the groundwater levels falls below a level less than 10 feet above the bottom of the well. This baseline assumption was based on the expectation that the required saturation in a domestic well is not great because of the generally low pumping rates required for domestic wells. The sensitivity of analysis results for this minimum saturation assumption were evaluated using alternative minimum well saturation levels. Sensitivity to the minimum saturation threshold was tested by varying the parameter (S) and observing the change in the count of wells going dry in each analysis period (**Table 7**).

The number of wells going dry over the period from 2020 to 2039 increases as the minimum saturation threshold is increased from 0 feet to 30 feet and then decreases with greater minimum saturation thresholds (**Figure 15**). The reason for this pattern is that at minimum saturation thresholds exceeding 30 feet, more wells are considered to be going dry before 2020 relative to after 2020 for those greater thresholds (i.e., the threshold applies both before and after 2020). The number of dry wells at the saturation threshold of 10 feet is 772, it increases to 890 at 30 feet, and at 50 feet it declines to 735. This analysis suggests that the number of wells expected to go dry is sensitive to the saturation threshold applied, but the relationship between saturation threshold and number of dry wells predicted after 2019 varies depending on how many wells go dry before 2020. Considering the results of this sensitivity analysis and the previous discussion regarding saturation needed to support typical domestic well pumping rates, the application of a minimum saturation threshold of 10 feet is interpreted to be a reasonable threshold for estimating the potential number of domestic wells that may go dry during the GSP implementation period.

3.2.5.3 WCR Cutoff Dates

The influence on results from varying the earliest year of WCR records used in the dry well analysis was also evaluated. As expected, the average well depths for older wells tend to be shallower than younger wells, likely because of the declining water levels that have occurred in the area and the resulting need to drill to greater depths to ensure reliable water supply. This trend towards deeper wells is illustrated in a comparison of the average total well depths for WCRs since 1970 and those since 1990, as presented in **Table 3**.

The changes in the numbers of total wells analyzed and the resulting numbers of dry wells drop as the cutoff date for WCRs is increased. The change from a WCR cutoff year of 1970 to 1975 has minimal (less than 10 percent) impact on all counts, but as this cutoff date in increased further the dry well count drops faster than the total well count (**Table 8**). The implication of this trend is that as the WCR cutoff date is moved forward in time from 1970, older wells that would be counted as going dry are not included in the analysis, resulting in a smaller number of wells predicted to go dry. Although many wells constructed since 1970 likely are no longer in existence or actively use, the 1970 WCR cutoff date provides an appropriately conservative estimate of wells predicted to go dry during the implementation period.

3.2.6 Potential Replacement Costs for Wells Impacted

The potential costs for addressing domestic well issues were evaluated in some detail. These costs were largely based on discussions with drillers who install domestic wells and replace pumps on a regular basis. These costs are summarized in **Table 9**, and include lowering a domestic well pump ($1,000 to $2,000), replacing a domestic well pump ($5,000 to $7,000), and drilling/installing a new domestic well to replace an existing well ($25,000 to $35,000). Estimates of total costs for a Domestic Well Mitigation Program were based on estimates of total number of dry wells expected to occur between 2020 and 2039, with WCRs scaled to the number of County well permits and considering both the GSP climate scenario and the alternative dry-start climate scenario for the GSP Implementation Period.

3.2.7 Updated Economic Analysis

As described in the Introduction, **Attachment 1** (Domestic Well Replacement Economic Analysis) incorporates updated estimates provided in this TM for the number of dry domestic wells into an economic analysis intended to replace Appendix 3.D of the Madera Subbasin GSP with newer information. The economic analysis evaluated the difference in costs for implementing a Domestic Well Mitigation Program concurrent with gradual reductions in groundwater pumping over a twenty-year period vs. not having a Domestic Well Mitigation Program and immediately implementing demand management and other PMAs to eliminate the overdraft in the subbasin to avoid significant and unreasonable adverse impacts on domestic well users. The overall conclusion remains consistent with the GSP: the cost of implementing a Domestic Well Mitigation Program is significantly less than the alternative.

3.3 Public Water System Wells

PWS wells data are maintained by the State Water Resources Control Board Division of Drinking Water in the Safe Drinking Water Information System (SDWIS); however, these data are incomplete at this time. In the Madera Subbasin, only 7 PWS wells are listed in SDWIS. Therefore, the WCR database was queried for PWS wells. There were 82 wells drilled in 1970 or later and tagged as “Municipal” or “Public”. This discrepancy is due, in part, to the fact that WCRs do not typically distinguish between Public Water Systems and other residential water systems serving more than one household. When a well driller fills out the WCR, the “Municipal” box is checked if the well is to be used for any purpose other than irrigation, industrial processes, or domestic single-household use. These can include PWS wells but can also include Local Small and State Small Water System wells (LSWS and SSWS, respectively), and wells used for drinking water at facilities such as rest stops, churches, schools, and other locations that sometimes are not supplied by a local PWS. The wells identified here are shown in **Figure 16**.

Depth to the bottom of perforated interval ranged from 30 to 1000 feet below ground surface in these wells. Of the 82, 10 were drilled prior to 1970 and are not considered here. These wells were compared to the snapshots of Depth to Water for the model years 2019, 2024, 2029, 2034, and 2039, with the GSP climate scenario. **Table 10** shows the results of this analysis.

Based on the comparison with the modeled depths to groundwater at these 5-year intervals, 10 PWS or other municipal wells are expected to have gone dry by 2020, and another 3 over the implementation period. Further analysis with data provided by individual well-operators would be required to identify specific water systems that are vulnerable.

3.4 Comparison of Estimated Domestic Well Impacts to Online Databases

The estimated numbers and locations of dry wells described in this TM (modeled dry wells) were compared to two available datasets related to reported domestic well supply issues: DWR’s Household Water Supply Shortage Reporting System, and Self-Help Enterprises (SHE) Tank Water Program participants (**Attachment 2**). While the assumptions underlying the estimates of modeled dry wells in this TM differ in some regards to the well issues included in these two datasets, the spatial patterns in modeled dry wells are very similar to the spatial patterns in the DWR and SHE datasets. Overall, the total numbers of modeled dry wells estimated in this TM are greater than the number of well issues included in the DWR and SHE datasets; however, it is likely that not all dry wells have been reported in these other two datasets. More details on the DWR Household Water Supply Shortage Reporting System dataset and the SHE Tank Water Program participants dataset and comparisons of these datasets to modeled dry wells presented in this TM are provided in **Attachment 2**.

4 PRIORITIZATION OF AREAS FOR ADDITIONAL MONITORING

Expansion of the monitoring network is important for areas of the Subbasin with higher densities of domestic drinking water wells. In addition, the dry well analysis performed above was used as a guide to locating areas that should be more closely monitored. The monitoring network should consider the presence of vulnerable populations, such as those reliant on groundwater and DAC/SDAC areas. Another key variable was to consider the locations of existing nested monitoring wells installed recently at seven locations throughout the Madera Subbasin.

The domestic well inventory analysis conducted for this study illustrates that domestic wells are most concentrated along and east of Highway 99, and that dry domestic wells are predicted to be most prevalent east of Highway 99. There are two existing nested monitoring wells located along Highway 99 in the northern portion of Madera Subbasin and one nested monitoring well located east of Highway 99 about mid-way between the eastern subbasin boundary and Highway 99 in the northern portion of Madera Subbasin. The two most dense clusters of domestic wells occur east of Highway 99 along Avenue 21 (Valley Lake Ranchos and Lake Madera Country Estates) and immediately south of Highway 145 (Madera Ranchos area). These are considered primary areas for siting of new nested monitoring wells (**Figure 17**). Four secondary areas for potential consideration of monitoring well siting were also identified in areas of significant but less dense domestic well clusters; these locations would fill gaps between existing nested monitoring wells and improve overall spacing and density of nested well monitoring sites in Madera Subbasin.

5 REFERENCES

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6 TABLES

Table 1. Summary of domestic well WCRs by decade.

WCR Date Range	WCRs in Date Range	Cumulative WCRs since Beginning of Date Range
Pre-1950	1	4721 (4986)
1950-1959	57	4720 (4985)
1960-1969	106	4663 (4928)
1970-1979	614	4557 (4822)
1980-1989	762	3943 (4208)
1990-1999	1323	3181 (3446)
2000-2009	1444	1858 (2123)
2010-2019	381	414 (679)
2020-Plus	33	33 (298)
Unknown	265	(265)

Table 2. Comparisons between different estimation methods.

	WCR (Installed Since 1970)	WCR (Installed Since 1990)	Permits (Records back to 1990)	Parcels	Census
Total Domestic Well Count or Estimate	4822	3446	4210	5898	7205
Domestic Well Count Excluding Wells Located within Water System Boundaries	4263	3099	3877	5898	7205
Domestic Well Count Inside Water System Boundaries	559	347	333	0 (parcels within WS excluded)	0 (blocks within WS excluded)
Domestic Well Percent of WCR-Based Count (1990-plus)			122%	138%	169%
With Depth Recorded	4522 (94%)	3249 (94%)	0	0	0
Location Precision	Varies	Varies	Parcel	Parcel	Census Block

Table 3. Relative Similarity Between Wells Recorded Since 1970 and Those Recorded Since 1990.

	Count of WCRs within the Madera Subbasin		1990 Set Percent of 1970 Set
	Since 1970	Since 1990	
Total Count	4822	3446	71%
Count within PWS	559	347	62%
Count Outside of PWS	4263	3099	73%
Count with Total Depth	4522	3249	72%
Average Total Depth	341 feet	365 feet	n/a

Table 4a. Summary of Dry Wells for Base Case. Wells drilled in 1970 or later, based on snapshot of depth to groundwater at end of period. Assumes 10 feet of well saturation above bottom of screen.

Year Range	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	97	4083	**287**	3796	287
2025 to 2029	0	3796	**152**	3644	439
2030 to 2034	0	3644	**333**	3311	772
2035 to 2039	0	3311	**0**	3311	772
During the period 1989 to 2019, prior to the implementation period, the model suggests 739 wells went dry.				Total	**772**

Table 4b. Summary of Dry Wells for Dry Start Case. Wells drilled in 1970 or later, based on snapshot of depth to groundwater at end of period. Assumes 10 feet of well saturation above bottom of screen.

Year Range	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	97	4083	**350**	3717	350
2025 to 2029	0	3796	**834**	2883	1184
2030 to 2034	0	3644	**110**	2773	1294
2035 to 2039	0	3311	**0**	2773	1294
During the period 1989 to 2019, prior to the implementation period, the model suggests 755 wells went dry.				Total	1294

Table 5a: Adjusted estimates of dry wells for Base Case based on WCRs since 1970 upscaled using ratio of permits to WCRs (1.22).

Year Range (Oct 31st Minimums)	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	118	4981	350	4631	350
2025 to 2029	0	4631	185	4446	536
2030 to 2034	0	4446	406	4040	941
2035 to 2039	0	4040	0	4040	941
During the period 1989 to 2019, prior to the implementation period, the model suggests 902 wells went dry.				Total	**941**

Table 5b: Adjusted estimates of dry wells for Dry Start Case based on WCRs since 1970 upscaled using ratio of permits to WCRs (1.22).

Year Range (Oct 31st Minimums)	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	118	4962	427	4535	427
2025 to 2029	0	4535	1017	3518	1443
2030 to 2034	0	3518	134	3384	1578
2035 to 2039	0	3384	0	3383	1578
During the period 1989 to 2019, prior to the implementation period, the model suggests 921 wells went dry.				Total	1578

Table 6: Dry Well Summary Based on Snapshots of Groundwater Depth at End of Periods ending in 2015, 2018, 2023, 2028, 2033, and 2038.

Year Range (Oct 31st Minimums)	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells Based on 5-Year Minimum
2019 to 2023	150	4015	**248**	3767	248
2024 to 2028	0	3767	**167**	3600	415
2029 to 2033	0	3600	**334**	3266	749
2034 to 2038	0	3266	**0**	3266	749
During the period 1989 to 2018, prior to the period described in this table, the model suggests 807 wells went dry.				Total	749

Table 7: Effect of Varying Saturation requirement on Dry Well Counts.

Saturation Setting	Dry Wells Total After 2019
0	539
10	605
20	642
30	682
40	625
50	569
60	543
70	554
80	518
90	394
100	325

Table 8: Effect of Varying Minimum Installation Year on Counts of Wells and Dry Wells.

Well Counts	Earliest Installation Year						
	1970	1975	1980	1985	1990	1995	2000
Total Count of WCRs in Comparison	4822	4690	4208	3972	3446	2625	2123
Fraction of 1970 (Total Count of Wells)	1.00	0.97	0.87	0.82	0.71	0.54	0.44
Total Count of Dry Wells	1511	1444	1289	1198	1001	711	534
Fraction of 1970 (Dry Wells)	1.00	0.96	0.85	0.79	0.66	0.47	0.35
Count of Dry Wells Prior to 2020	739	688	580	518	396	251	186
Fraction of 1970 (Dry Prior to 2020)	1.00	0.93	0.78	0.70	0.54	0.34	0.25
Count of Dry Wells from 2020 to 2039	772	756	709	680	605	460	348
Fraction of 1970 (Dry Wells 2020 to 2039)	1.00	0.98	0.92	0.88	0.78	0.60	0.45

Table 9: Summary of Domestic Pump and Well Costs.

Issue	Type of Problem	Solution	Related to GSP	Typical Cost
Water level in well below pump setting depth	**Pump**	**Lower Pump**	**Yes/No**	**$1,000 to $2,000**
Pump not working (old age or pump-related issue)	**Pump**	**Replace Pump and Equipment**	**No**	**$5,000 to $7,000**
Well casing/screen failure (due to old age)	**Well**	**Replace Well**	**No**	**$25,000 to $35,000**
Water level below bottom of well	**Aquifer**	**Replace Well**	**Yes**	**$25,000 to $35,000**

Table 10: PWS and other Municipal Wells - Dry Well Summary Based on Snapshots of Groundwater Depth at End of Periods ending in 2019, 2024, 2029, 2034, and 2039.

Year Range (Oct 31st Minimums)	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	1	62	2	60	2
2025 to 2029	0	60	0	60	2
2030 to 2034	0	60	1	59	3
2035 to 2039	0	59	0	59	3.
During the period 1989 to 2019, prior to the implementation period, the model suggests 10 wells went dry.				Total	3

7 FIGURES

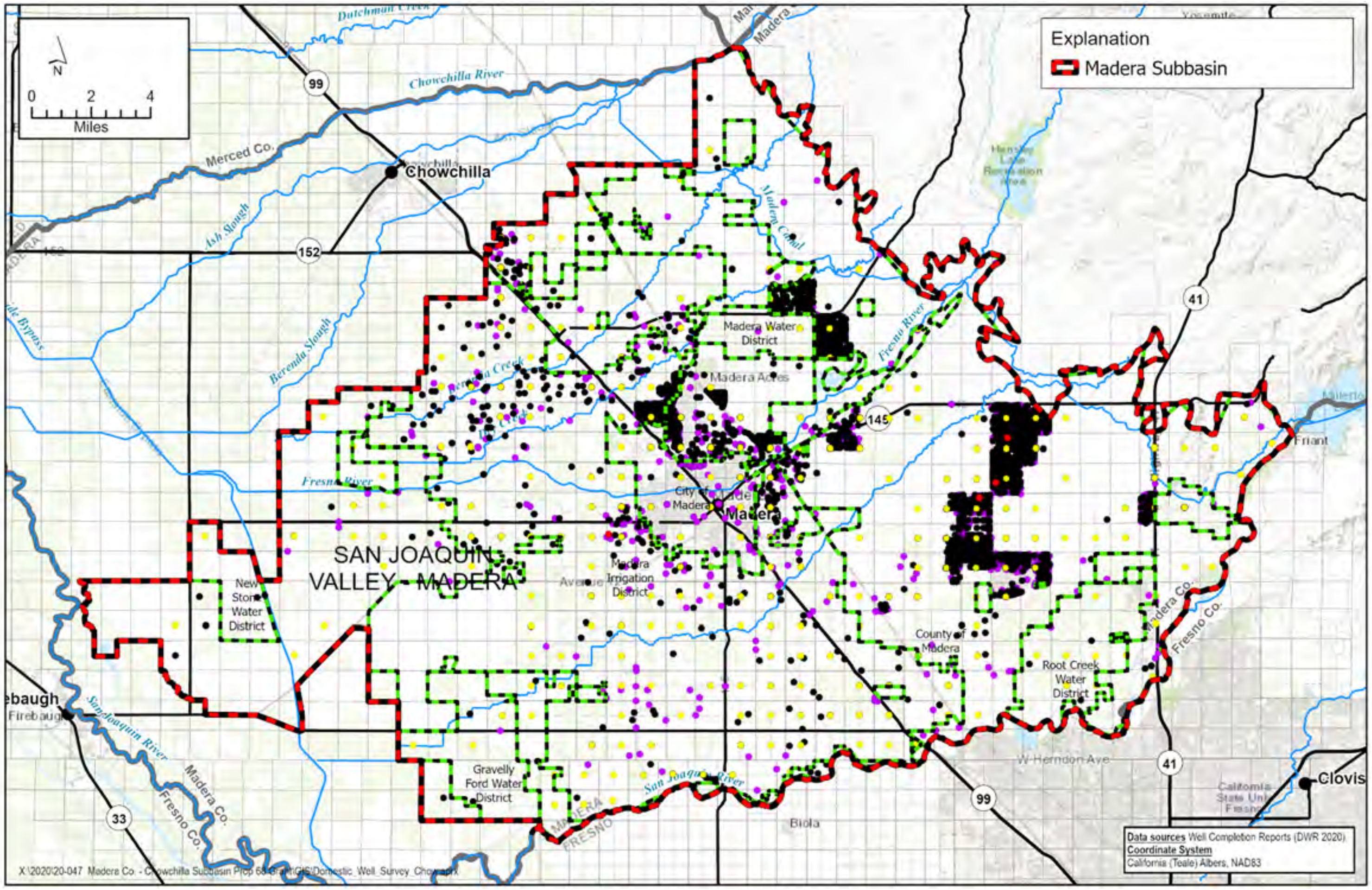

Figure 1a. Well Permits for new construction domestic wells located by best available method.

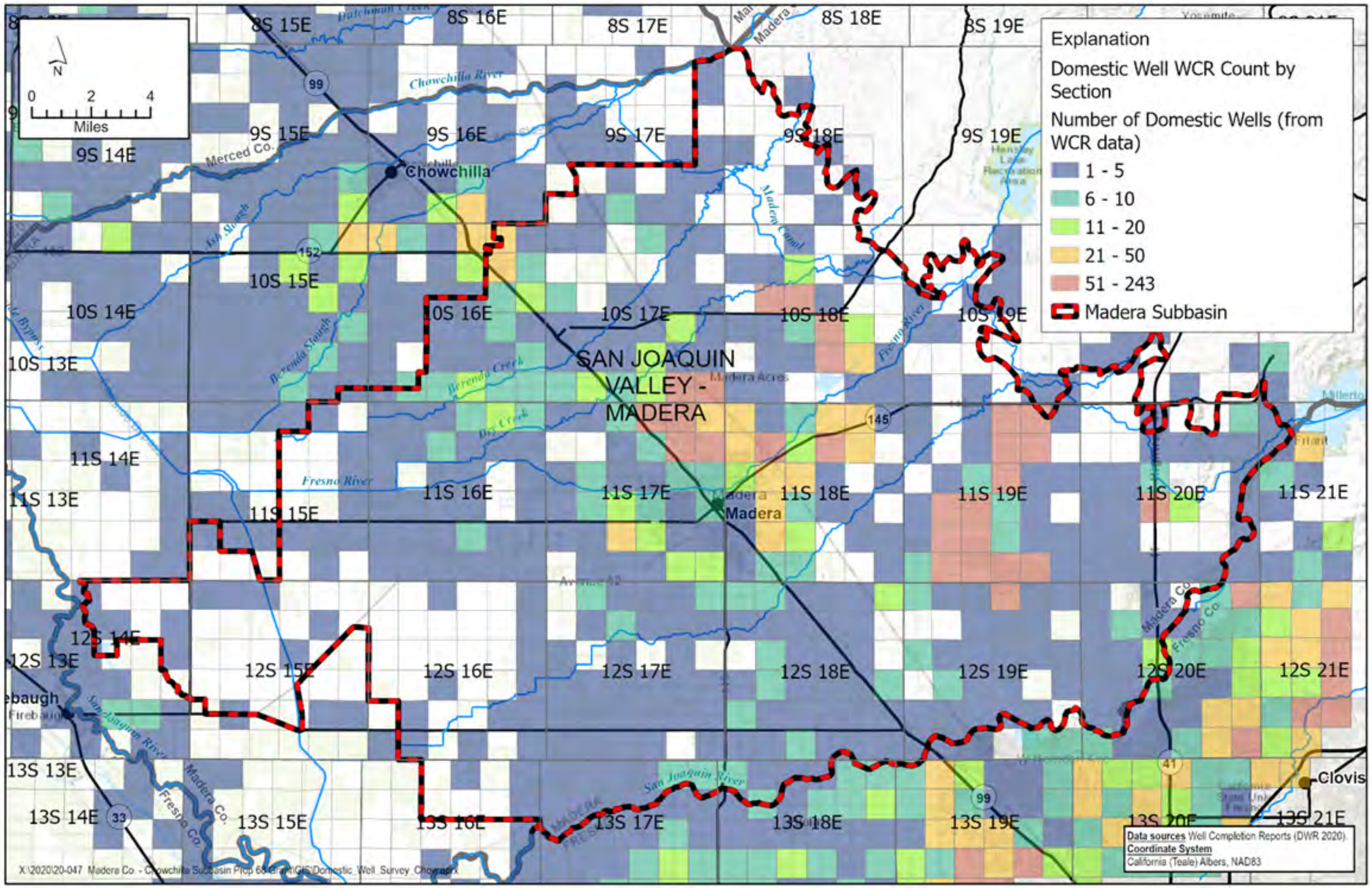

Figure 1b. Well Completion Report new construction domestic well counts by Section.

