Root Creek Water District
Groundwater Sustainability Agency

August 2019

DRAFT

Groundwater Sustainability Plan

LIMITATION

In preparation of this Groundwater Sustainability Plan (Plan), the professional services of Provost & Pritchard Consulting Group were consistent with generally accepted engineering principles and practices in California at the time the services were performed.

Judgments leading to conclusions and recommendations were made based on the best available information but are made without a complete knowledge of subsurface geological and hydrogeological conditions. This Plan is intended to provide information from readily available published or public sources. We understand that the interpretations and recommendations are for use by the Root Creek Water District Groundwater Sustainability Agency (RCWDGSA) in assisting the GSA in making decisions related to potential water supplies and groundwater management activities in light of California's new and evolving Sustainable Groundwater Management Act (SGMA) regulations. Subsurface conditions or variations cannot be known, or entirely accounted for, in spite of significant study and evaluation. Future surface water and groundwater quantity, quality, and availability cannot be known. Trends have been estimated and projected based upon past historical data and events and are used for planning purposes. It should be noted that historic trends may not be indicative of future outcomes. Historic hydrology has been used to identify averages and potential extremes that may be experienced in future years; however, it will be important for the GSA to continually evaluate all the parameters that make up the agency water budget. Additionally, the rapidly changing regulatory environment surrounding the SGMA and State regulatory agencies may render any or all recommendations invalid in the future if not implemented and necessary approvals, permits, or rights obtained in a timely manner. Information contained in this GSP should not be regarded as a guarantee that only the conditions reported and discussed are present within the RCWDGSA or that other conditions may exist which could have a significant effect on groundwater availability.

In developing our methods, conclusions, and recommendations we have relied on information that was prepared or provided by others. We have assumed that this information is accurate and correct, unless noted. Changes in existing conditions due to time lapse, natural causes including climate change, operations in adjoining GSAs or subbasins, or future management actions taken by a GSA may deem the conclusions and recommendations inappropriate. No guarantee or warranty, expressed or implied, is made.

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Acronyms

AF or af .... Acre-feet
AFY .... Acre-feet per Year
CASGEM .... California State Groundwater Elevation Monitoring Program
CEQA .... California Environmental Quality Act
CIMIS .... California Irrigation Management Information System
CVP .... Central Valley Project
CVRWQCB .... Central Valley Regional Water Quality Control Board
CV-SALTS .... Central Valley Salinity Alternatives for Long-Term Sustainability
CVSC .... Central Valley Salinity Coalition
CWC .... California Water Code
DAC .... Disadvantaged Communities
DBCP .... Dibromo-Chloropropane
DTSC .... Department of Toxic Substances Control
DWR .... Department of Water Resources
EC .... Electroconductivity
E-clay .... Corcoran Clay
EDB .... Ethylene-Dibromide
EPA .... Environmental Protection Agency
ESJRWC .... East San Joaquin River Watershed Coalition (pg 4-21) same as ESJWQC?
ESJWQC or Coalition .... East San Joaquin Water Quality Coalition (pg 2-22)
ET .... Evapotranspiration
ETaw .... Evapotranspiration of applied water
FT .... Foot
FWUA .... Friant Water Users Authority
GAMA .... Groundwater Ambient Monitoring and Assessment
GDE .... Groundwater Dependent Ecosystem
GIS .... Geographic Information System
GMP .... Groundwater Management Plan
GPD .... Gallons per Day
GPM .... Gallons per Minute
GQTM .... Groundwater Quality Trend Monitoring
GSA .... Groundwater Sustainability Agency
GSP .... Groundwater Sustainability Plan
GWS .... Groundwater System
HCM .... Hydrogeologic Conceptual Model
HPC .... Heterotrophic Plate Counts
IMP .... Infrastructure Master Plan
InSAR .... Interferometric Synthetic Aperture Radar
IRLP .... Irrigated Lands Regulatory Program
ITRC .... Irrigation Training & Research Center
Ksat .... Saturated hydraulic conductivity
LiDAR .... Light Detection and Ranging
LSCE .... Luhdorf & Scalmanini
MCL .... Maximum Contaminant Level
Mg/L .... Milligram per liter
MID .... Madera Irrigation District
MSL .... Mean Sea-Level
NASA InSAR .... National Aeronautics and Space Administration Interferometric Synthetic Aperture Radar
NASA .... National Aeronautics and Space Administration
NAVSTAR .... Navigation Satellite Timing and Ranging