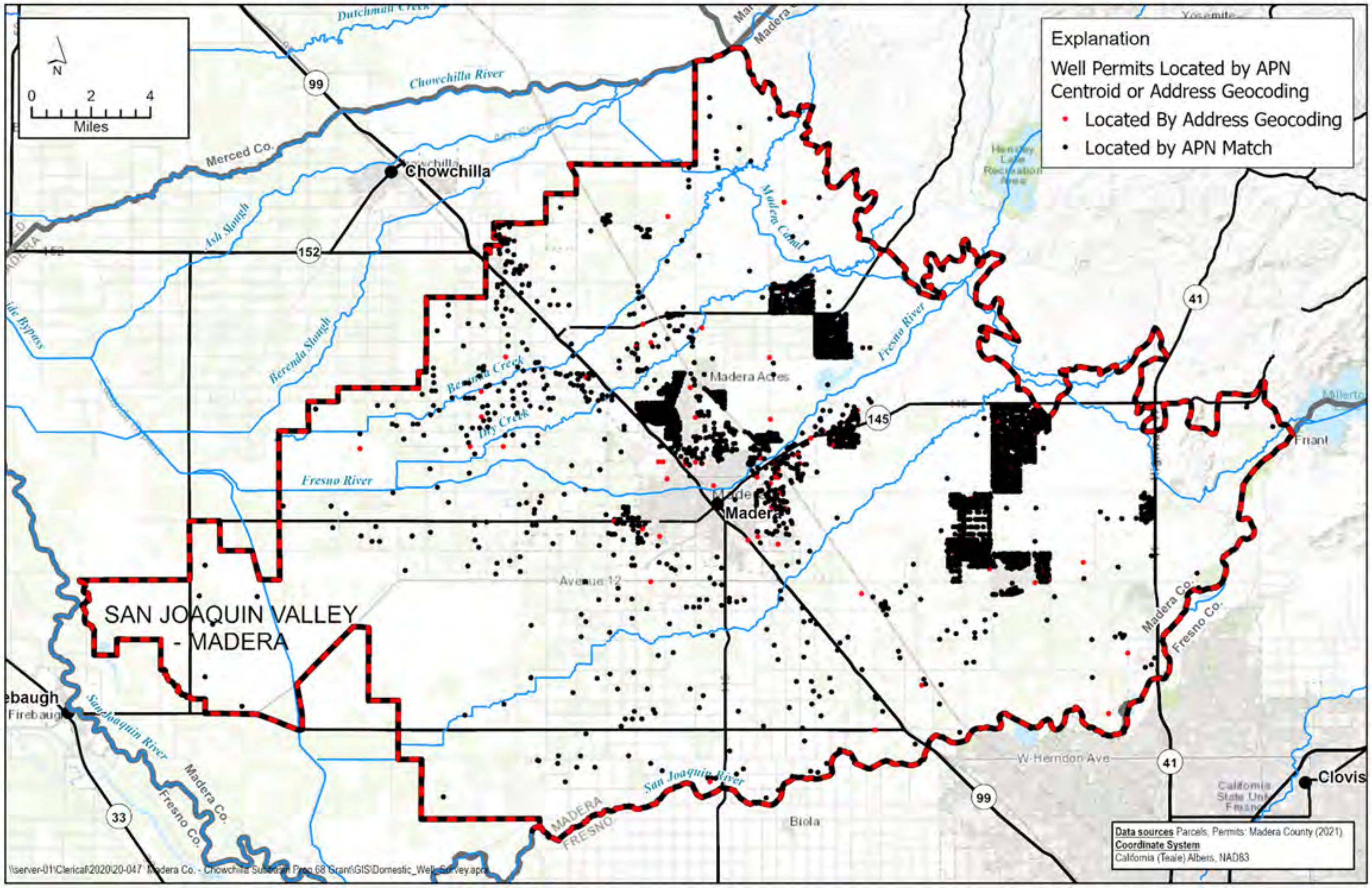

Figure 2a: Permit locations and geolocation method in Madera Subbasin.

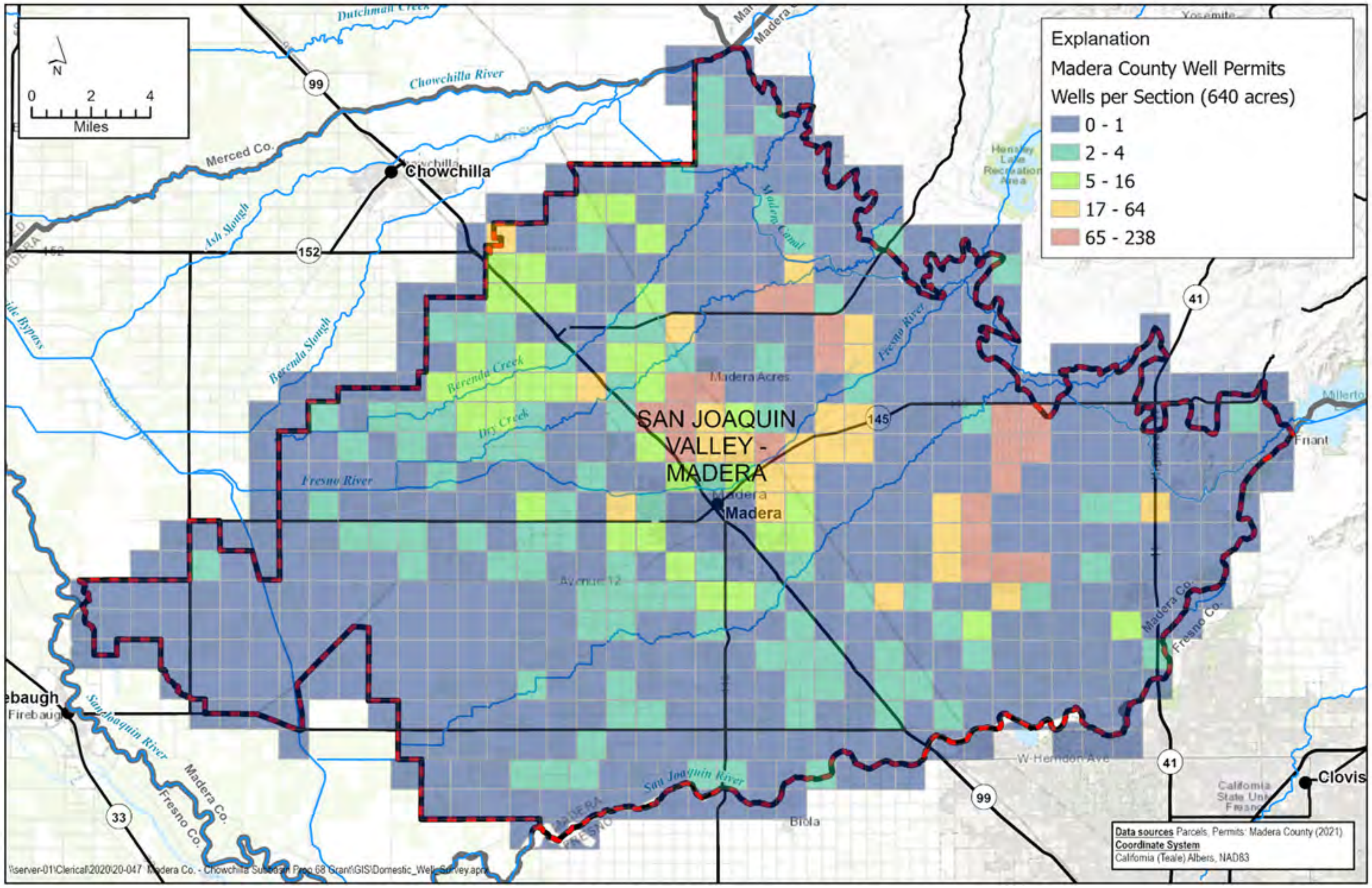

Figure 2b. Permit location counts by Township/Range/Section.

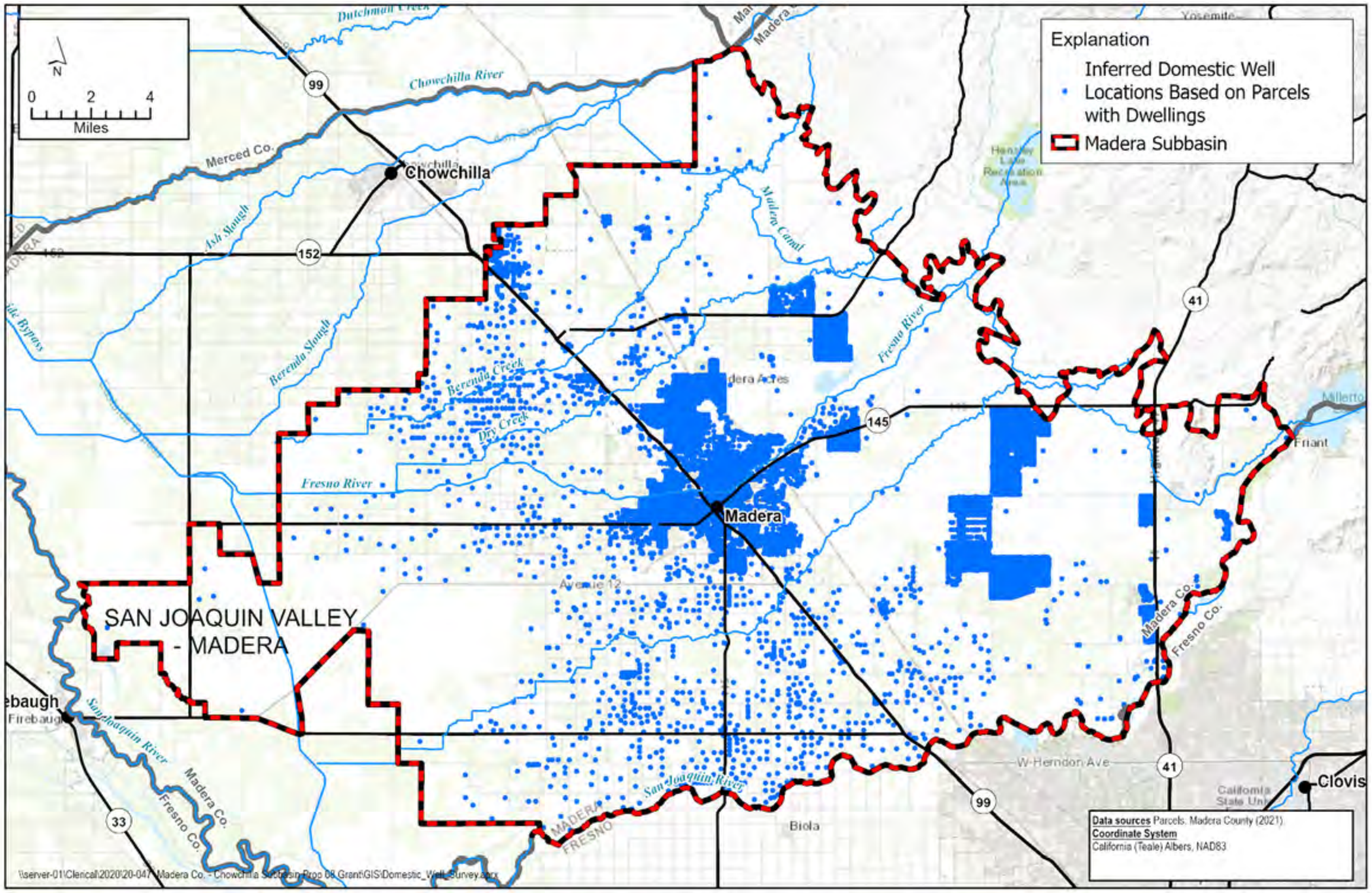

Figure 3: Inferred well locations based on Parcel Dwelling Status.

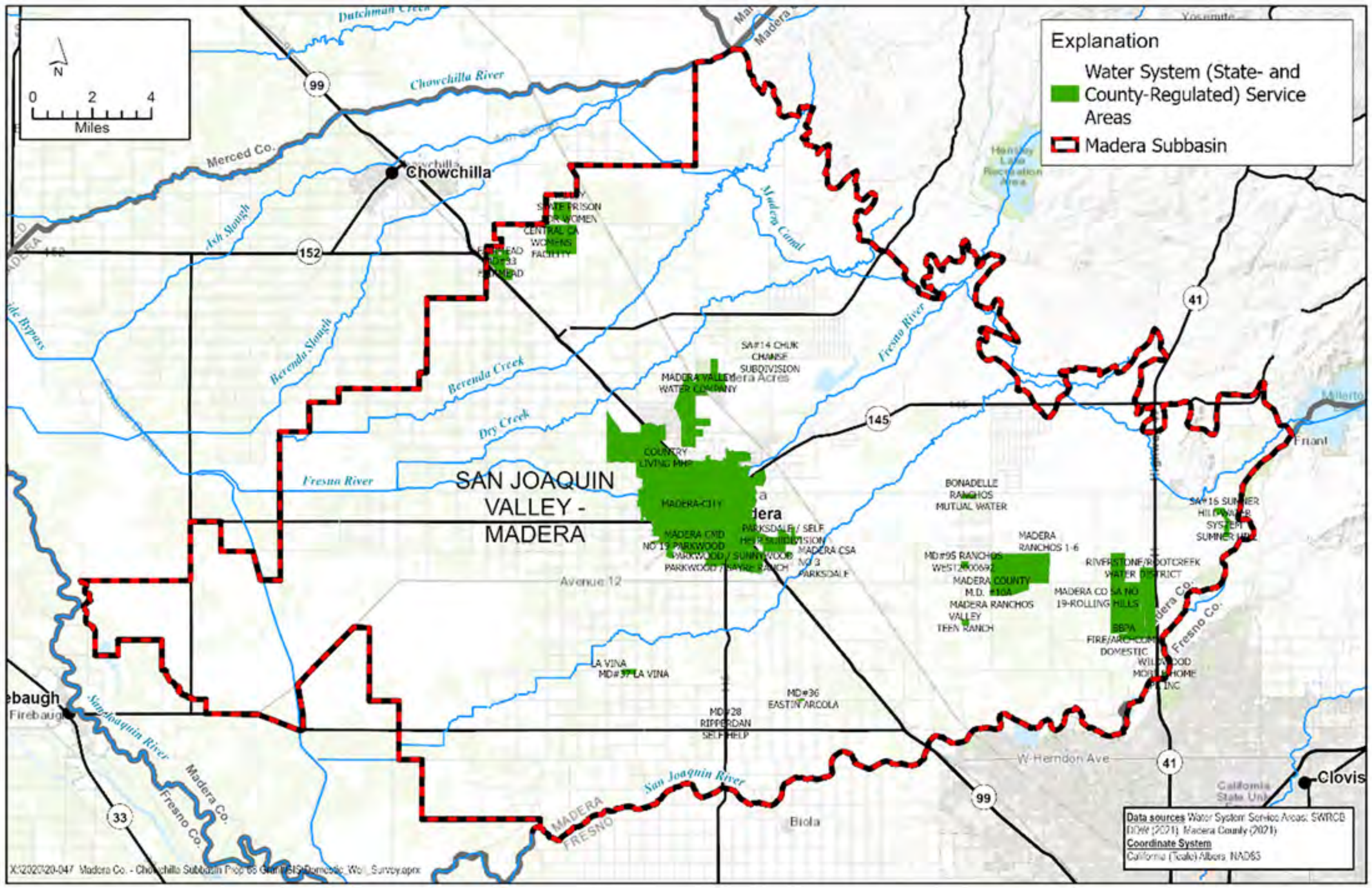

Figure 4: Water System Boundaries in Madera County.

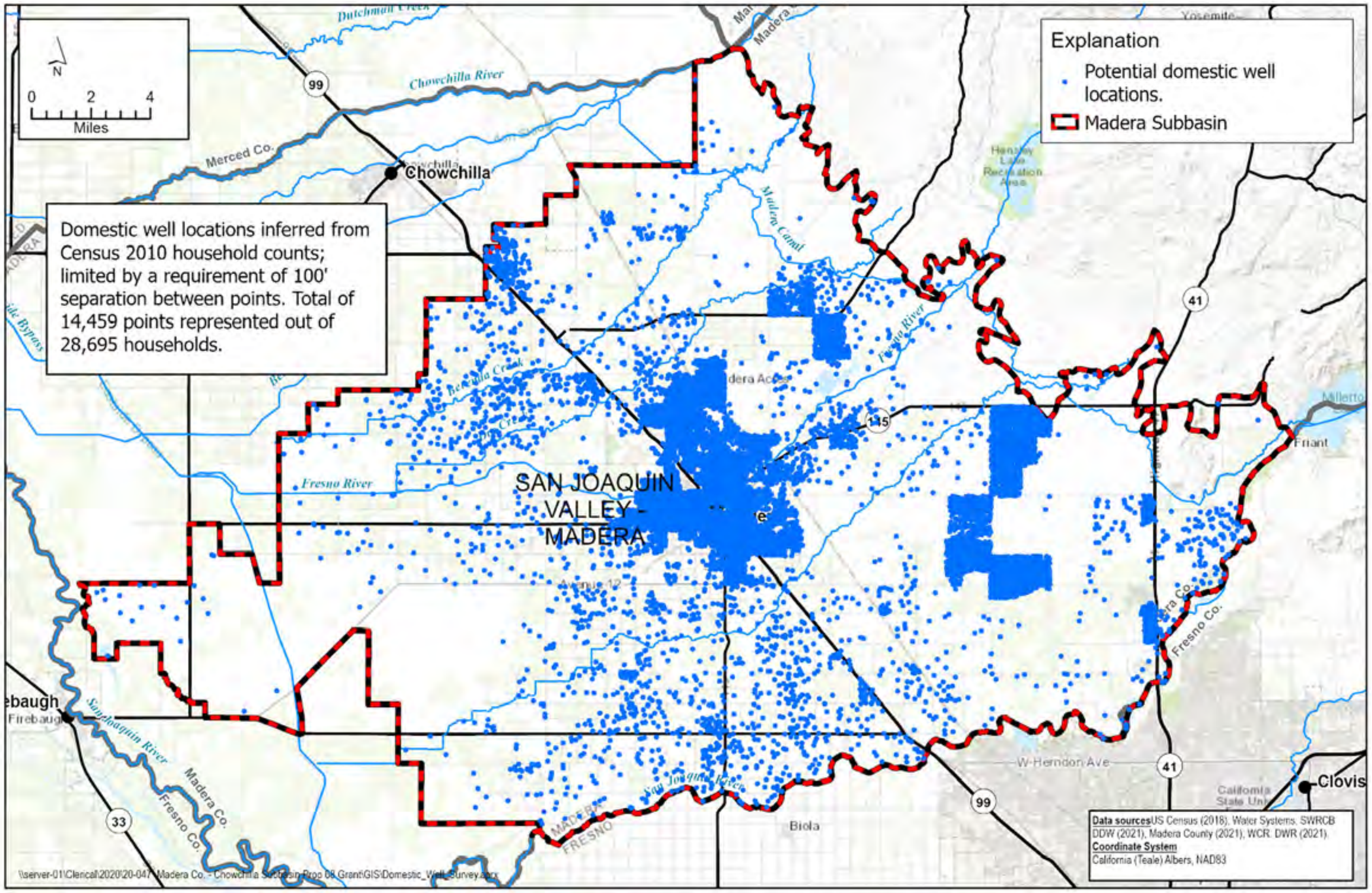

Figure 5: Inferred well locations based on 2010 Census Household counts.