NOAA .... National Oceanic and Atmospheric Administration
NRCS .... Natural Resource Conservation Service
NRDC .... Natural Resources Defense Council
OAL .... California Office of Administrative Law
P&P .... Provost & Pritchard
PBO .... Plate Boundary Observatory
PWS .... Public Water System
Qb .... Flood Basin Deposits
Qoa .... Quaternary Older Alluvium
Qt .... Terrace Deposits
QTc .... Quaternary and Tertiary age continental deposits
Qya .... Quaternary Younger Alluvium
RCWD or District .... Root Creek Water District
RCWDGSA .... Root Creek Water District GSA
RWQCB .... Regional Water Quality Control Board
SAGBI .... Soil Agricultural Groundwater Banking Index
SGMA .... Sustainable Groundwater Management Act
SJR .... San Joaquin River
SJRR .... San Joaquin River Restoration
SJRRP .... San Joaquin River Restoration Program
SJVAPCD .... San Joaquin Valley Air Pollution Control District
SNMP .... Salt and Nitrate Management Plan
SOPAC .... Scripps Orbit and Permanent Array Center
SWP .... State Water Project
SWPPP .... Stormwater Pollution Prevention Plan
SWRCB .... State Water Resources Control Board
SWS .... Surface Water System
TCP .... Trichloropropane
TDS .... Total Dissolved Solids
Ti .... Ione Formations
UNAVCO .... University NAVSTAR Consortium
USBR or Reclamation .... United States Bureau of Reclamation
USGS .... United States Geological Survey
WDR .... Waste Discharge Requirement

Executive Summary

Developing a Groundwater Sustainability Plan (GSP) for a Groundwater Sustainability Agency (GSA), a Groundwater Basin, the San Joaquin Valley, the Central Valley, the State of California is no small feat. Four years have gone by since we started travelling this road, and much progress has been made but much yet remains. The Root Creek Water District (RCWD or District) and the Root Creek Water District GSA (RCWDGSA) are relatively new agencies, having been formed in 1996 and 2016 respectively. Both agencies are located in southeastern Madera County along the banks of the San Joaquin River. Farming in this region has been active for centuries and reflection of this history paints a more vibrant picture of cultural and past practices and use of the land.

The following historical perspective is by Joseph Barcroft in 1933 from the *History of Fresno and Madera Counties*:

> Both Madera County and Fresno County since the separation of Madera have claimed, through publicity agencies, to be the "geographical center" of California, and both are close enough to that suppositious place to warrant the claim. The State of California is very irregular, geometrically, and so it is questionable whether there is a geometrical "center." But the median point of the land area of the state has been determined by scientifical authority at Washington to be a place about 25 miles northeast of the City of Fresno, at a point in Madera County somewhere near what is called O'neals Station, north of the San Joaquin River. Madera County has an area of 2,112 square miles, about equally divided into plains, foothills and high mountain region. The population in 1930 was 17,164.
>
> Madera County has led a political existence coordinate with its fellow California counties for forty years -1893 to 1933. Prior to this period, it shared in the existence of Fresno County of which its area was a part - (prior to that it was part of Mariposa County). Before that, the land that is now Madera County was traversed by fur trader, explorer and gold seeker, and shared in the beginnings of San Joaquin Valley life.
>
> Territorially, Madera County is the area enclosed by the crest of the Sierra Nevada on the east, by the Chowchilla River on the north and by the San Joaquin River on the south and west. Almost midway through this belt of land flows the Fresno River, on which the City of Madera, the county seat, now stands. Of these three rivers, the San Joaquin is the only one large enough to establish a year-round water course; and as it reaches the lowest point of the plains, turns northwesterly and by its curve defines the extent of Madera County on two sides. The Chowchilla on the north has only a seasonal flow. Like the Fresno, its winter and spring drainage is used in irrigation or lost on the plains. By the formation of Madera County, the Fresno River was entirely separated from the county to which its name was given.
>
> Madera history, before and after the formation of the county in 1893, has been determined by its three different physical areas and its consequent resources; First, the belt of foothill region in which gold was discovered and the first village established for the accommodation of homesteaders on the only available water supply; secondly, the plains area, with but scant water supply under natural conditions, which could furnish only pasture until such time as electric power warranted pumping or highly capitalized water storage furnished gravity water

> to the farmer; and thirdly, the higher Sierras, with their timber and mineral and opportunities for recreation and the accommodation of tourists.
>
> It was the coming of the Central Pacific railroad to the San Joaquin Valley that shifted the center of gravity of life in the region from the foothills to the plains. This was in 1872.
>
> Already, to be sure, there was a considerable river trade, and Henry Miller, Isaac Friedlander and other San Francisco capitalists had made various moves to use the San Joaquin river water as a basis for agricultural development or land speculation. But most of this affected lands lower down than what is now Madera County. The fever of land speculation in government scrip, following the Civil war, had brought considerable areas of dry farming land in the west part of the county into private hands, but without any actual settlements.
>
> The first considerable farming development in what is now Madera County, begun in 1868 and known as the Alabama settlement, . . . a station was established called "Borden." It was this that resulted, a few years later, in the first in the district of the townsite struggles that characterized much of California history.

Madera Subbasin

With passage of the law known as the Sustainable Groundwater Management Act (SGMA) in 2014, a new path is being initiated that regulates both surface water and groundwater supplies. The Madera Subbasin as defined in State of California Bulletin 118 covers a significant amount of agricultural land in Madera County. The other subbasins in Madera County are the Chowchilla Subbasin which abuts the Madera Subbasin to the northwest and the Delta Mendota which abuts on the southwest. SGMA requires that a plan be developed for the Madera Subbasin and that a Plan Manager be identified for submitting the plan and serving as the point of contact between the agency and the Department of Water Resources (DWR).

The agencies within the Madera Subbasin have been meeting since the new law was signed to develop the local policies, structure, and coordination that is needed to enable discussion as well as the technical analysis needed to comply with the law. To this end, the agencies within the basin have developed seven GSAs that collectively represent the entire basin. These GSAs have worked together on many aspects of the technical basis for the plan. Several GSAs have also decided that they wish to develop their individual plan, and they will be stitched together to make one plan. To this end, the structure and layout of this plan mimics the other plans within the basin and utilizes coordination of individual plans such as the monitoring plan and other basin-wide infrastructure to completely cover the basin.

To also allow for ease in the review of the plan, the basin setting is described first for the basin and then specifics of the GSA are presented.

Root Creek WD GSA

The RCWDGSA covers almost 10,000 acres in southeast Madera County located southwest of the intersection of State Highway 41 and Avenue 12 along the banks of and just north of the San Joaquin River. In size, the GSA accounts for less than 3 percent of the land area within the Madera Basin. The District, which lies wholly within the GSA has recently contracted for surface water supplies from the Madera Irrigation District (MID) and the Wonderful Nut Orchards for up to 17,000 acre-feet (af) of surface water in a given year. The District has also recently completed the first phase of an agricultural conveyance and distribution system that has the ability to deliver surface water to approximately 2,500 acres of farmland. Since its completion, the system has delivered approximately 13,200 af of surface water to date in the past three years with the potential to add an additional 3,000 af through the end of this season. To accomplish these achievements the district has invested more than 12 million dollars. While large, the purchase and delivery of surface water supplies are crucial to the long-term groundwater sustainability of not only the District and the GSA but also the region and the subbasin.

Data from monitoring historical groundwater levels in wells has indicated a general long-term lowering trend of about 3.5 feet per year. Recent readings of groundwater levels have indicated a rise in groundwater levels associated with the import of surface supplies. It is still too soon to evaluate the long-term trend related to these recent activities, but it does indicate the District has had a positive influence on groundwater levels in the region of the basin in which it is located.

The Plan
RCWDGSA and specifically RCWD will play its role in the overall goal within the Madera Subbasin to stabilize groundwater levels. This doesn't mean that groundwater levels won't go up and down – they will. Rather, over the long term, the groundwater levels will approximate the present levels. This will be accomplished within RCWDGSA by the expansion of the In-Lieu Groundwater Project completed in 2014 and the use of intentional recharge projects. Management actions will be considered as well including reduction of groundwater demand, increase of data collection, education and outreach, regulatory policies, incentive-based programs, and enforcement actions.