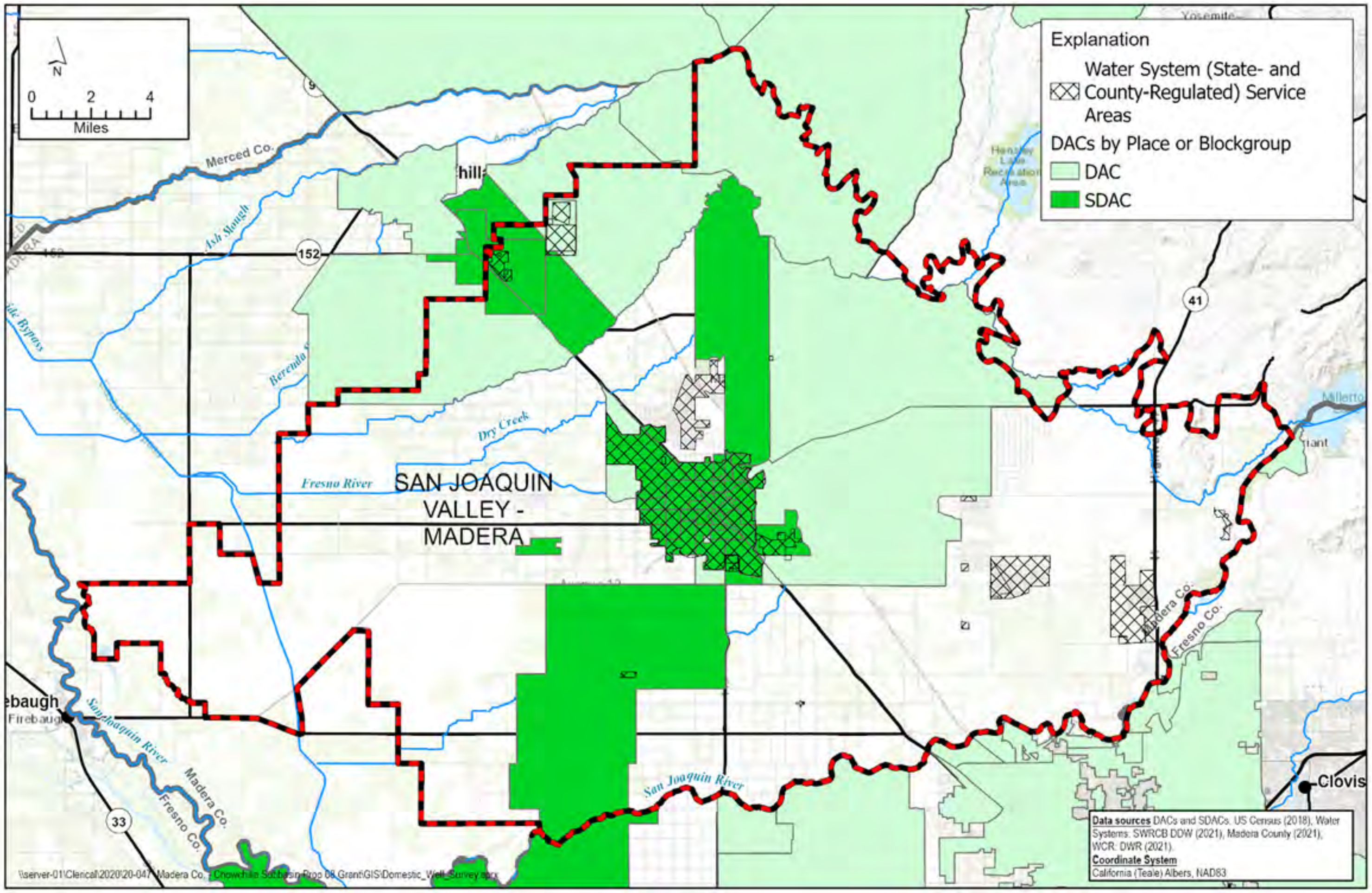

Figure 6: DACs and SDACs in the Madera Subbasin.

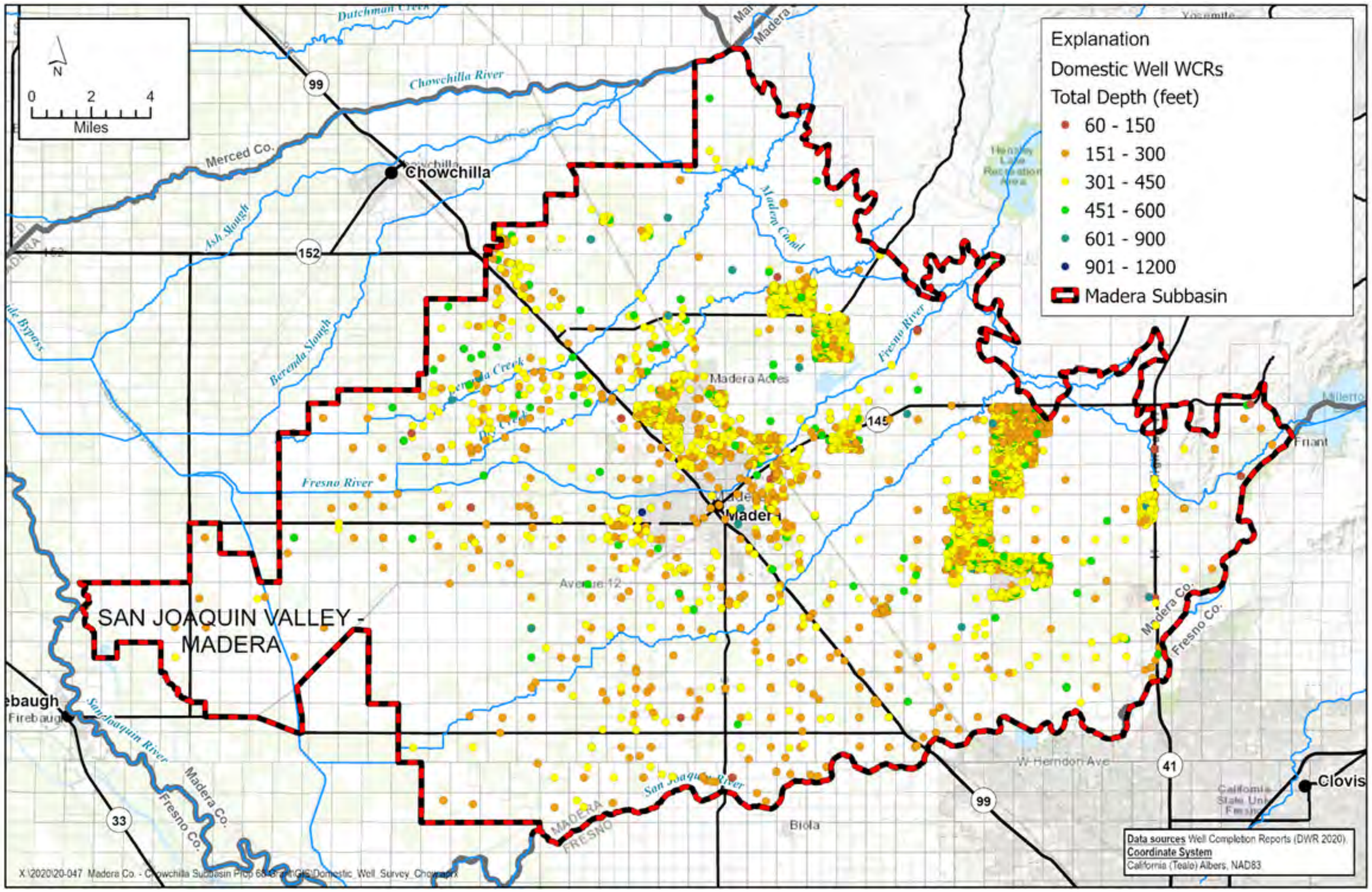

Figure 7a: Domestic wells in Madera Subbasin with depth from WCR.

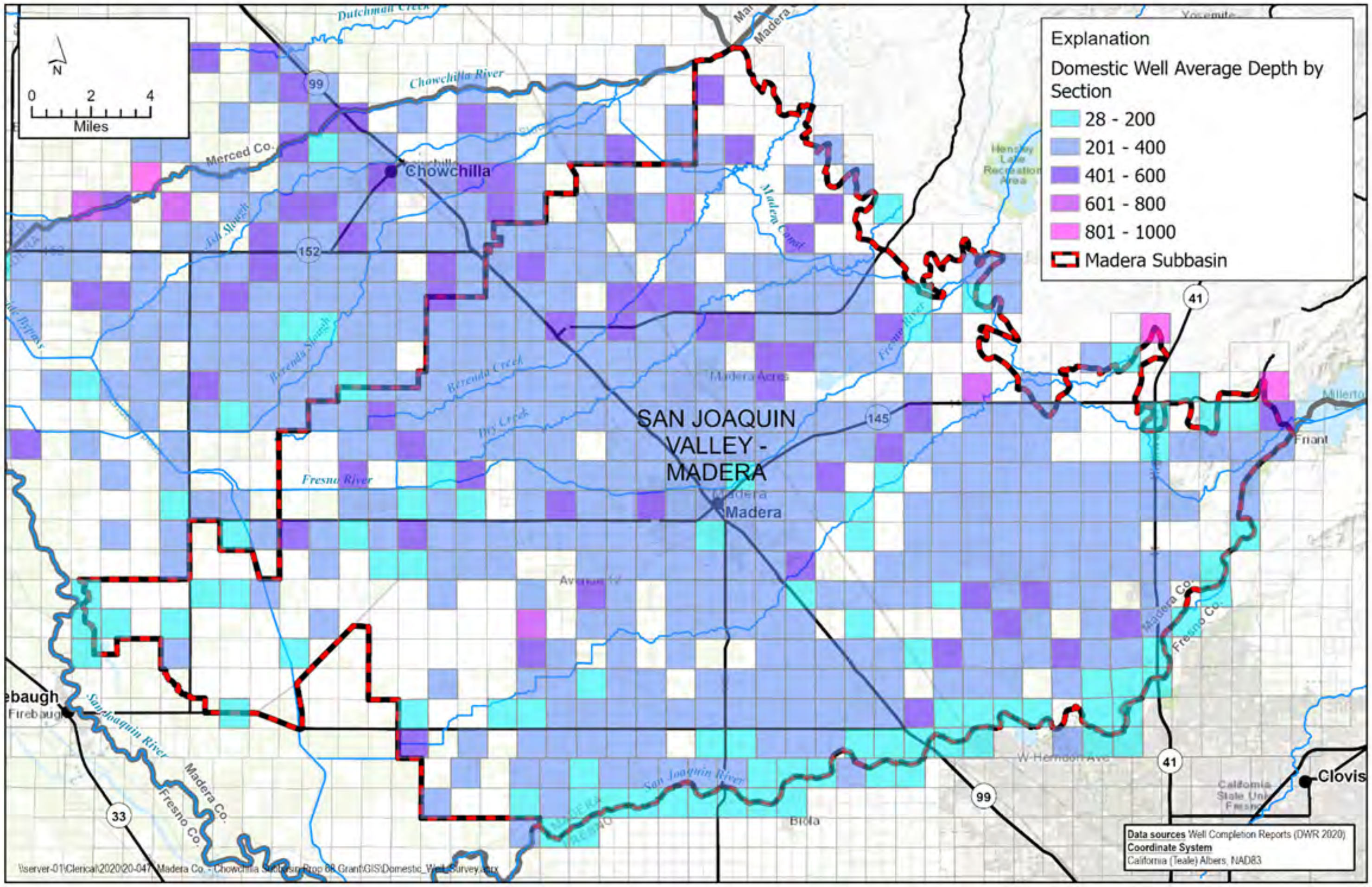

Figure 7b. Domestic Wells in Madera Subbasin with Average Depth by Township/Range/Section.

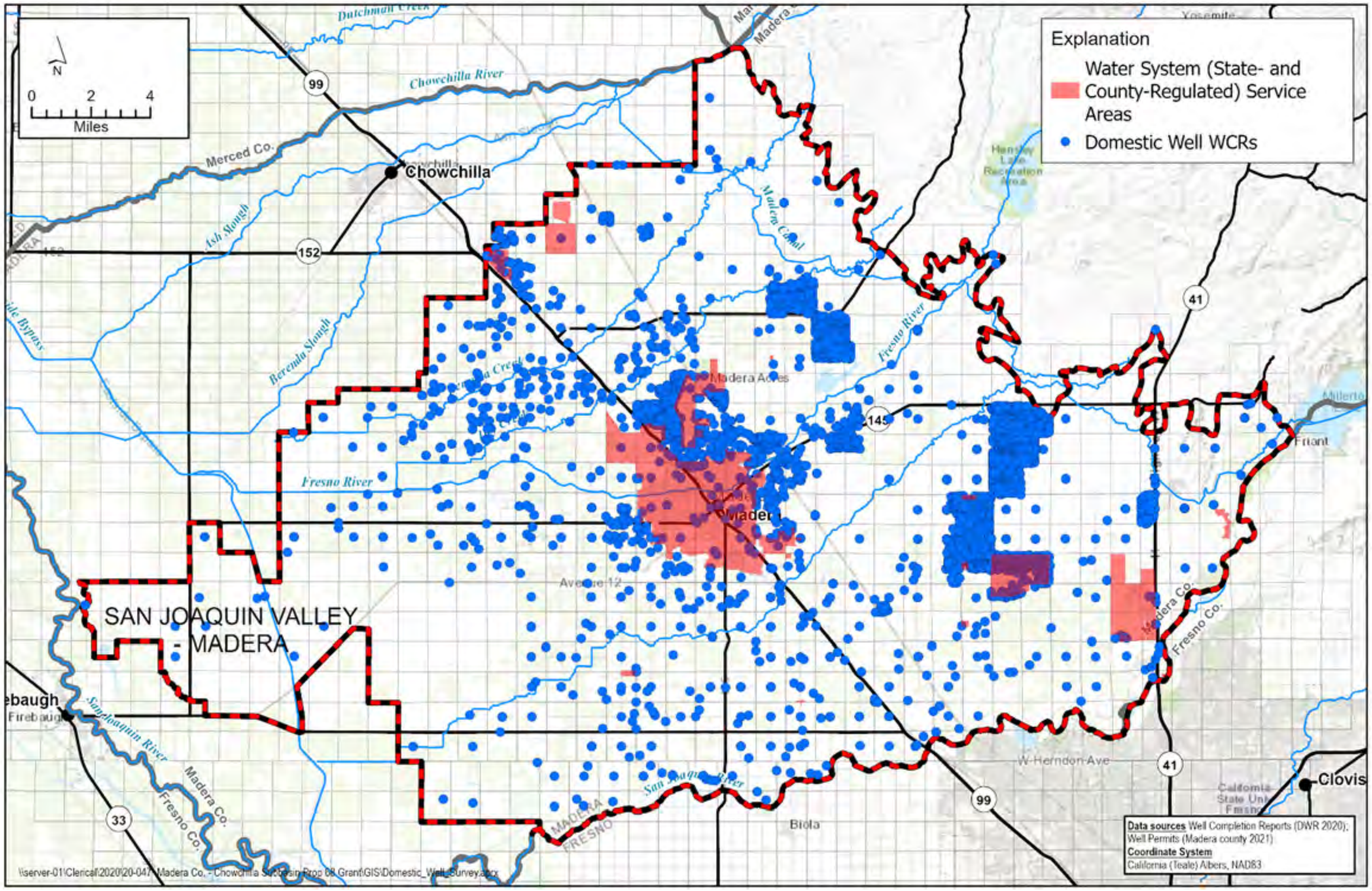

Figure 8: Domestic WCRs compared with Community PWS, County Maintenance Districts, and Community Service Areas.

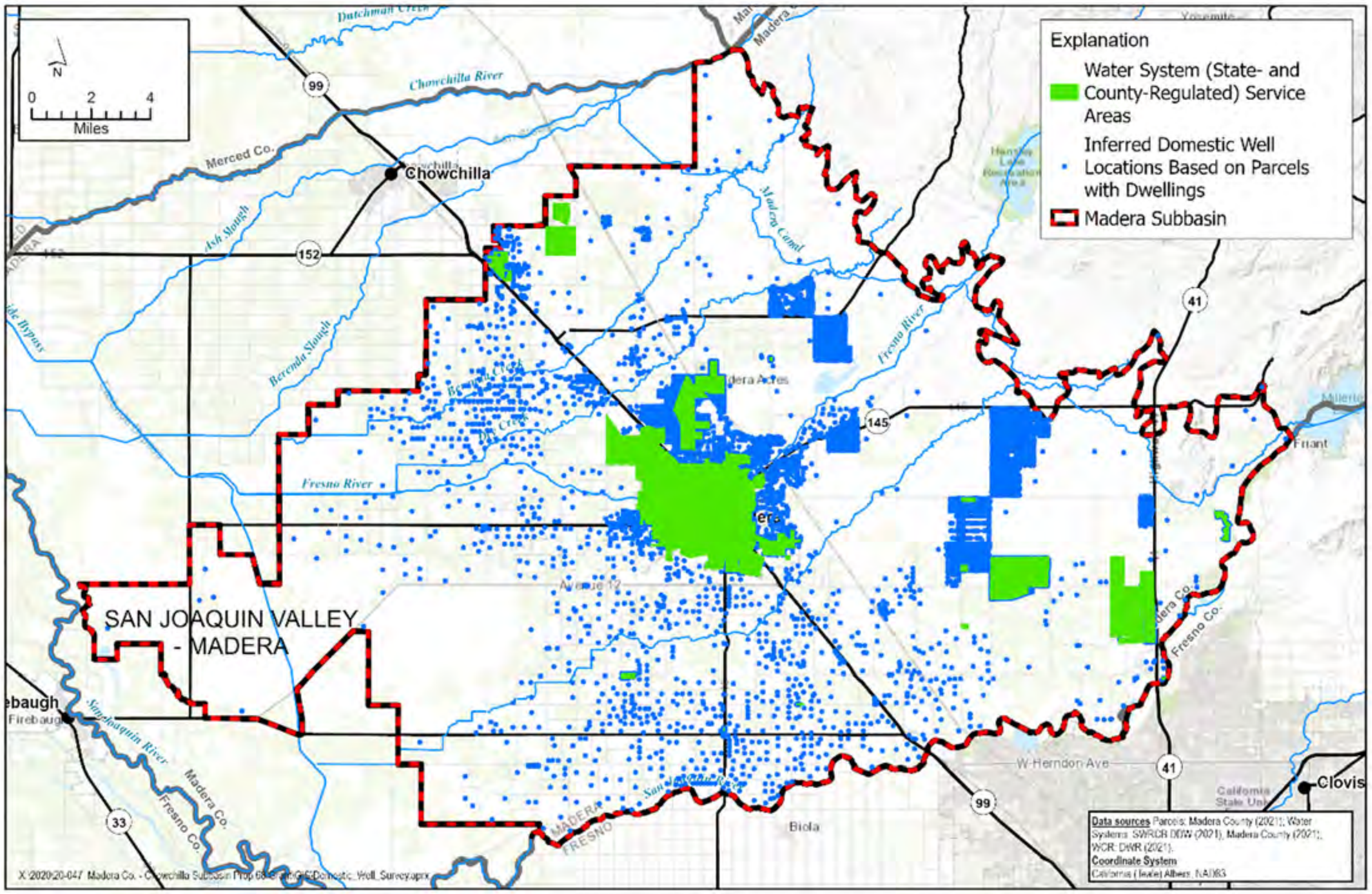

Figure 9: Parcels with Dwellings as Inferred Well Locations. With Community PWS, County Maintenance Districts, and Community Service Areas.

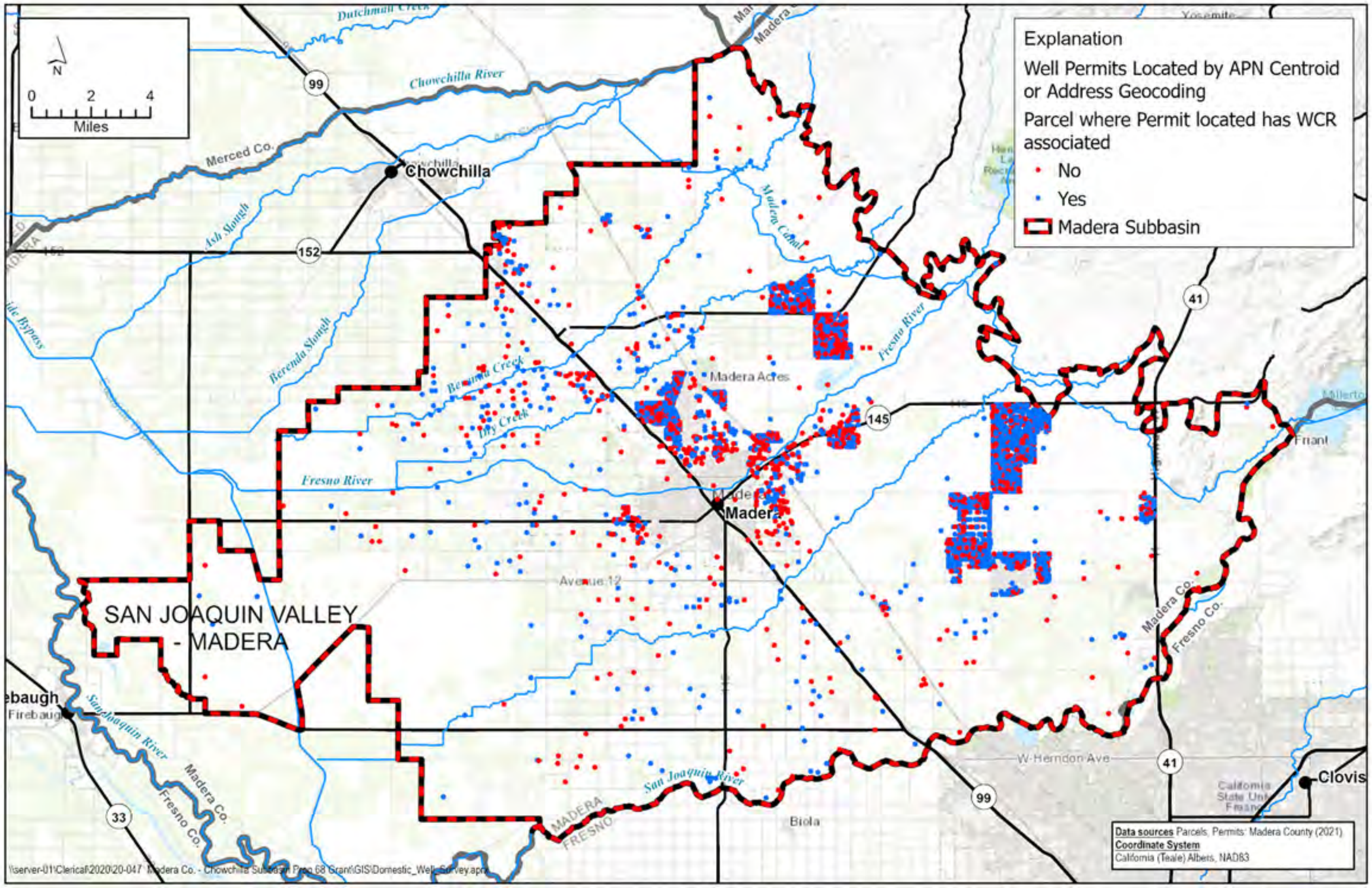

Figure 10: Permit locations with colocated WCRs.

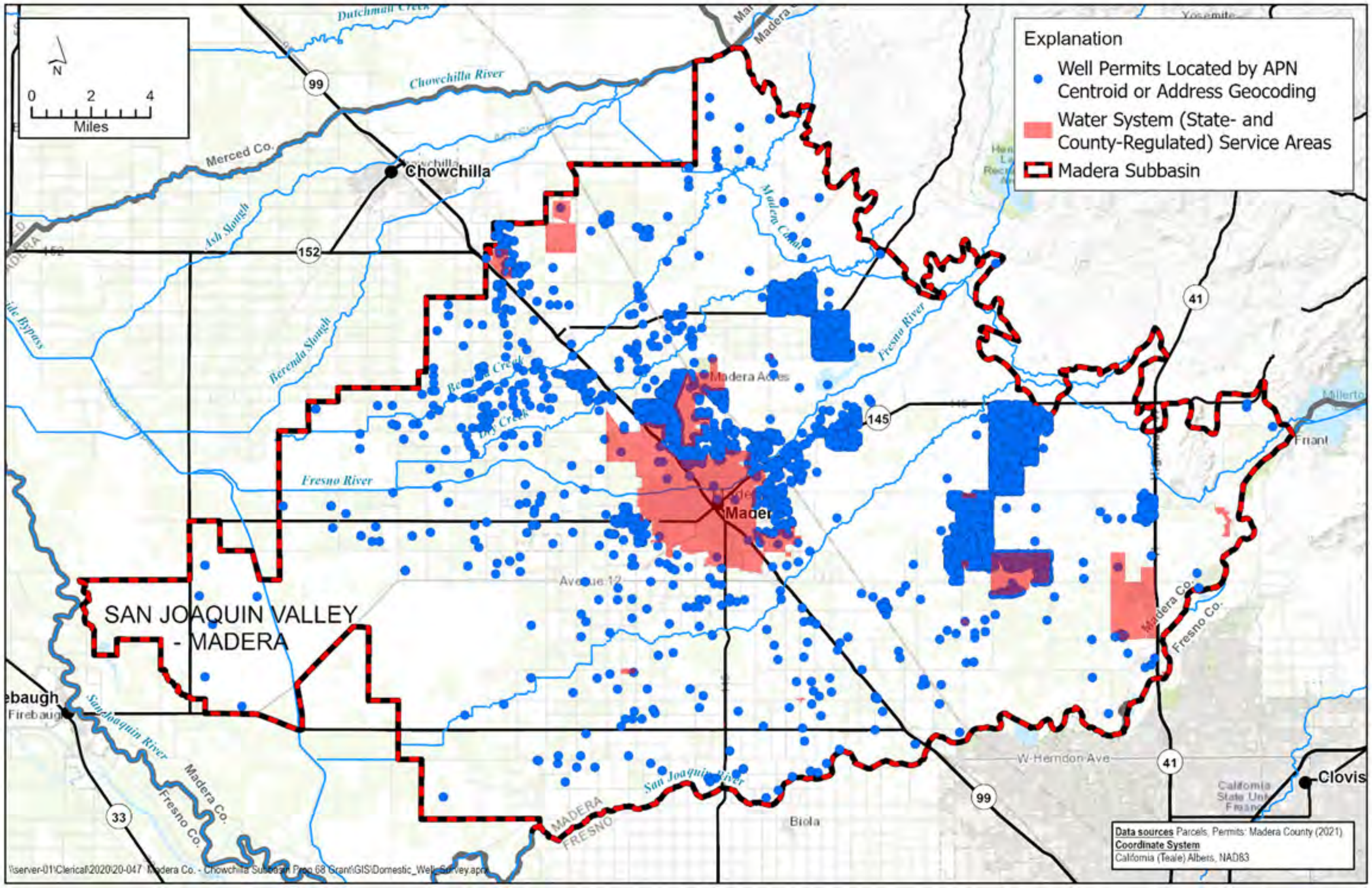

Figure 11a: Domestic Well Permits Compared with PWS, Community Service Districts and County Maintenance Districts.

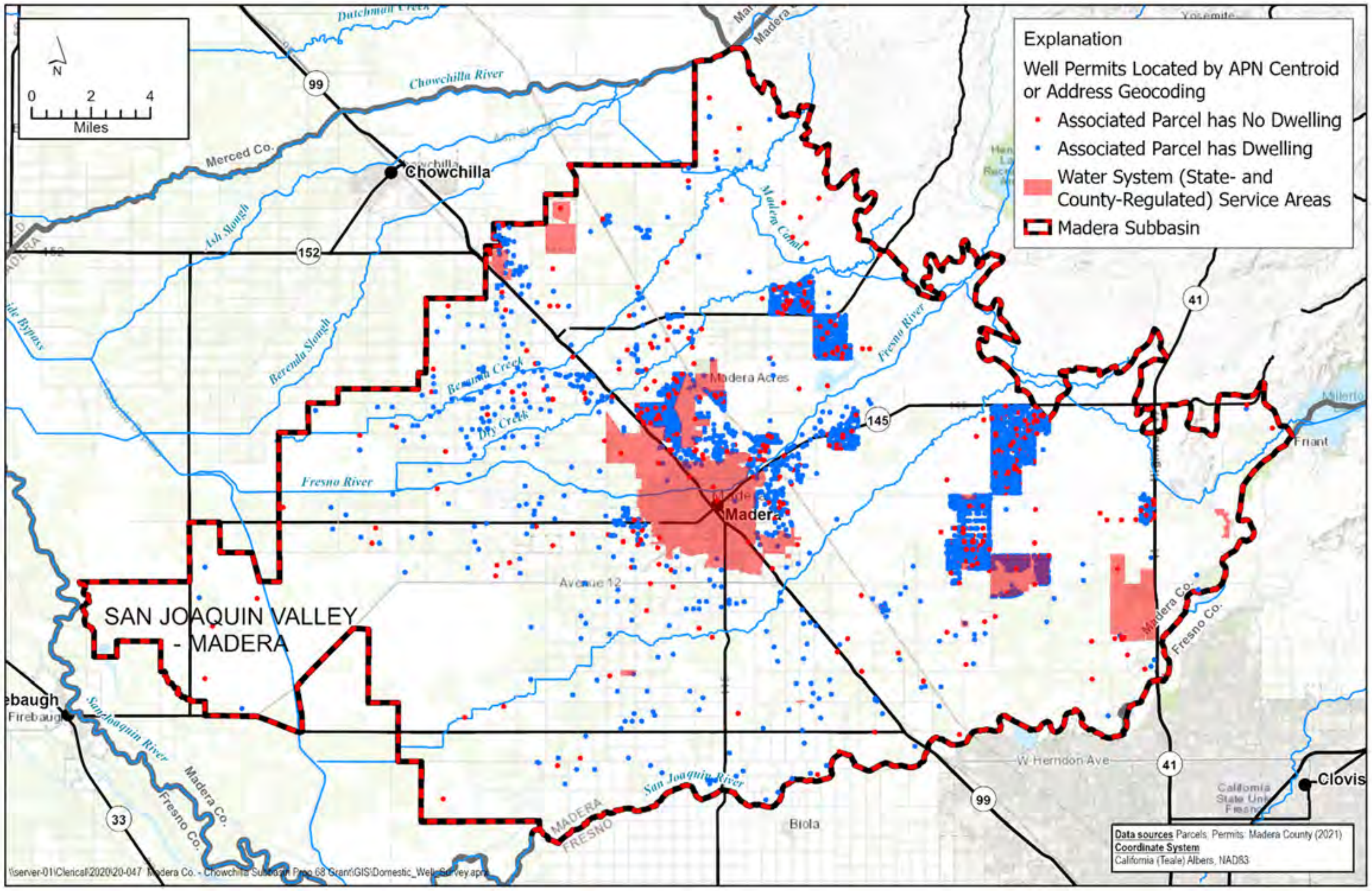

Figure 11b: Domestic Well Permits Compared with Parcel Characteristics.

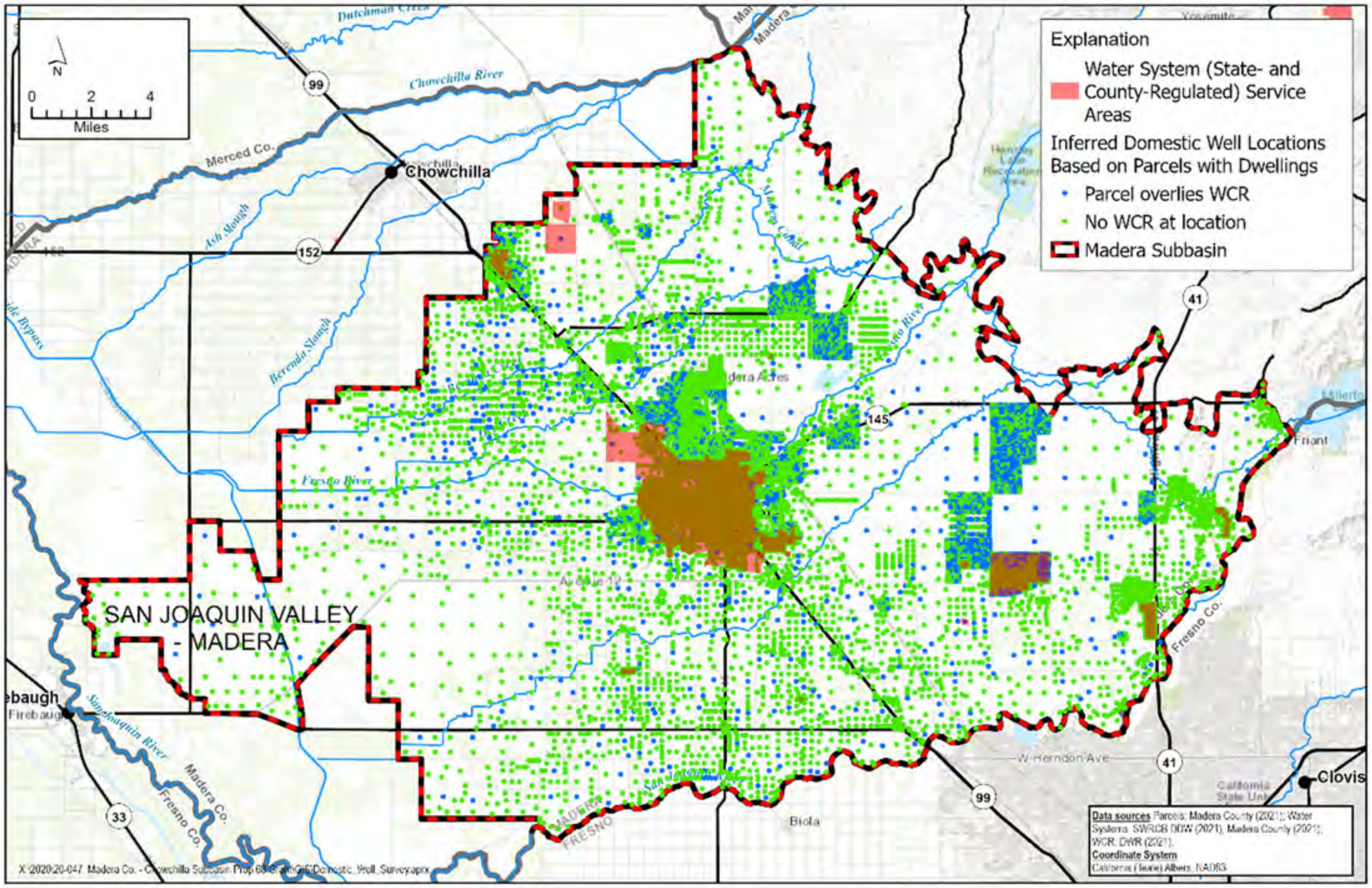

Figure 12: Inferred Domestic Well locations based on Parcels with Dwellings, with Water Systems and presence/absence of WCRs on parcel.

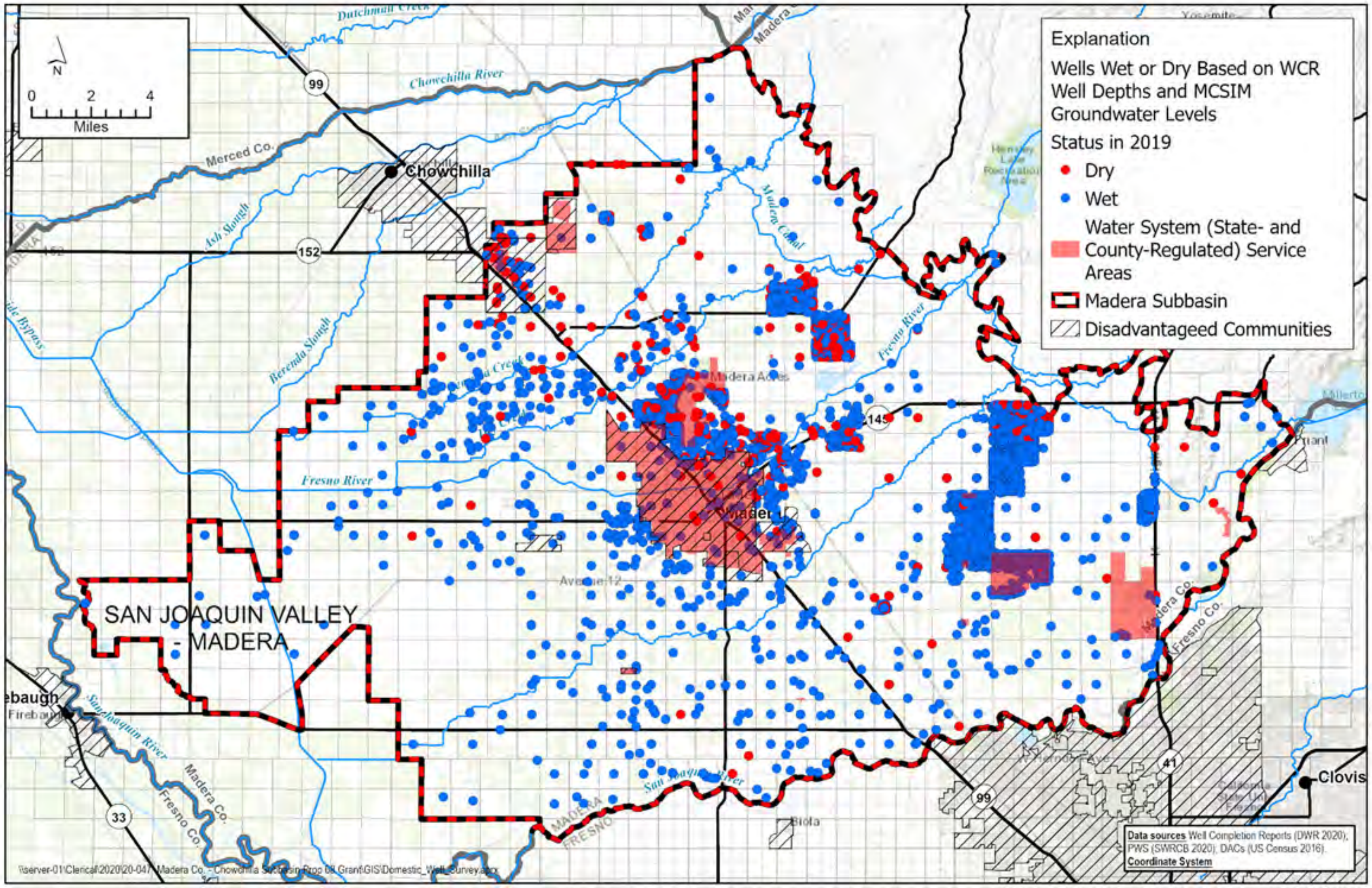

Figure 13a: Status of domestic wells in 2019 - Based on WCR well depths and locations compared to MCSIM groundwater depths.

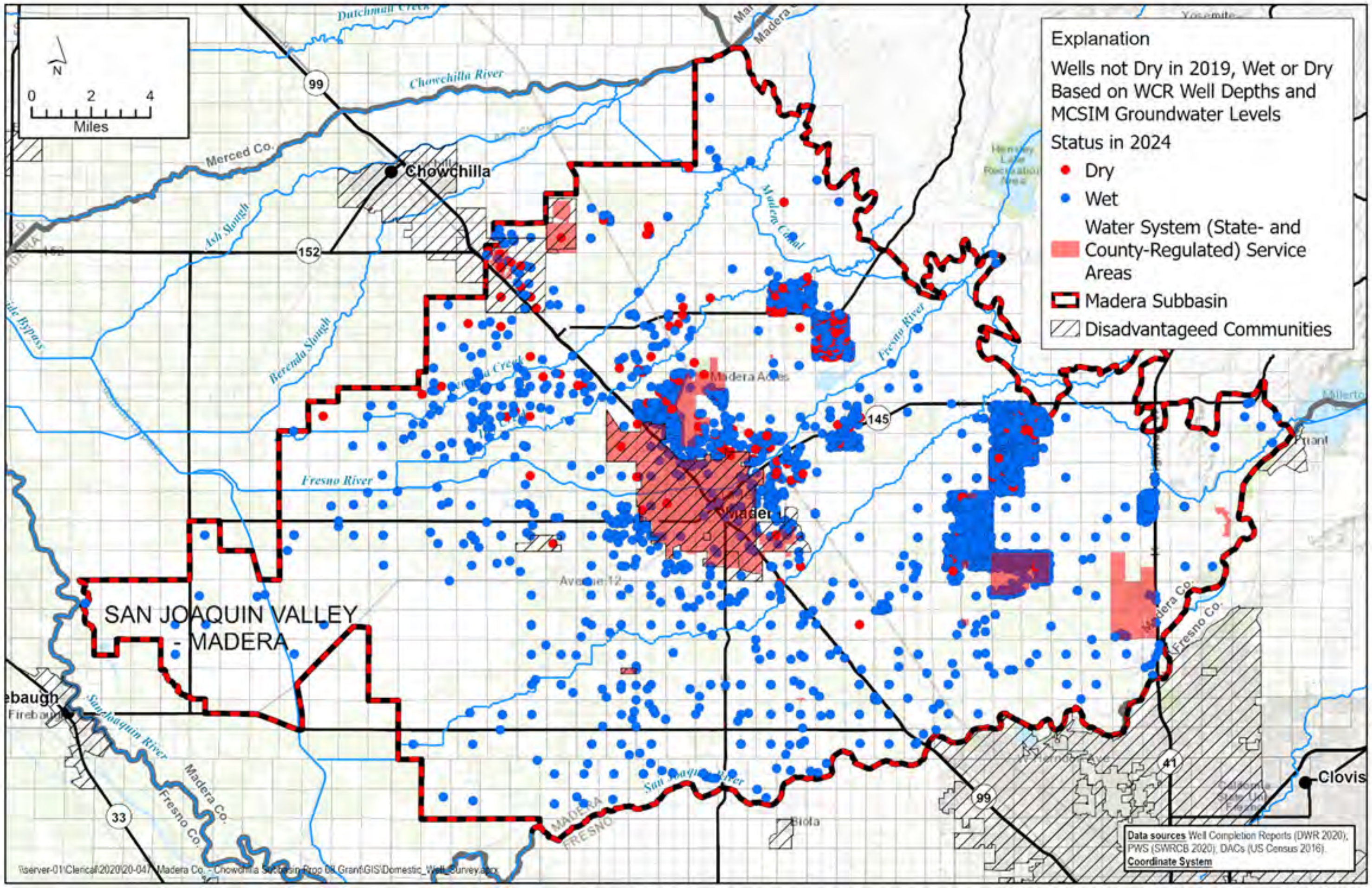

Figure 13b: Status of Wells in 2024 - Based on WCR Well Depths and Locations Compared to MCSIM Groundwater Depths.