DWR has required the following sustainability indicators must be addressed in the plan:

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable seawater intrusion
- Significant and unreasonable degraded water quality
- Significant and unreasonable land subsidence
- Depletions of interconnected surface water that have significant and unreasonable impacts on beneficial uses of the surface water

For the RCWDGSA, groundwater levels and groundwater storage are the two sustainability indicators that are most crucial. Water quality considerations will be discussed, especially due to recent developments that have authorized the change in land use designation by the County for the Riverstone development. The other three either do not apply, such as seawater intrusion, or are not being experienced, such as land subsidence, or in the case of interconnected surface water there is not sufficient evidence to identify if at the location of the district whether this condition exists.

Success can be measured many ways: one being – has the GSA developed the surface supplies and infrastructure to accomplish its goal? and another – have the GSA neighbors and the subbasin developed the projects and implemented the management actions to accomplish their goal so that the goals for the subbasin been achieved? Much of the second goal is based upon the coordination and cooperation of the adjacent GSA neighbors as well as the basin neighbors. More details on the specifics of the coordination agreements, inter-basin agreements, goals, and plan implementation strategies can be found later in the document.

1 Introduction

1.1 Purpose of Groundwater Sustainability Plan

On September 16, 2014, Governor Jerry Brown signed into law a three-bill legislative package, composed of AB 1739 (Dickinson), SB 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act (SGMA) which was passed in 2014 and is codified in Section 10720 et seq. of the California Water Code. This legislation created a statutory framework for developing local groundwater management that can be sustained during planning and implementation without causing undesirable results.

SGMA requires governments and water agencies of high and medium-priority basins to halt overdraft and bring groundwater basins into balanced levels of pumping and recharge. Under SGMA, these basins should reach sustainability within 20 years of implementing their sustainability plans. For critically over-drafted basins, including the Madera Subbasin that the Root Creek Water District Groundwater Sustainability Agency (RCWDGSA) area is part of, the deadline for achieving sustainability is 2040.

In his signing statement, Governor Brown emphasized that "groundwater management in California is best accomplished locally." With ongoing financial and technical assistance from the Department of Water Resources (DWR), the RCWDGSA is working to achieve area-wide collaboration between neighboring water agencies and helping to achieve groundwater sustainability.

1.2 Sustainability Goal

From the first edition of DWR Publication 118 in 1980, the San Joaquin Valley Basin, including the Madera Subbasin, has been determined to be in a state of overdraft and has been identified by the state as being "Critically Overdrafted." Between 1988 and 2016, the Madera Subbasin has lost approximately 3.6 million acre-feet (af) of water from subsurface storage through a combination of groundwater pumping and below-normal recharge driven by an extended drought and low surface water supplies. This is still small compared to the estimated storage of approximately 22.7 million acre-feet within the subbasin. Chapter 3 of this Groundwater Sustainability Plan (GSP) discusses this chronic water imbalance in more depth.

While the Madera Subbasin has lost a great deal of its stored water in recent decades, the aquifers beneath the subbasin still contain more water than the total of all the reservoirs on the watersheds above the subbasin. The extensive storage volume has long masked the effects of overdraft from year to year, providing a buffer against the extreme fluctuations in surface water supplies depending on the rain year. Water agencies in the subbasin must work together to maintain the viability of the aquifer so that buffer capacity is always available.

To that end, the goal of this GSP is to immediately reduce and eventually eliminate systematic overdraft within the RCWDGSA area. Eliminating overdraft is defined as balancing average annual groundwater withdrawals with average annual natural and artificial groundwater recharge, accounting for subsurface flows into and out of the GSA area, over a rolling range of years. The variability in surface water supplies, in contrast to the steady nature of water demands, makes it infeasible to achieve balance every year. In reality, there will be years where the GSA area gains storage and other years where the storage balance declines, but overall the average basin storage will no longer be in decline within the GSA area once this plan becomes fully effective.