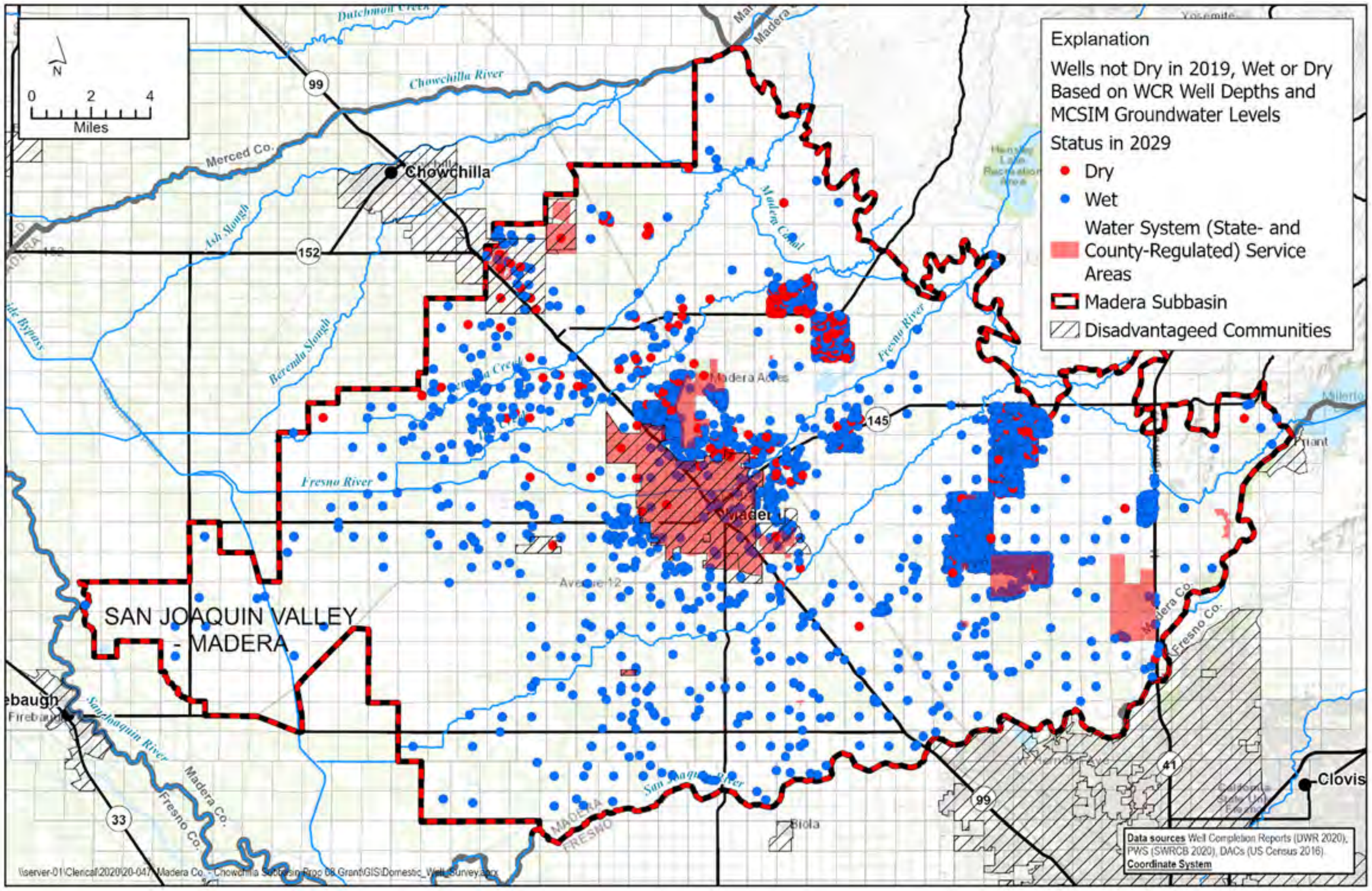

Figure 13c: Status of Wells in 2029 - Based on WCR Well Depths and Locations Compared to MCSIM Groundwater Depths.

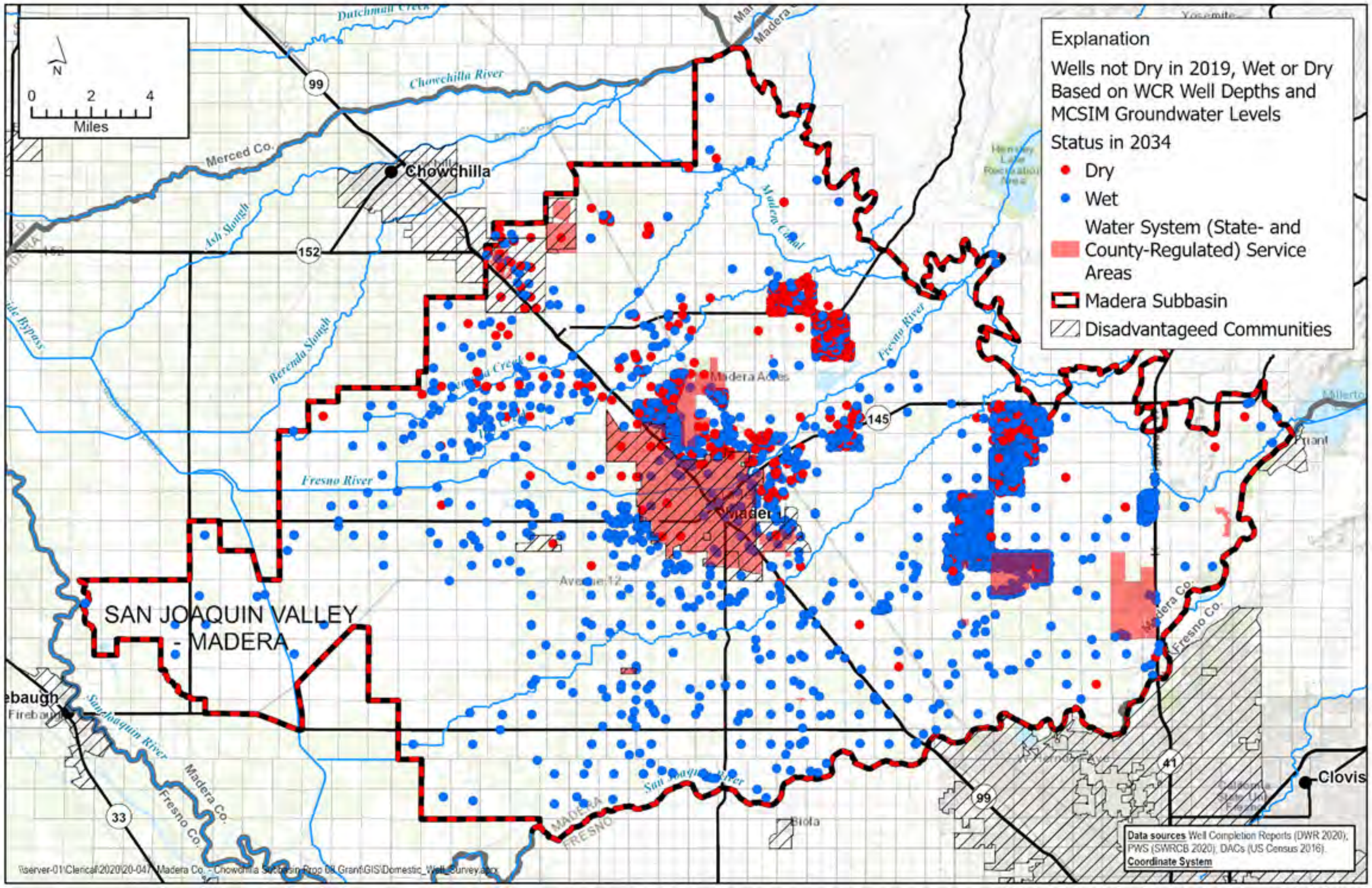

Figure 13d: Status of Wells in 2034 - Based on WCR Well Depths and Locations Compared to MCSIM Groundwater Depths.

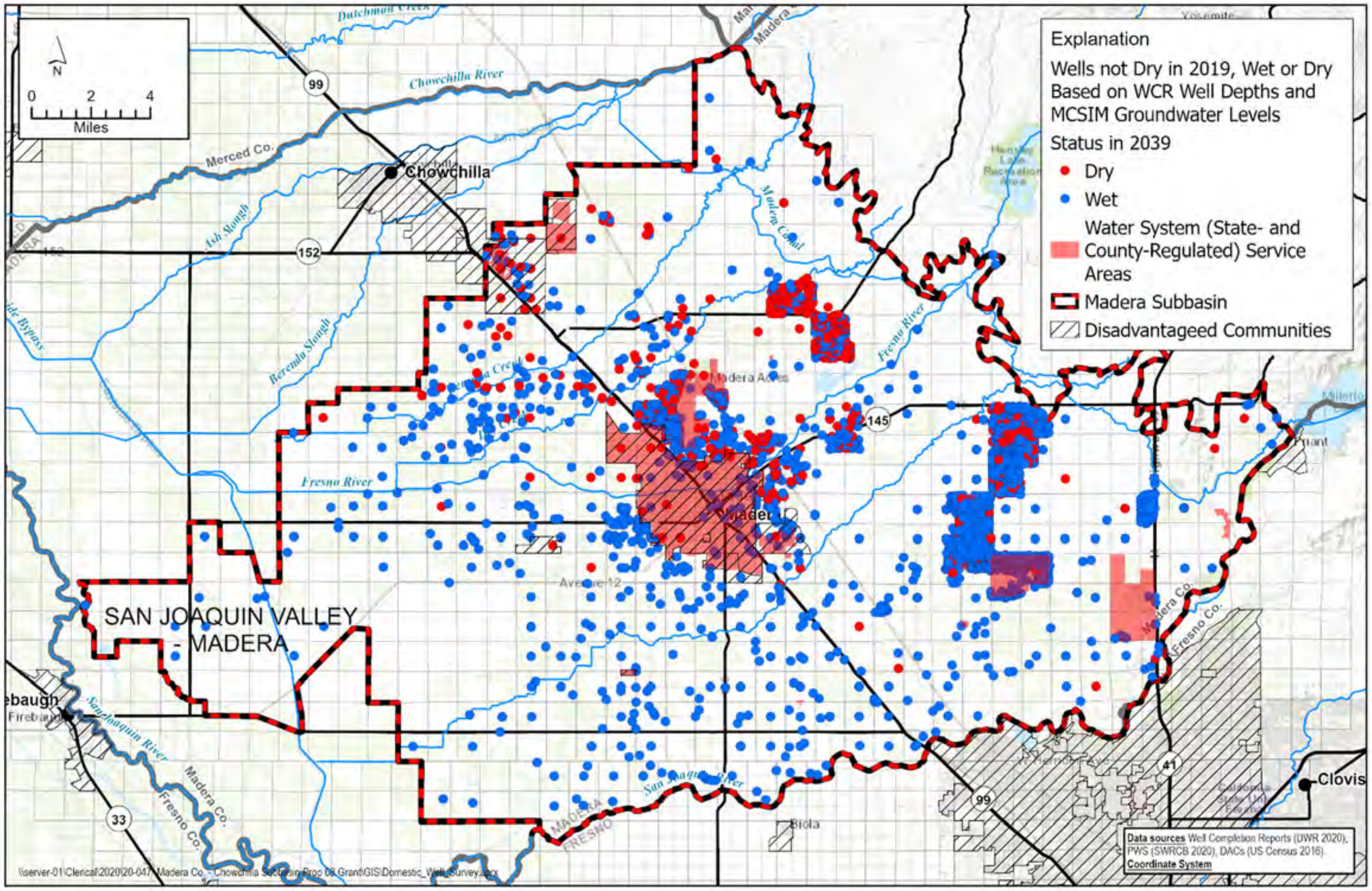

Figure 13e: Status of Wells in 2039 - Based on WCR Well Depths and Locations Compared to MCSIM Groundwater Depths.

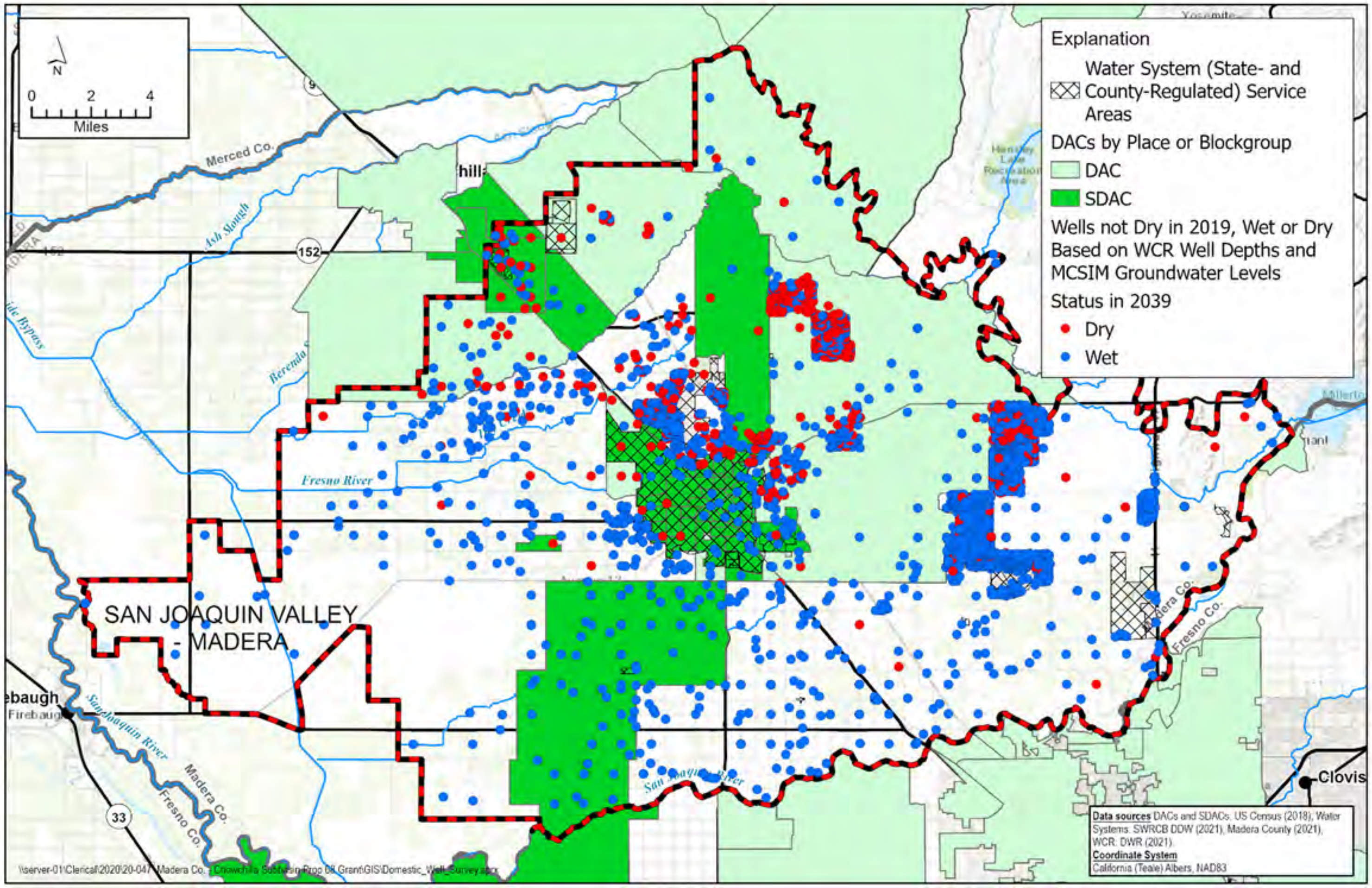

Figure 13f: DACs and SDACs with WCR-Based Wells and Predicted 2039 Status.

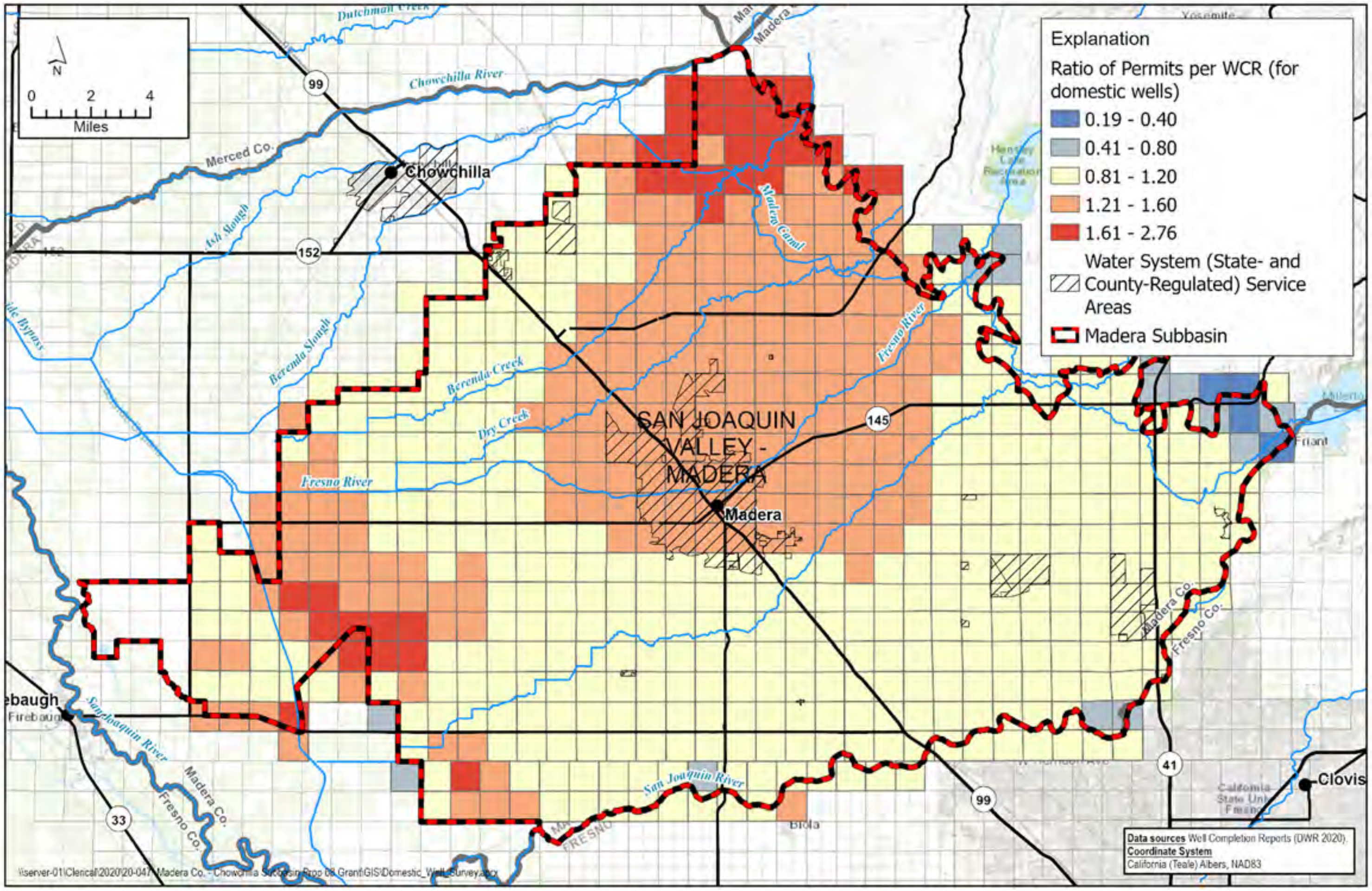

Figure 14: Map of domestic well Permits compared to domestic well WCR (from 1990 and later) locations.

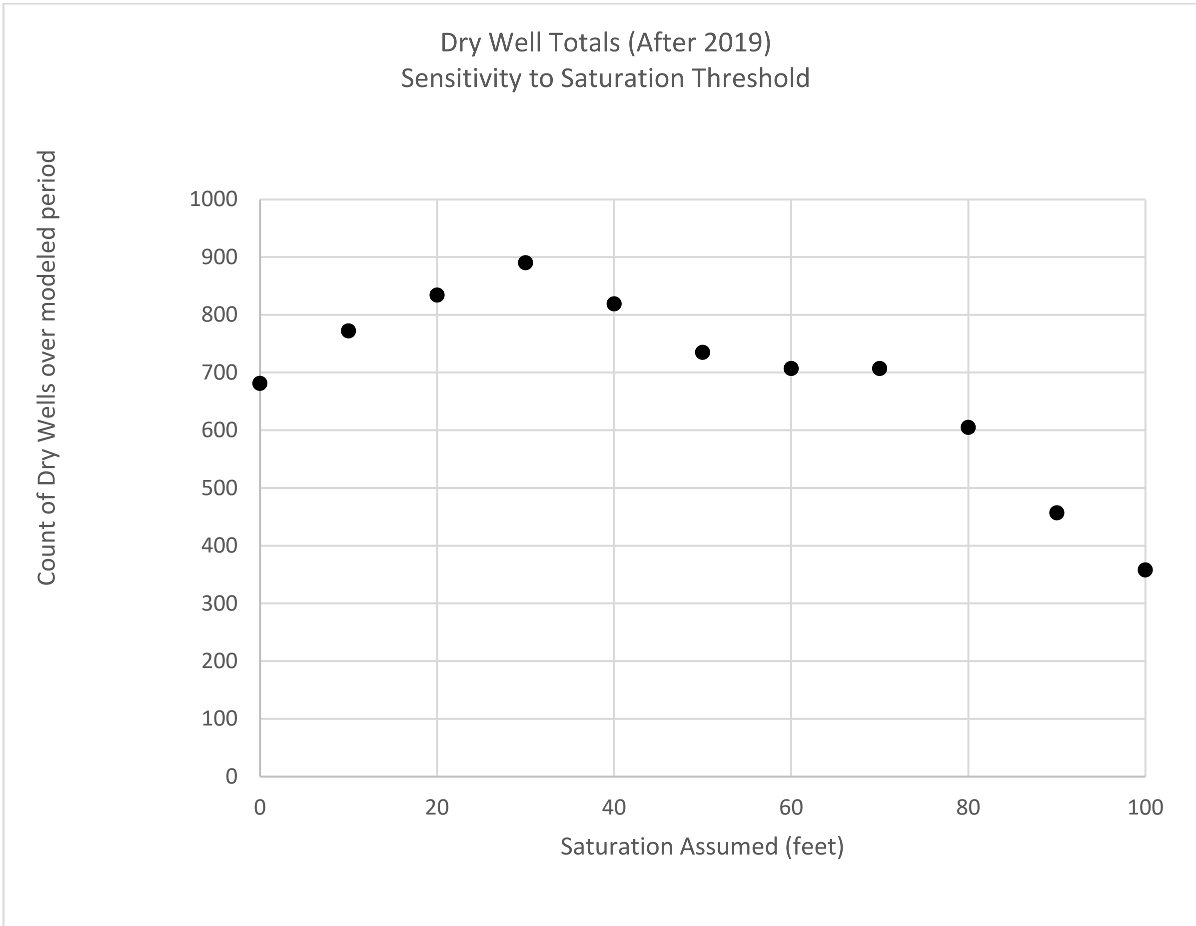

Figure 15: Counts of Dry Wells after 2019 as a Function of Minimum Saturation Threshold.