In order to accomplish this overarching goal, this plan identifies undesirable results, which are outcomes that will be realized should the plan's strategies not be effective or not be effectively implemented. Undesirable results are marked by minimum thresholds, or data points, which if not met mean an undesirable result has been realized. The RCWD has built facilities that are thought to be of sufficient size and magnitude to accomplish its goal and avoid undesirable results. The RCWDGSA is also reliant upon its neighboring agencies to do the same. It is understood that none of the goals can be realized in a year; it will take time to achieve the regional goals. Many won't be fully achieved until well into the 20-year implementation period defined in the SGMA legislation. Measurable objectives and interim milestones have been defined to gauge progress during the intervening years and to help assure not only that the GSA is moving toward its sustainability goals, but also that the rate of progress is as planned and sufficient to meet the overall implementation schedule.

While the Madera Subbasin is required to be sustainable as a whole, it should be noted that some areas within the subbasin, especially the southeast portion, can and should be evaluated separately. **Figure 1-1** shows this area which is bounded by the San Joaquin River on the south, Road 32 on the west, State Highway 41 on the East, and the contact with the foothills of the Sierra Nevada on the north and the northeast. **Figure 1-1** is a recent aerial showing land development to agricultural and rural residential development and the location of limited surface water use. Throughout this GSP, it becomes painfully obvious that surface supplies have been limited and groundwater flows are directed to the center of this developed area. This GSP covers the southeastern one-quarter to one-third of the area and it will be imperative that the neighboring Madera County GSA be active in this local region in project implementation and demand management activities. It is the responsibility of all agencies within the subbasin to coordinate and ensure sustainable management practices of surface and groundwater use in order to reach the sustainability goal.

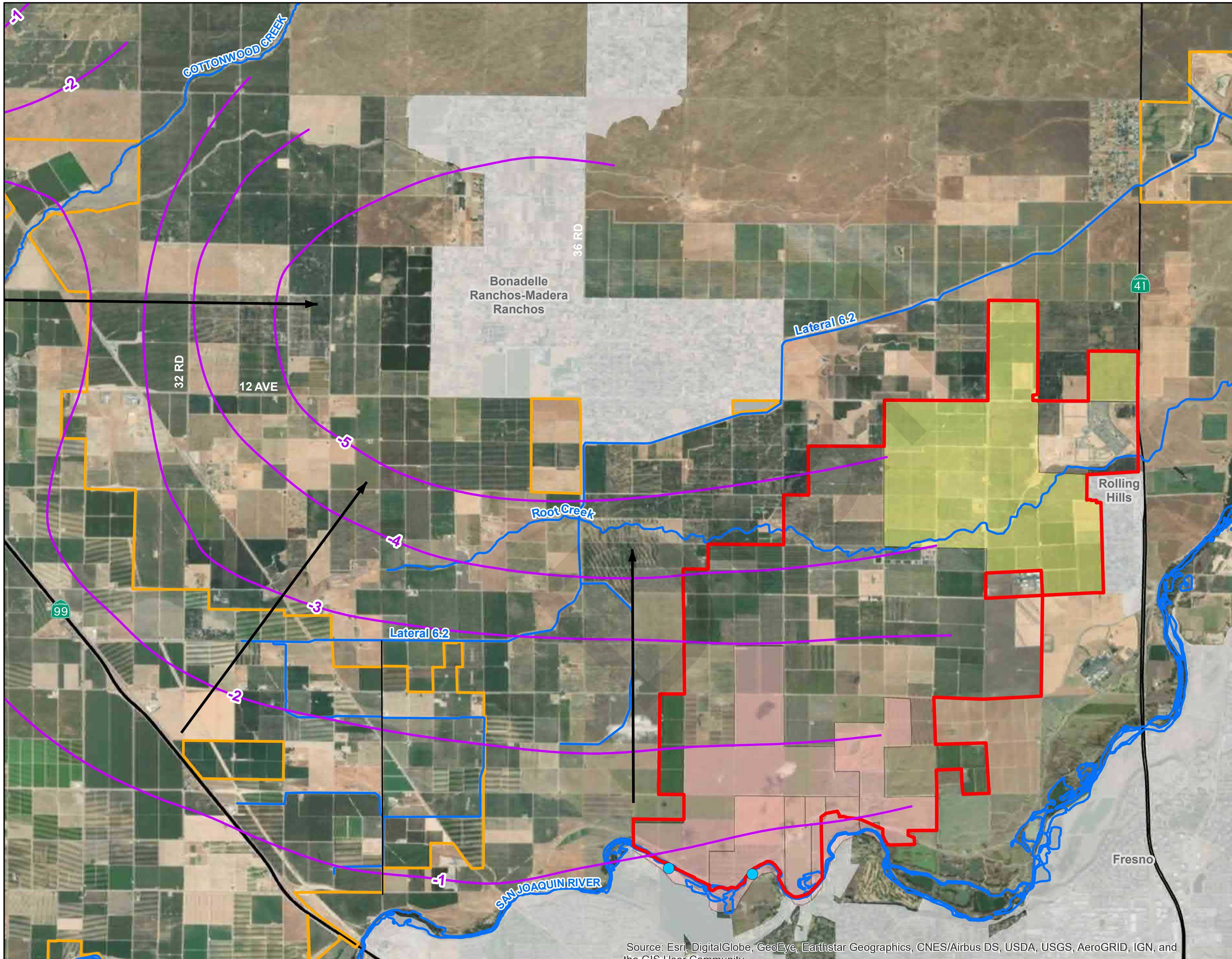
Sustainability goals, undesirable results, minimum thresholds, and measurable objectives are all defined and discussed in detail in Chapter 4 of this GSP.