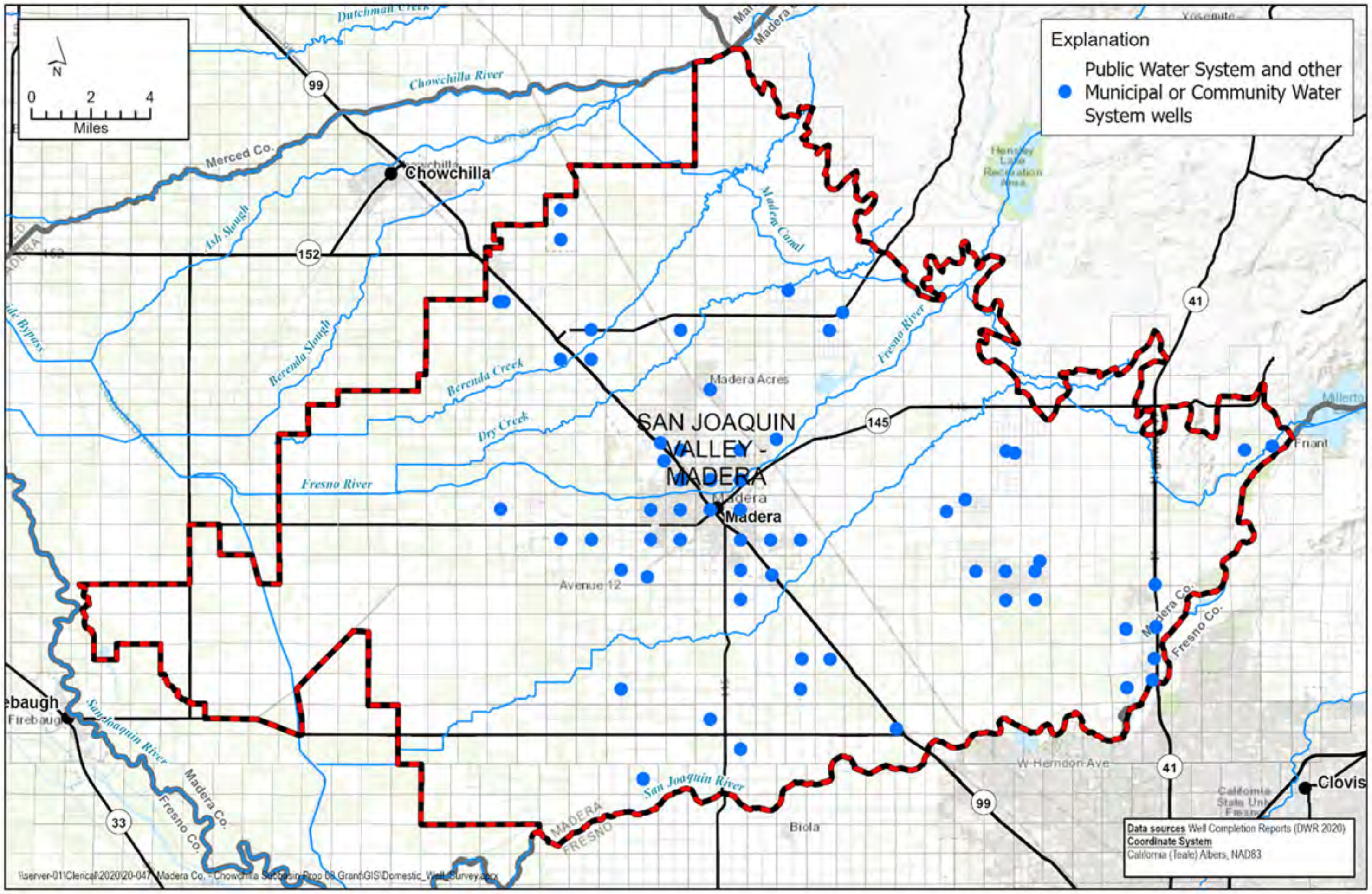

Figure 16: Public Water System and other Municipal or Community Water System wells. Based on WCR data.

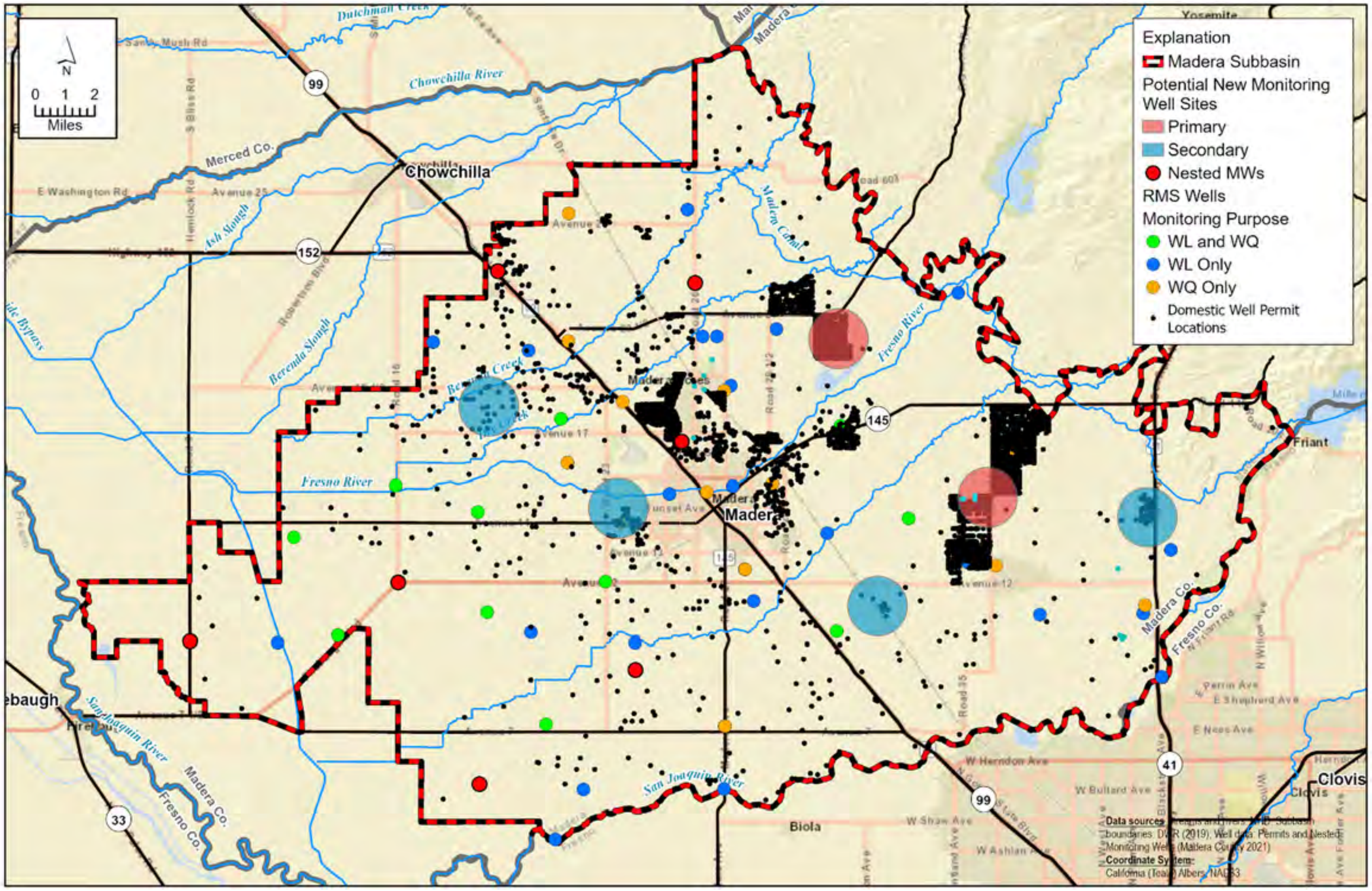

Figure 17: Map of Proposed New Monitoring Well Sites.

ATTACHMENT 1

Domestic Well Replacement Economic Analysis – Madera Subbasin Update

ERA Economics
1111 Kennedy Place, Suite #4
Davis, CA 95616

Technical Memorandum

Subject: Domestic Well Replacement Economic Analysis – Madera Subbasin Update

By: ERA Economics

To: LSCE and the Madera County GSA

Date: January 10, 2022

Purpose and Background

In June 2019 ERA provided a technical memorandum (TM) estimating the cost and benefit of more rapid implementation of demand management under the Madera Subbasin Joint GSP. The economic analysis was included as Appendix 3D to the Madera Subbasin Joint GSP. The analysis was prepared with the best available data and information at that time. After finalizing the GSP, the LSCE and DE consultant teams have continued to assist the Madera Subbasin GSAs with GSP implementation and annual GSP reporting. LSCE was engaged by the Madera County GSA to prepare an updated domestic well inventory for the subbasin.

The economic analysis included as Appendix 3D to the Madera Subbasin Joint GSP estimated the total cost of replacing domestic wells potentially impacted by declining groundwater levels under baseline conditions without SGMA and under the draft proposed GSP implementation plan (so-called "with-SGMA" scenario).

This technical memorandum (TM) serves as an update to those estimates by: (i) updating the project and demand management schedule to reflect the adopted allocation in the Madera Subbasin, (ii) incorporating updated data and analysis on potentially impacted wells from the domestic well inventory, (iii) updating all costs and benefits to current dollars (e.g., well replacement costs), and (iv) refining the economic analysis to compare the cost and benefit of accelerating demand management specified in the GSP. That is, the 2019 analysis compared the draft proposed GSP implementation to baseline conditions without SGMA, whereas this analysis compares the proposed plan with phased implementation of projects and management actions (PMAs) to an accelerated, immediate implementation of PMAs, notably with immediate, full demand management to avoid further domestic well impacts.[1]

These updates to the data affect the resulting economic analysis and results. The 2019 estimate of domestic wells needing to be replaced without increased demand management was 228 wells, which at that time was doubled to account for potential under-reporting. In addition, a sensitivity calculation as

[1] Whereas the cost of immediate demand management implementation has been included, the effect on cost of accelerating recharge and supply projects has not yet been estimated. A full cost estimate of projects for all GSAs in the subbasin is still under development. If this additional cost were included, it would strengthen the conclusion of this analysis.

part of the earlier analysis verified that the conclusions would have held even if the number of affected wells were substantially larger. The updated domestic well inventory puts the number of domestic wells potentially needing replacement between 1,260 and 1,578 over the 20-year GSP implementation period. This TM briefly summarizes the updated analysis, results, and summary conclusions.

Summary Conclusions

Results of this updated analysis comparing the cost of accelerated PMA implementation to the benefit of avoided domestic well replacement costs support the general conclusion of the 2019 analysis. The loss in agricultural value from more rapid demand management still greatly exceeds domestic well replacement costs even though the estimated number of potentially dewatered domestic wells has increased and the cost of replacement for each domestic well has increased by 20 percent. That is, the results of the economic analysis show that the additional cost of more rapid demand management is substantially greater than the cost of replacing potentially dewatered domestic wells and paying higher pumping costs due to lower water levels. This supports the phased implementation schedule and domestic well mitigation program defined in the GSP.

Updated Assumptions

Assumptions and results below are summarized for each of the cost categories considered. All costs (or savings) are expressed as constant 2021 dollars converted to present value using a 3.5 percent real (inflation-free) discount rate[2]. The two implementation scenarios compared are referred to as *GSP implementation* (the phased implementation as described in the GSP) scenario and the *immediate demand reduction* (full demand reduction to eliminate overdraft from 2021 onward) scenario.

1. **Number of dewatered wells needing replacement**. Revised estimates of dewatered wells are calculated and described in the Technical Memorandum prepared by LSCE for the Madera Subbasin Domestic Well Inventory. For this analysis, a total of 1,578 wells were estimated to be dewatered, spread across four 5-year periods. The cost analysis further assumed that well impacts would be evenly divided by year within each 5-year period[3]. For the comparison scenario with immediate demand reduction, it was assumed that none of those wells would need replacement.
2. **Costs to replace dewatered domestic wells**. The 2019 estimate of an average $25,000 per replaced domestic well is updated to $30,000 per domestic well.
3. **Groundwater pumping depth to water (DTW).** The average DTW for the GSP implementation scenario was provided from groundwater model projections described in the Madera Subbasin Joint GSP. The immediate demand reduction scenario is intended to represent immediate elimination of average annual overdraft. A time series was created that followed the

[2] The current federal discount rate for water projects is 2.25%, but a real rate of 3.5% better reflects borrowing conditions in Madera County. A 1.5% increase or decrease in the real discount rate does not affect the conclusions of the analysis.
[3] The timing of the well replacement within each 5-year period does not affect the conclusions of this analysis.

general hydrologic variation estimated for the GSP implementation scenario but held the DTW the same on average during the 2021-2040 implementation period. The ending (2040) difference in DTW between the two scenarios was then carried forward beyond 2040. These pumping depth differences are the basis for the estimated annual pumping cost savings.

4. **Changes in variable costs to pump groundwater, for both domestic and agricultural users.** Energy prices, estimated using a mix of PG&E's latest electricity rates for agricultural pumping, have increased substantially. The analysis now uses an average of PG&E's 2021 AG-B and AG-C peak and off-peak summer rates, resulting in an estimate of $0.40 per acre-foot per foot of lift for the variable cost to pump groundwater. As a result, more rapid demand management provides greater savings (avoided pumping lift) for domestic and agricultural pumping. All agricultural and domestic groundwater pumping in the basin would receive this avoided lift benefit from faster demand reduction.

5. **Costs of demand management under GSP implementation.** Costs of demand reduction have been revised based on the latest estimates of the net return to agricultural water use developed for planning the SALC program. In addition, pumping volumes have been updated to reflect current conditions and the planned ramp-down adopted in the Madera County GSA groundwater allocation ordinance (applicable to the GSP implementation scenario only). These values do not represent average returns to all lands and crops in the subbasin but rather the lands and crops more likely to participate in a demand reduction program. For purposes of this analysis, the lost net return from demand reduction is valued at $230 per acre-foot[4].

Results

The following discussion compares costs between the GSP implementation scenario and the (alternative) immediate demand management scenario. General observations are:

- Demand management costs are greater in the immediate implementation scenario because demand management would be implemented sooner (immediately) and for more years during the GSP implementation period. Recharge and supply projects' costs have not been included in this analysis, but their present value costs would also increase because they would be implemented sooner.
- Pumping costs are lower in the immediate demand reduction scenario because, by definition, the average annual overdraft is eliminated immediately. The effect (smaller DTW and lower pumping cost) is carried throughout the remaining years of GSP implementation and in perpetuity.
- Well replacement costs occur in the GSP implementation scenario but are not required in the immediate demand reduction scenario.

[4] The value of water depends on future crop market conditions. Note that a higher value (greater than $230 per acre-foot applied in this TM) would further increase the cost of accelerated demand management relative to avoided well replacement and additional pumping costs.

- The net effect of these differences in costs results in the GSP implementation scenario having a substantial cost advantage (by about $120 million in present value, or 27 percent) over the immediate demand reduction scenario. In other words, the Madera Subbasin is better off (i.e., realizes benefits that exceed costs) implementing its phased GSP implementation plan and developing/funding the domestic well mitigation program to replace impacted wells than it is if it were to implement immediate demand reduction to avoid dewatering any domestic wells.

Table 1 summarizes the results of the economic analysis. All values are expressed in present value terms. The first two rows show the number of and cost to replace wells estimated to go dry in each scenario. The next rows present the pumping cost savings of the immediate demand reduction scenario relative to the GSP implementation scenario, broken down by domestic pumping and agricultural pumping. The next row shows the demand management costs. For the GSP implementation scenario, demand management is phased in at two percent per year initially, increasing to 6 percent per year until full demand management is reached by 2040. In contrast, the immediate demand reduction scenario implements the full demand management required in 2020, resulting in substantially higher demand management costs.

Table 1. Costs of GSP Implementation Scenario Compared to Costs of Immediate Demand Reduction Scenario - Summary Results for Madera Subbasin, Present Value ($ in Millions)

	GSP Implementation with Well Replacement	Immediate Demand Reduction	Difference
Domestic Well Replacement			
Number	1,578	0	1578
Cost, PV	$38.64	$0.0	$38.64
Pumping Cost (Savings), PV			
Domestic	NA	-$6.41	$6.41
Agricultural	NA	-$86.11	$86.11
Demand Mgmt. Cost, PV	$449.76	$701.74	-$251.98
Total Cost, PV*	$488.41	$609.23	-$120.82

* Totals may not add exactly due to rounding.

Discussion

Results indicate that the cost of implementing demand management on a faster trajectory (in this case, in year one of the implementation period) would not be cost effective from a subbasin-wide perspective. The avoided costs (fewer domestic wells requiring replacement) would be small ($39 million) relative to the additional lost agricultural net return[5] from immediate implementation ($252 million) for the Madera Subbasin, even after accounting for pumping cost savings ($93 million). The general conclusions are robust to the assumptions used. That is, results are not sensitive to reasonable ranges in key assumptions,

[5] Note that demand management would result in additional economic impacts to other county businesses and industries. These additional indirect impacts are not considered in this updated analysis but would only further support its conclusions.

including the loss in net return per acre-foot of demand management, the total level of demand management, when demand management begins to scale in, or the cost of replacing a domestic well.

This analysis only compares the cost of well replacement to net costs of immediate demand management implementation; it has not considered the timing of other projects such as new surface water supplies or groundwater recharge. That comparison is not possible with current information, and the GSP implementation schedule already reflects an aggressive timeline for project implementation. The cost (in present value) of accelerating implementation of projects has also not been included here. The additional cost of accelerating a recharge project by, say five years, would be the increased present value of the project's capital and O&M cost stream. Costs of new supply and recharge projects have not been accelerated, so the present value of costs for immediate implementation is underestimated. Simply stated, including these additional costs would further support the conclusions of this analysis.

ATTACHMENT 2

Madera Subbasin – Evaluation of DWR Household Water Supply Shortage Reports and Self-Help Enterprises Tank Water Participants

Luhdorff & Scalmanini
Consulting Engineers

TECHNICAL MEMORANDUM

DATE:	February 7, 2022	Project No. 20-2-153
TO:	File – Madera Subbasin Domestic Well Inventory	
FROM:	Pete Leffler, PG, CHG; Nick Watterson, PG; Aaron King	

SUBJECT: **Madera Subbasin - Evaluation of DWR Household Water Supply Shortage Reports and Self-Help Enterprises Tank Water Participants**

INTRODUCTION

To support efforts related to implementing the Madera Subbasin Groundwater Sustainability Plan (GSP), the Subbasin completed a Domestic Well Inventory project that identified potential domestic wells in the Subbasin and analyzed potential impacts to domestic wells caused by lowering of groundwater levels historically and during the 20-year GSP implementation period starting in 2020. The Domestic Well Inventory for the Madera Subbasin compiled information on domestic wells in the Subbasin from Well Completion Reports and County well permit datasets and compared these data to modeled groundwater levels in the Subbasin from the GSP over the period from 2014 through 2040. During development of the GSP, historical and future groundwater levels throughout the Subbasin were modeled based on historical conditions and projected future conditions. This memorandum summarizes a review of records in the Department of Water Resources (DWR) Household Water Supply Shortage Reporting System and also participants in the Self-Help Enterprises (SHE) Tank Water Program and includes a comparison of these two datasets with the results from analyses of domestic well impacts conducted as part of the Madera Subbasin Domestic Well Inventory.

DWR HOUSEHOLD WATER SUPPLY SHORTAGE REPORTING SYSTEM

Overview of the Household Water Supply Shortage Reporting System

The DWR Household Water Supply Shortage Reporting System (https://mydrywell.water.ca.gov/report/) is a site for reporting of problems with private (self-managed, not served by public water system) household water supplies. The site was initially created in 2014 as part of drought emergency response efforts and continues to be used to collect information on household water supply shortages from private well or surface water sources. The data in the reporting system reflect information on water supply shortage issues voluntarily submitted by private, local, state, federal, and non-governmental individuals and organizations. Because the data do not undergo review or quality control by DWR, the reported information is not suggested to be complete in its accounting for all water supply shortages and it is also noted by DWR that there may be errors and omissions in data, duplicate entries, and records for non-household related water supply issues. Furthermore, during review of the data, many incomplete and inconsistent records were noted, with many reports providing very little detail for use in understanding the cause of the issue reported. There are a variety of potential causes for issues related to the quantity or quality of water produced by a well, and this can include issues related to the well pump, water distribution system, or the well structure, without relationship to groundwater conditions in the aquifer.