1.3 Coordination Agreements

The Madera Subbasin is home to seven Groundwater Sustainability Agencies (GSAs). They are Madera Irrigation District GSA, Madera County GSA, City of Madera GSA, Madera Water District GSA, Gravelly Ford Water District GSA, Root Creek Water District GSA, and New Stone Water District GSA. The Madera County GSA on behalf of all the GSAs in the subbasin applied to and received funding from the DWR for grant funds to prepare a GSP. New Stone GSA had made the decision that they would prepare their own GSP and as such this subbasin would need a Coordination Agreement. Gravelly Ford WD and Root Creek WD were part of the regional GSP development until 2018. During this period, Davids Engineering and Luhdorff and Scalmanini had developed two reports. The first being "Data Collection and Analysis," dated July 2017 and the second, "Draft Preliminary Basin Boundary Water Budget" dated February 2018. These two reports are thought to be representative of the basin and the historical conditions that have been experienced. These reports are used as the basis for this RCWD GSP.

The Madera County GSA developed a draft Coordination Agreement for review and distributed it to the GSAs on December 5, 2018. RCWDGSA, recognizing that it planned to pursue development of its own GSP, edited the draft Coordination Agreement to represent regional cooperation and coordination while not developing a joint GSP and resubmitted the draft Coordination to the group on February 21, 2019.

The agencies continue to discuss and revise the specific terms of the coordination agreement. As of this date a coordination agreement has not been executed.



Root Creek WD

Figure 1-1

Southeast Madera County
Surface Water Source and Use

- Root Creek WD
- Service Area
- Holding Contracts
- Madera ID
- City/Town
- River Diversion
- Flow Direction
- Waterway
- Average Annual Rates of Water Level Decline (Ft), 1980- 2011*

*Source: Madera County AB 3030 Update Report by Ken Schmidt & Associates, December 2013

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1.4 Inter-basin Agreements

It is understood that coordination needs to exist between the adjacent subbasins. Some initial discussions occurred with the North Kings GSA, but the other Madera Subbasin GSAs asked that there be regional cooperation rather than discussions between the GSAs. At the request of the other Madera Subbasin GSAs, the RCWDGSA has not had any ongoing dialogue with the agencies in the Kings Subbasin.