The submission of information to the Household Water Supply Shortage Reporting System is done through completion of a report submittal form (https://mydrywell.water.ca.gov/report/public/form), which includes questions related to the issue, including required entries on the following:

- Type of shortage: a) Dry well, b) low streamflow, or c) other
- Description of the water issue: a) well is dry (no longer producing water), b) reduction in water pressure/lower flows, c) well pumping sand/muddy water, d) well is catching air (have to wait to be able to pump, e) reduction in water quality, or f) other
- Primary use of the well or creek: a) household, b) agriculture/irrigation, c) combination of household/agriculture, or d) other
- Approximate date problem started
- County

As of January 2022, the reporting system included 3,769 entries across the state of California, with dates when the problem started spanning the period from 2012 through 2021.

Household Water Supply Shortage Records within Madera Subbasin

The Household Water Supply Shortage Reporting System contains a total of 46 reports with locations in the Madera Subbasin. The reports within the Subbasin were grouped into four categories according to the type of water supply issue indicated: 1) dry wells, 2) reduced flow or impaired water quality, 3) collapsed well, and 4) surface water problem or inadequate explanation of issue. Figure 1 presents the number of reported well-related issues by year within the Madera Subbasin. Of the 406 reports within Madera Subbasin, 330 were categorized as a dry well issue, 62 were categorized as reduced flow or impaired water quality issues, and six were surface water problem/inadequate explanation of issue or collapsed well. As illustrated on Figure 1, most water supply issues in the system were reported to have started in 2014, 2015, and 2021, with relatively fewer during other years. The greatest number of reports occurred during 2015 after multiple years of drought conditions in the area. Figure 2 shows the locations of the water supply issue reports in the system. Most water shortage reports in the Subbasin are located in the eastern areas of the Subbasin, mainly northeast of Highway 99 in clustered areas north and east of the City of Madera.

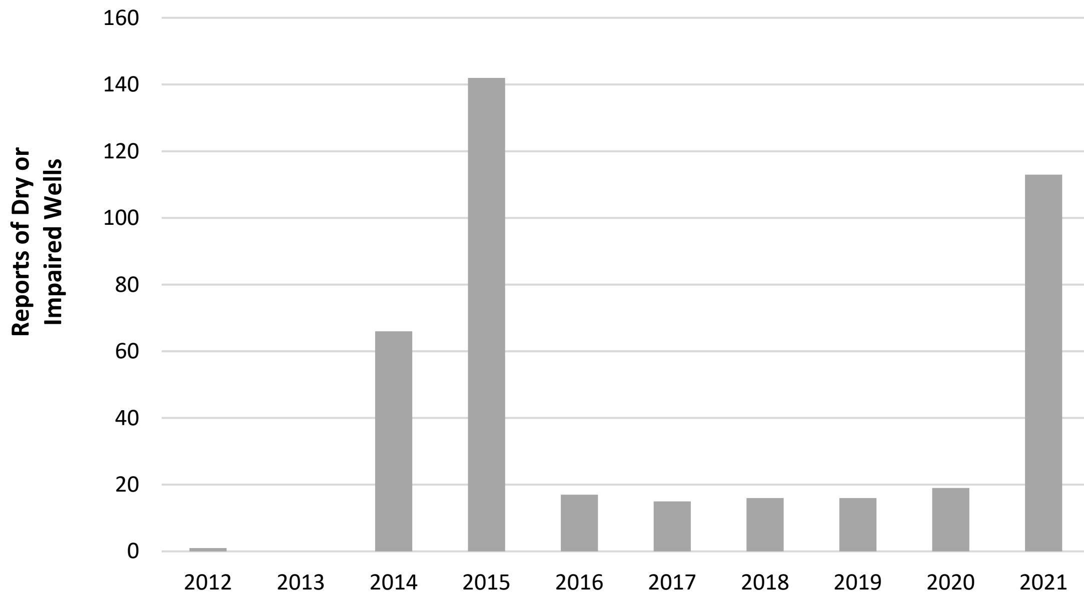

Figure 1. Chart of Household Water Supply Shortage Report Records in Madera Subbasin

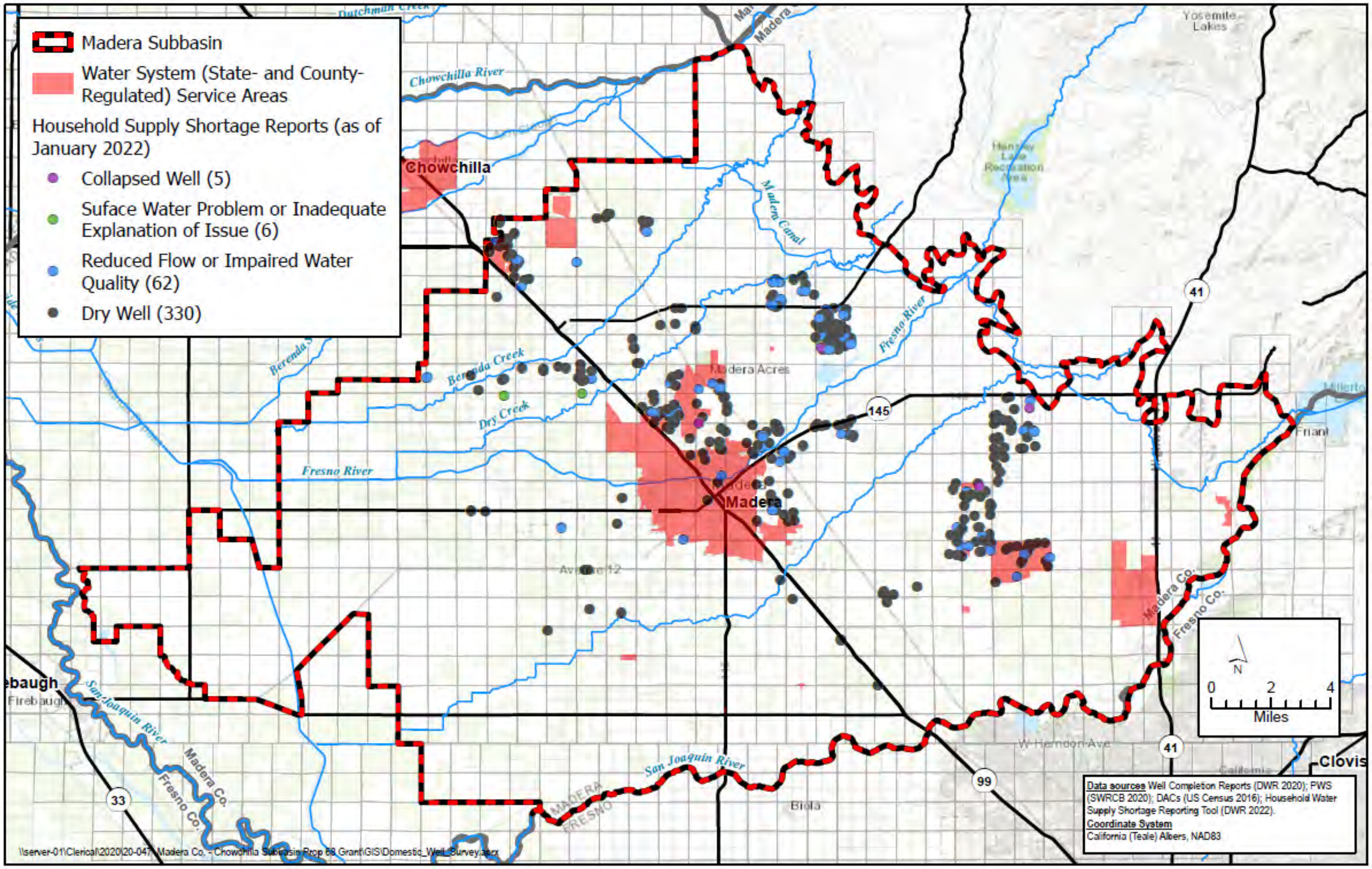

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Figure 2
DWR Household Water Supply Shortage Reporting Data

Madera Subbasin
Groundwater Sustainability Planning

SHE TANK WATER PROGRAM PARTICIPANT DATA

Overview of the SHE Tank Water Participant Data

The SHE Tank Water Program provides a temporary water supply solution for households experiencing a well water shortage in eight counties in and adjacent to the San Joaquin Valley: Fresno, Kern, Kings, Madera, Mariposa, Merced, Stanislaus, and Tulare. The SHE Water Tank Program assists households experiencing well water shortages by installing a water tank and hauling water and filling the tank to restore access to water for the home. The SHE Tank Water Program is intended as a short-term solution to provide participants access to water for one year while working towards a long-term solution. Data on participants in the SHE Water Tank Program as of January 2022 were provided by SHE (https://www.arcgis.com/home/webmap/viewer.html?webmap=377849cbc9c54046917d864a635e9674&extent=-120.0525,34.8083,-117.2593,36.0392). As of January 2022, the SHE Tank Water Program includes 769 participants in the eight-county area served by the program. The available Tank Water Program participant data only provide locations for participants without other attributes indicating the date or type of issue necessitating the reliance on tank water. There are a variety of potential causes for issues related to the quantity or quality of water produced by a well, and this can include issues related to the well pump, water distribution system, or the well structure, without relationship to groundwater conditions in the aquifer.

SHE Tank Water Participants within Madera Subbasin

The SHE Tank Water Program covers eight counties within the San Joaquin Valley, along with some areas located outside of the San Joaquin Valley and outside of DWR-designated groundwater basins (e.g., foothill areas). The SHE Tank Water Program includes 239 participants within the Madera Subbasin. Figure 3 presents a map of the Tank Water Program participants within the Madera Subbasin. As illustrated on Figure 3, most of the Tank Water Program participants in the Madera Subbasin are located in clustered areas generally north and east of the City of Madera. Figure 4 is a map comparing the locations of SHE Tank Water participants and dry wells in the DWR Household Water Supply Shortage dataset. The spatial distribution of Tank Water participants and dry wells reported in the DWR dataset are very similar and likely include some of the same wells, although no information is available to evaluate such direct relationships in the two datasets.

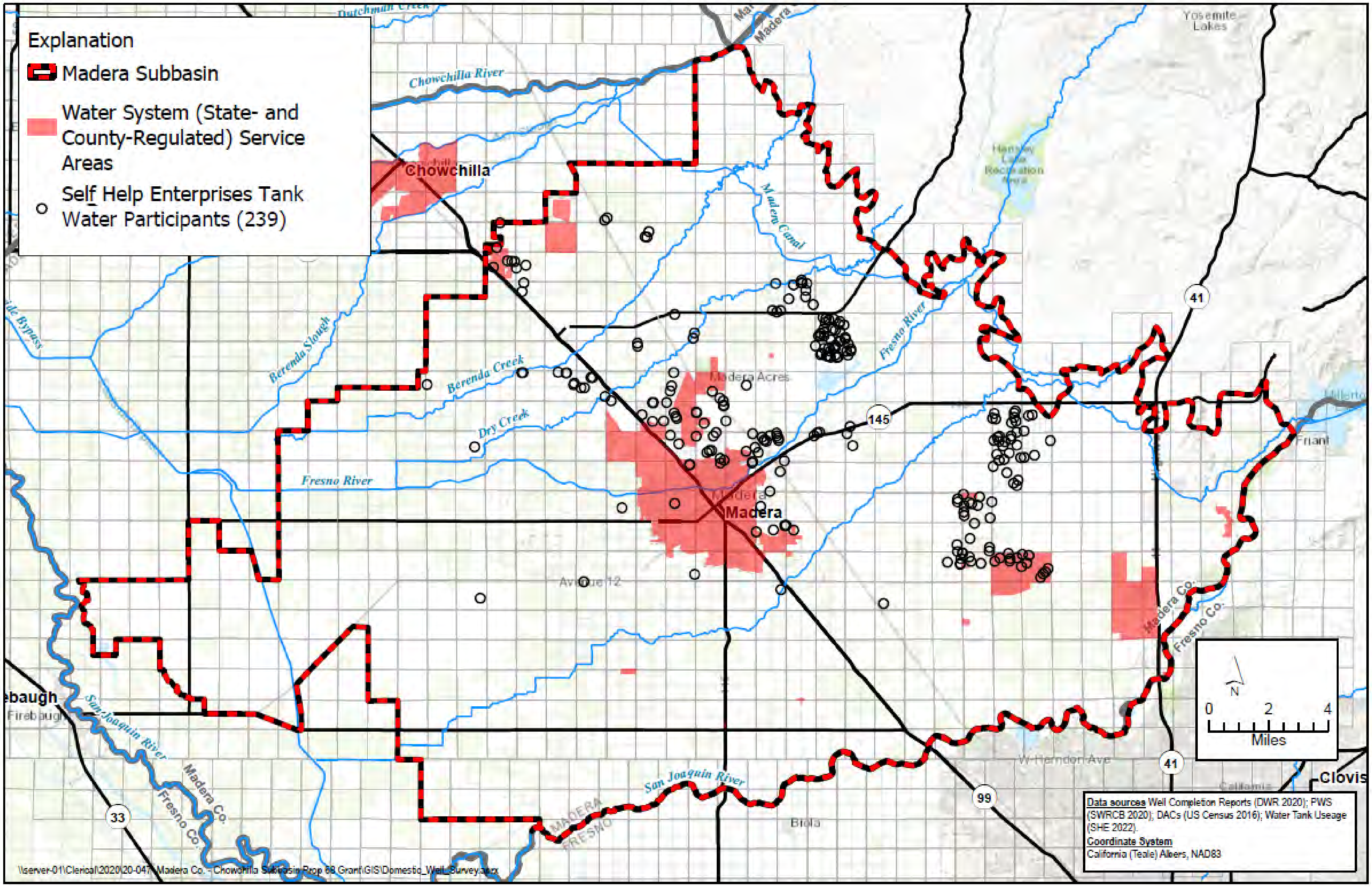

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Figure 3
Locations of Self Help Enterprises Tank Water Participants
Madera Subbasin
Groundwater Sustainability Planning

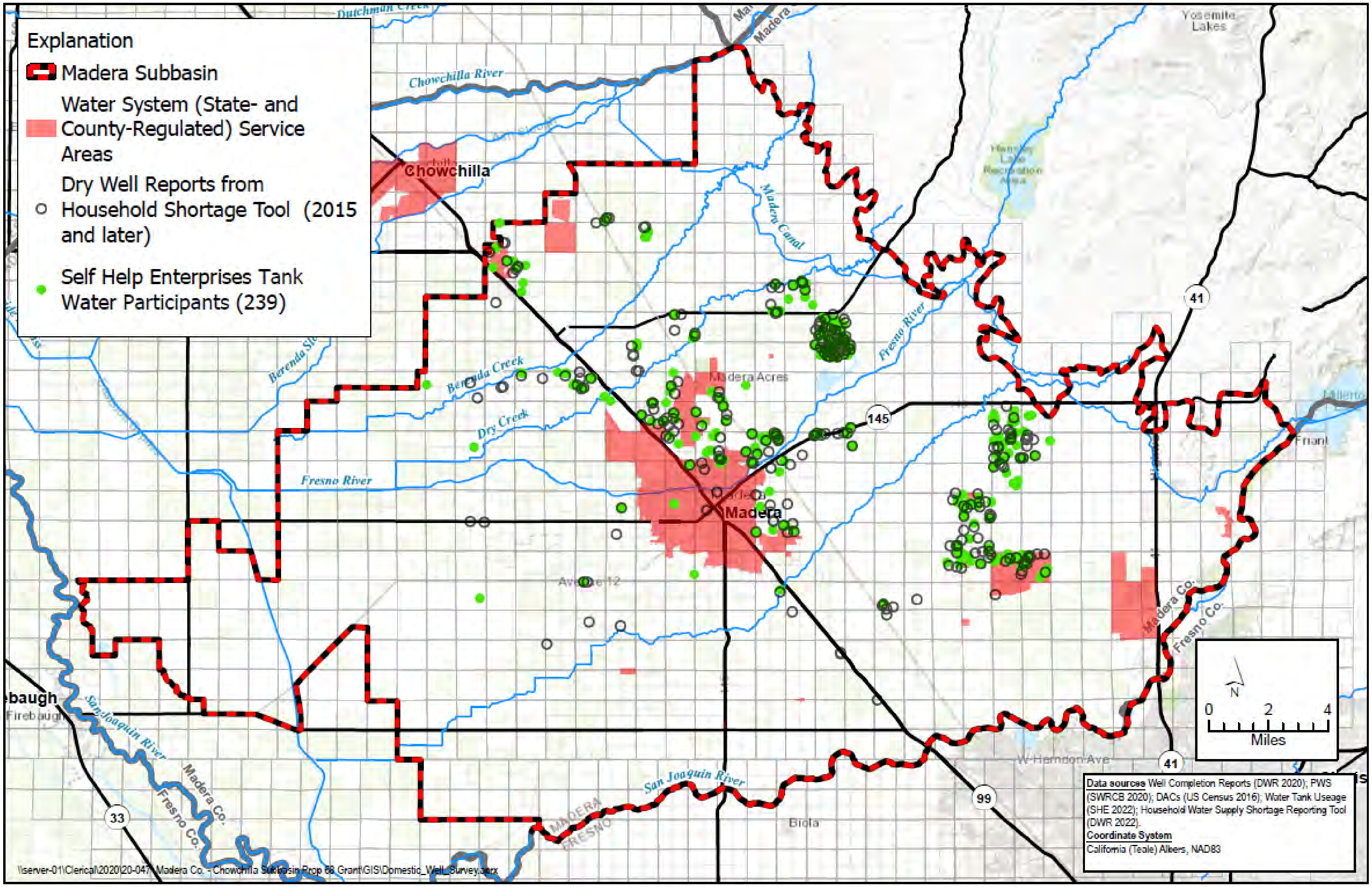

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Figure 4
Comparison of SHE Tank Water Participants and DWR Dry Well Reports
Madera Subbasin
Groundwater Sustainability Planning

COMPARISONS OF DWR DRY WELL RECORDS AND SHE TANK PARTICIPANTS WITH ANALYSES OF DRY WELLS FROM THE DOMESTIC WELL INVENTORY

Analyses of potential domestic well impacts in the Domestic Well Inventory were conducted at five-year intervals based on modeled groundwater levels across the Subbasin. To understand differences between dry wells reported to the Household Water Supply Shortage Reporting System and also SHE Tank Water Program participants in relation to estimates of potential dry wells from the Madera Subbasin Domestic Well Inventory analyses, the spatial distribution of dry wells in the Household Water Supply Shortage Reporting System dataset and Tank Water Participants were compared with modeled dry wells over the period from 2015 through 2024.

The comparisons presented in this TM are intended to provide a general sense for the spatial distribution of the different datasets, recognizing the datasets present different types of information related to domestic well issues. As noted above, there are a variety of potential causes for a well experiencing issues related to the quantity of water produced by a well that may be unrelated to groundwater conditions in the aquifer. Some of these issues may be reflected in the DWR Water Supply Shortage Reports and SHE Tank Water Program participants list. It is also likely that many households with wells that have gone dry have not reported such occurrences to the DWR Household Water Supply Shortage Reporting System and many of these households have also not participated in the SHE Tank Water Program. As described in the technical memorandum summarizing the Madera Subbasin Domestic Well Inventory, analyses of potential dry domestic wells in the Domestic Well Inventory are based only on the relationship between available well construction (e.g., screen depth and total well depth) and simulated groundwater levels at each domestic well location.

Comparison of DWR Dry Well Records with Modeled Dry Wells in the Domestic Well Inventory

Maps comparing dry well records in DWR's Household Water Supply Reporting System with dry wells modeled as part of the Domestic Well Inventory are presented in Figures 5 and 6. Figure 5 presents a comparison of all reported dry wells in DWR's system (2012 through 2021) with modeled dry wells estimated for the period 2015 through 2024 in the Domestic Well Inventory. Figure 6 presents a comparison of reported dry wells during the years 2015 through 2019 in DWR's system with modeled dry wells between 2015 and 2019 in the Domestic Well Inventory. Figure 6 provides a more direct spatial comparison of dry wells in the two datasets over the same five-year period, whereas Figure 5 presents an overview of the spatial relationship between the two datasets spanning a longer timeframe. Although there are considerably more modeled dry wells than reports of dry wells in DWR's system in either comparison, the spatial patterns in the two datasets show many similarities, with most modeled dry wells and reports of dry wells occurring in clustered areas to the north and east of the City of Madera. Some of the differences in locations between the modeled dry wells and reported dry wells in Figures 5 and 6 are likely a result of differing resolutions of locational information available in the two datasets.

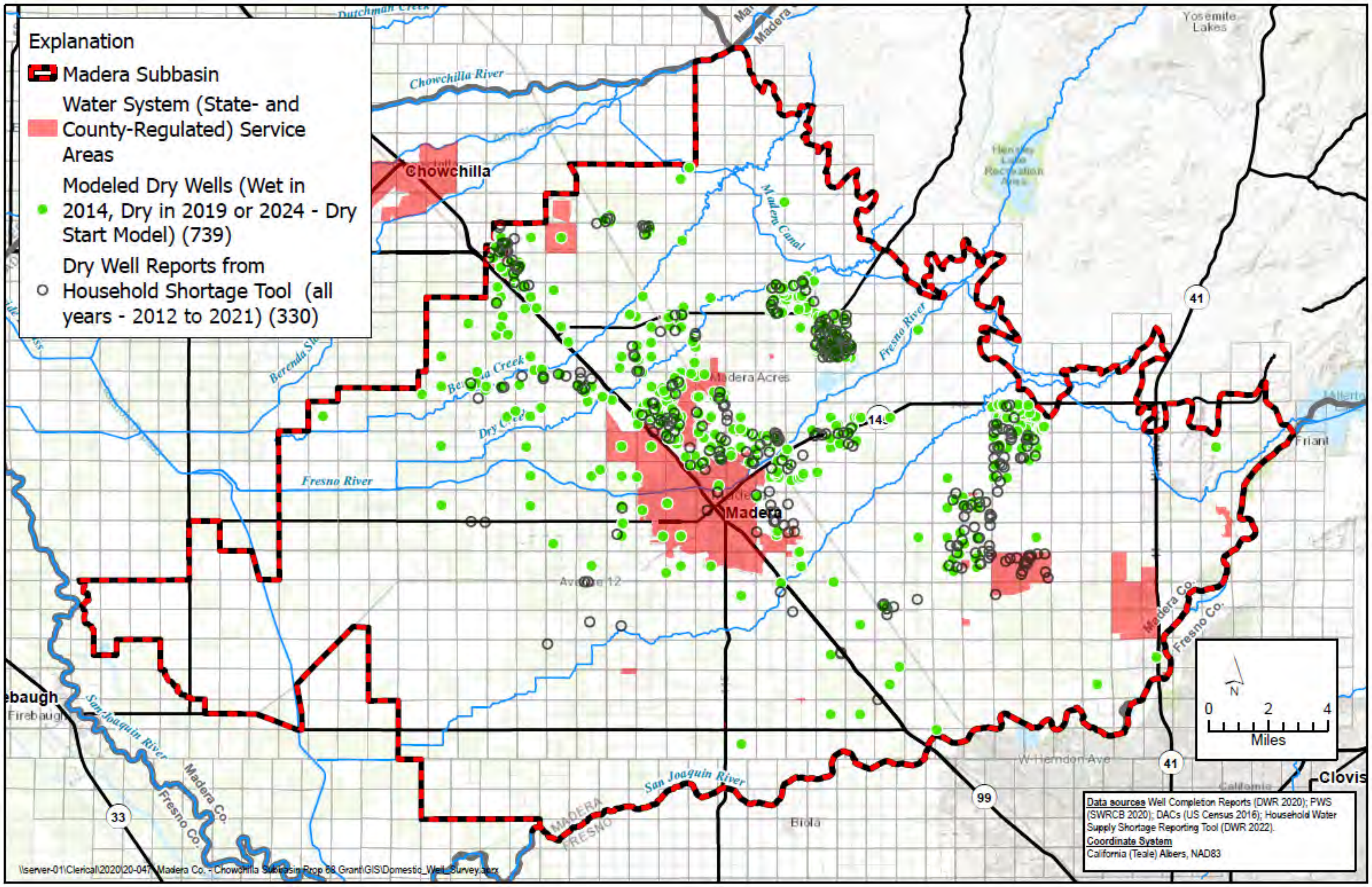

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Figure 5
Comparison of DWR Dry Well Reports with Modeled Dry Wells Between 2015 and 2024

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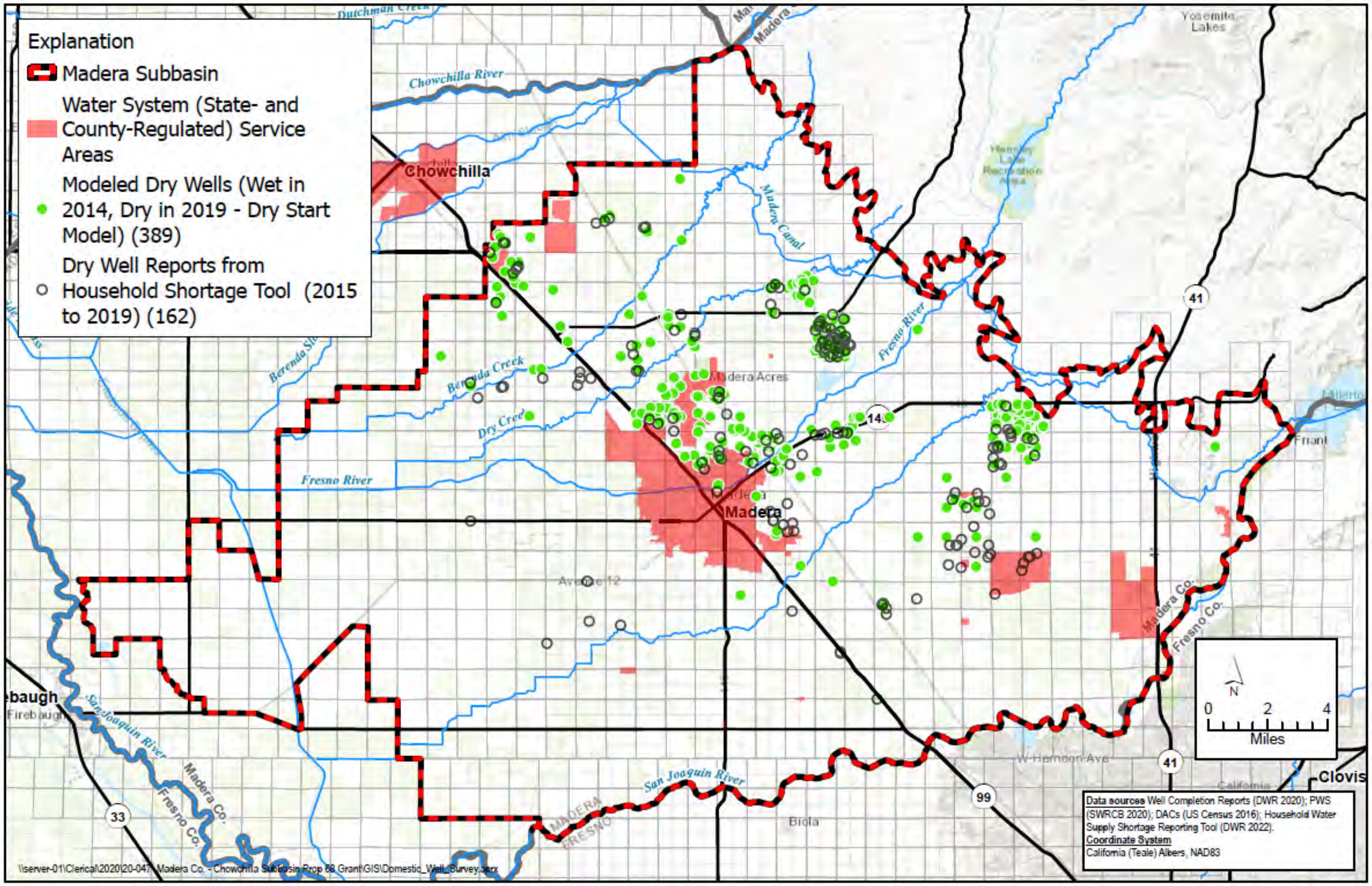

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Figure 6
Comparison of DWR Dry Well Reports with Modeled Dry Wells Between 2105 and 2019

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Comparison of SHE Tank Water Participants with Modeled Dry Wells in the Domestic Well Inventory

A map comparing SHE Tank Well Participants with dry wells modeled as part of the Madera Subbasin Domestic Well Inventory are presented in Figure 7. Figure 7 presents a comparison of all SHE Tank Water Program participants in the Subbasin as of January 2022 with modeled dry wells estimated for the period 2015 through 2024 in the Domestic Well Inventory. Although there are considerably more modeled dry wells than Tank Water Participants (as is the case with dry well reports in the DWR's Household Water Supply Shortage System), the spatial patterns in the two datasets show many similarities, with most modeled dry wells and SHE Tank Water Participants occurring in areas north and east of the City of Madera.

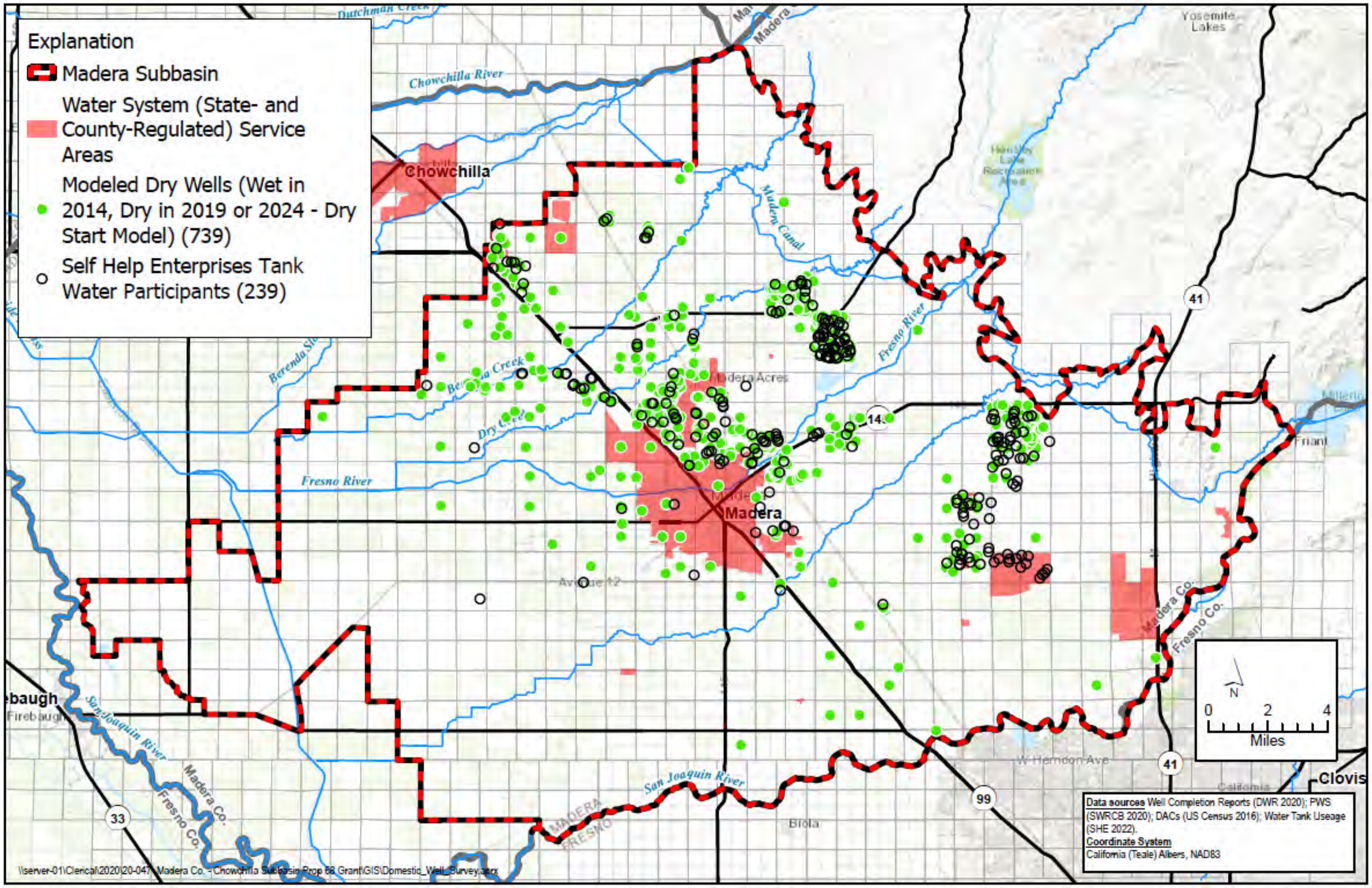

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Figure 7
Comparison of SHE Tank Water Participants with Modeled Dry Wells Between 2015 and 2024
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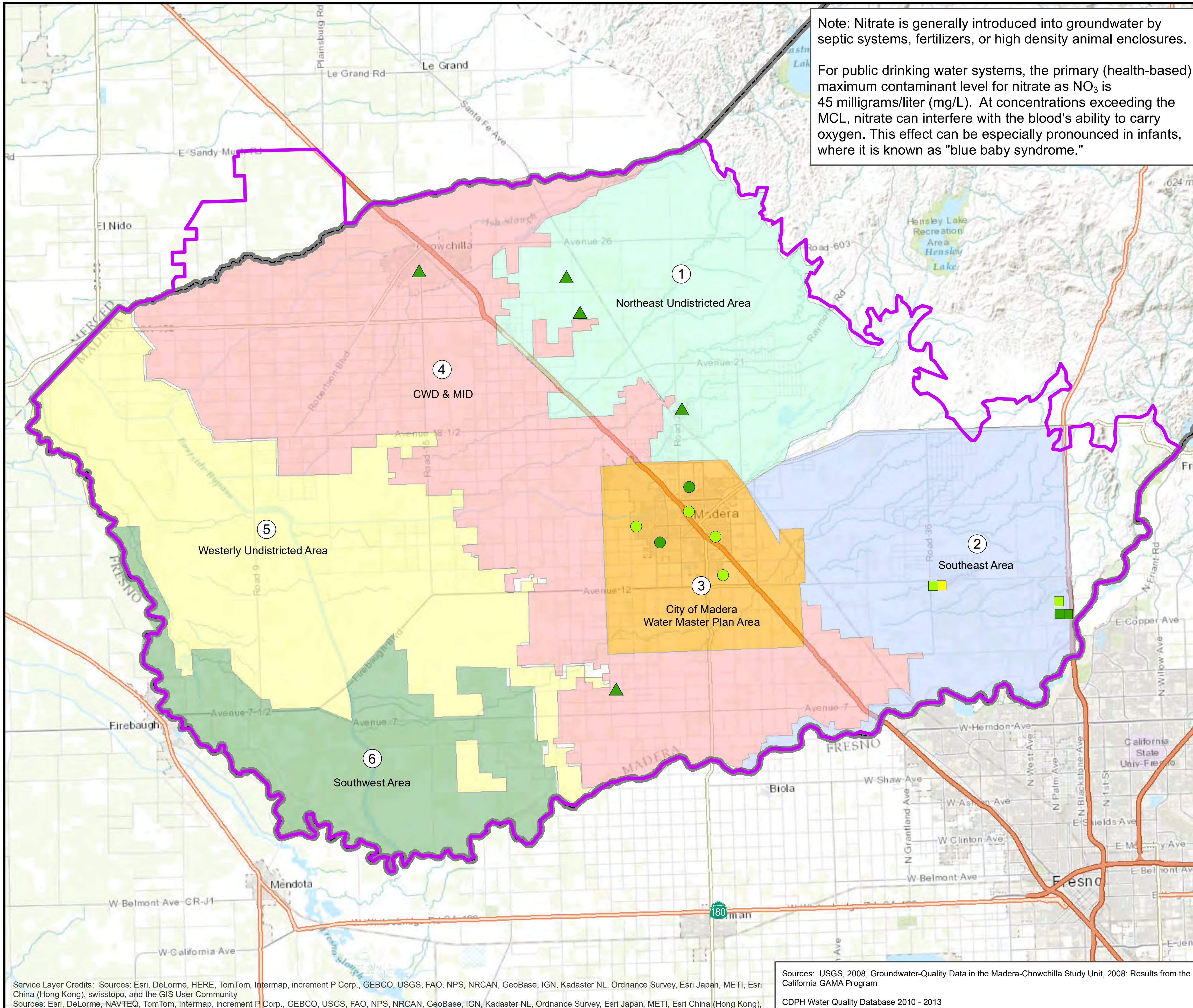

Service Layer Credits: Sources: Esri, DeLorme, HERE, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

Sources: USGS, 2008, Groundwater-Quality Data in the Madera-Chowchilla Study Unit, 2008: Results from the California GAMA Program

CDPH Water Quality Database 2010 - 2013

MAP OF NITRATE (AS NO_3) CONCENTRATION IN DEEP WELLS

MADERA REGIONAL GROUNDWATER MANAGEMENT PLAN
APRIL 2014

NORTH

0 2 4
MILES

Nitrate as NO_3 (mg/L) in City Wells > 600 feet

- < 5
- 5 - 15
- 15 - 30
- 30 - 45
- > 45

Nitrate as NO_3 (mg/L) in County Wells > 600 feet

- < 5
- 5 - 15
- 15 - 30
- 30 - 45
- > 45

Nitrate as NO_3 (mg/L) in USGS GAMA Wells > 600 feet

- < 5
- 5 - 15
- 15 - 30
- 30 - 45
- > 45

Groundwater Management Plan Boundary

Madera County Boundary

Note: All wells are classified by total well depth. Some wells may have screen perforations that begin shallower than the depth classification and therefore represent composite water quality across two or more aquifers.

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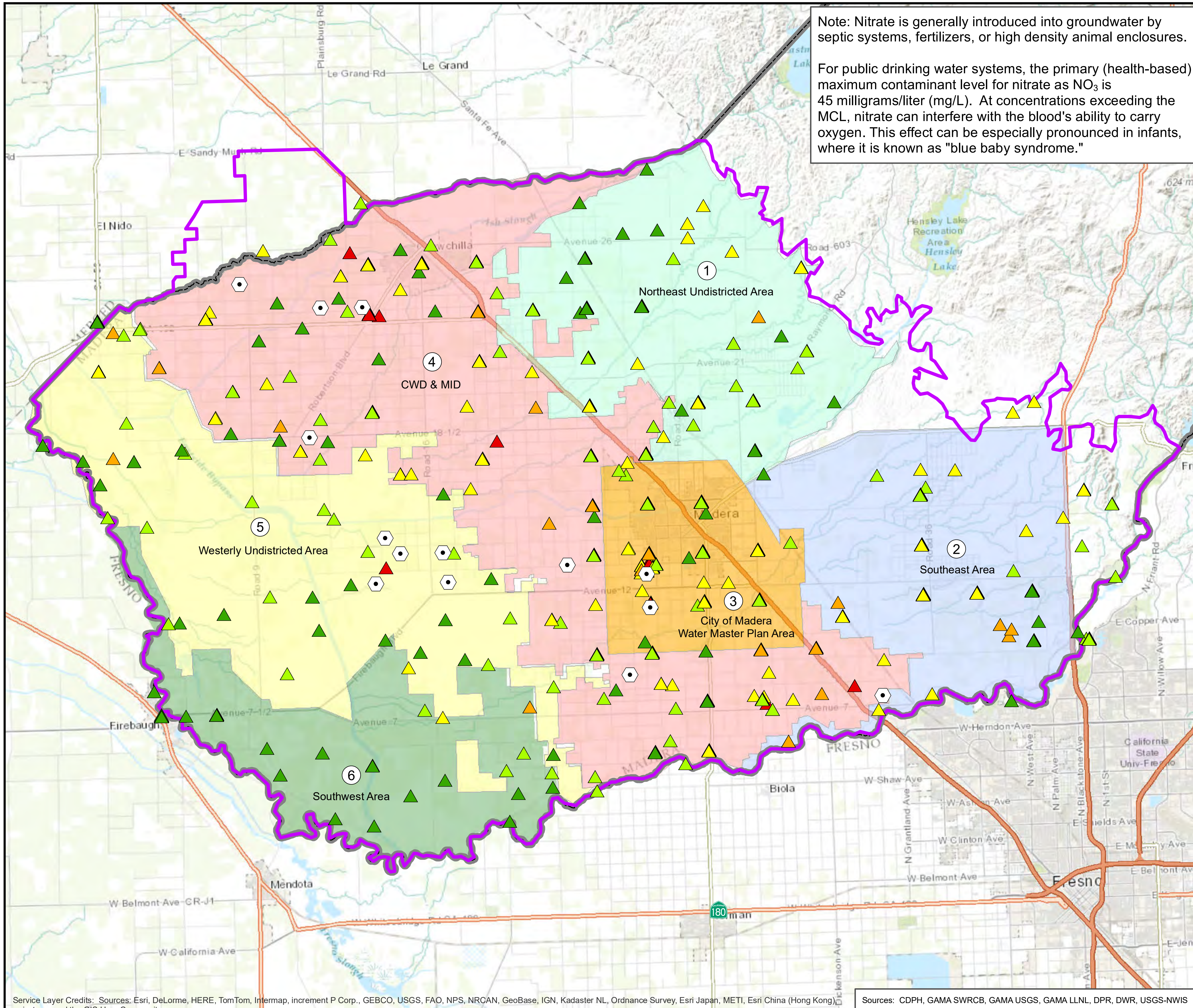
MAP OF NITRATE (AS NO_3) CONCENTRATION IN WELLS OF UNKNOWN DEPTH

MADERA REGIONAL
GROUNDWATER MANAGEMENT PLAN
APRIL 2014



NORTH

0 2 4
MILES

- Land-Use that may contribute to Nitrate contamination

Nitrate as NO_3 (mg/L) in Other USGS GAMA Wells

- < 5
- 5 - 15
- 15 - 30
- 30 - 45
- > 45
- Groundwater Management Plan Boundary
- Madera County Boundary

Note: Well construction records were not available for these wells. Some wells may have screen perforations that connect two or more aquifers and may therefore represent composite water quality.

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