1.5 Agency Information

Regulation Requirements:

§354.6(a) The name and mailing address of the Agency

Root Creek Water District Groundwater Sustainability Agency
P.O. Box 27950
Fresno, CA 93729

Contact: Julia Berry
Phone: (559) 970-8778
Email: julia@rootcreekwd.com

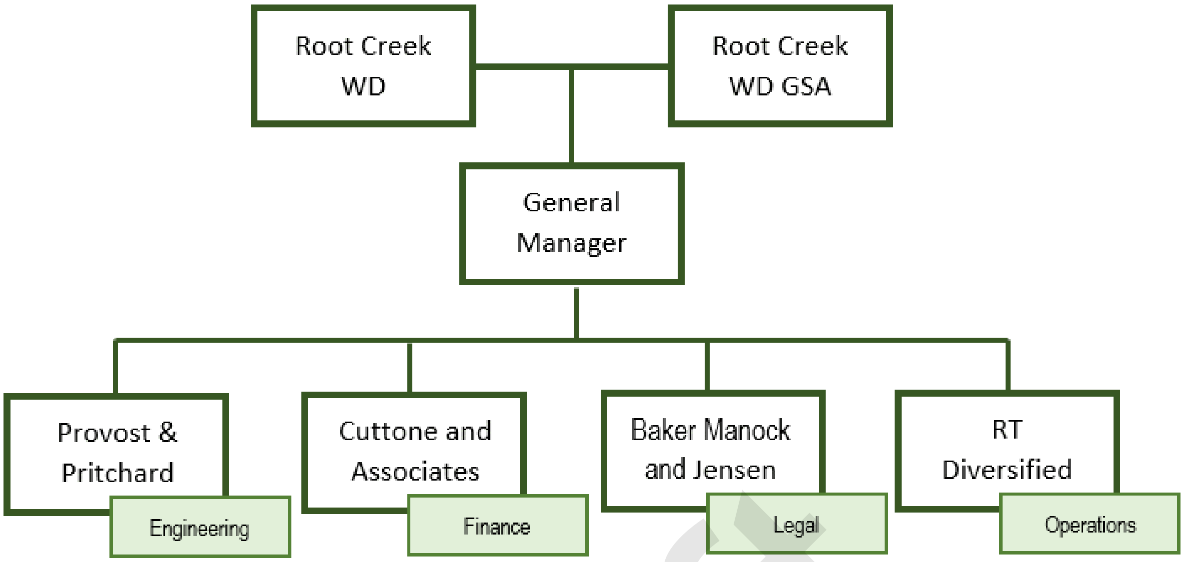
1.5.1 Organization and Management Structure of the GSA

Regulation Requirements:

§354.6(b) The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan. **§354.6(c)** The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.

The RCWDGSA is coterminous with the Root Creek Water District (RCWD or District) boundary. The RCWDGSA will be responsible for implementing the plan. It should be recognized that the GSA will implement the plan through the actions of the Root Creek Water District. The RCWD has contracts for surface water supplies and has constructed and owns infrastructure that will be the facilities used to import and deliver these surface water supplies to growers within the district. The manager for both agencies is Julia Berry and she will be the contact and the individual for directing the activities of both the RCWDGSA as well as the RCWD.

The Riverstone development is within the District and currently consists of approximately 400 municipal connections. The Riverstone development relies exclusively on groundwater and has three municipal wells. The RCWDGSA and the RCWD have no employees and rather relies upon consultants and contracted operational staff. The organizational chart below depicts the organizational structure.



The General Manager for RCWDGSA is Julia Berry and her contact information is as follows:
Name: Julia Berry
Phone: : (559) 970-8778
Mailing Address: P.O. Box 27950
Fresno, CA 93729

Email: juliaberry@sbcglobal.net

Within the Madera Subbasin and per the coordination agreement, the Basin Plan Manager is presently Stephanie Anagnoson. The Subbasin Plan Manager is the contact with the DWR for the subbasin as well as having the responsibility to submit information on behalf of the GSA to the department. The Subbasin Plan Manager is not responsible for implementing the GSP for the RCWDGSA. That responsibility is solely the responsibility of the General Manager of the RCWDGSA.

The contact information for the Subbasin Plan Manager is as follows:
Name: Stephanie Anagnoson
Phone: (559) 675-7703 ext 2265
Mailing Address: 200 W. 4th Street
Madera, CA 93637

Email: stephanie.anagnoson@maderacounty.com

1.5.2 Legal Authority of the GSA

Regulation Requirements:

§354.6(d) The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the plan.

RCWD elected to be the GSA over its jurisdiction and filed the formal notice to do so on June 8, 2016.

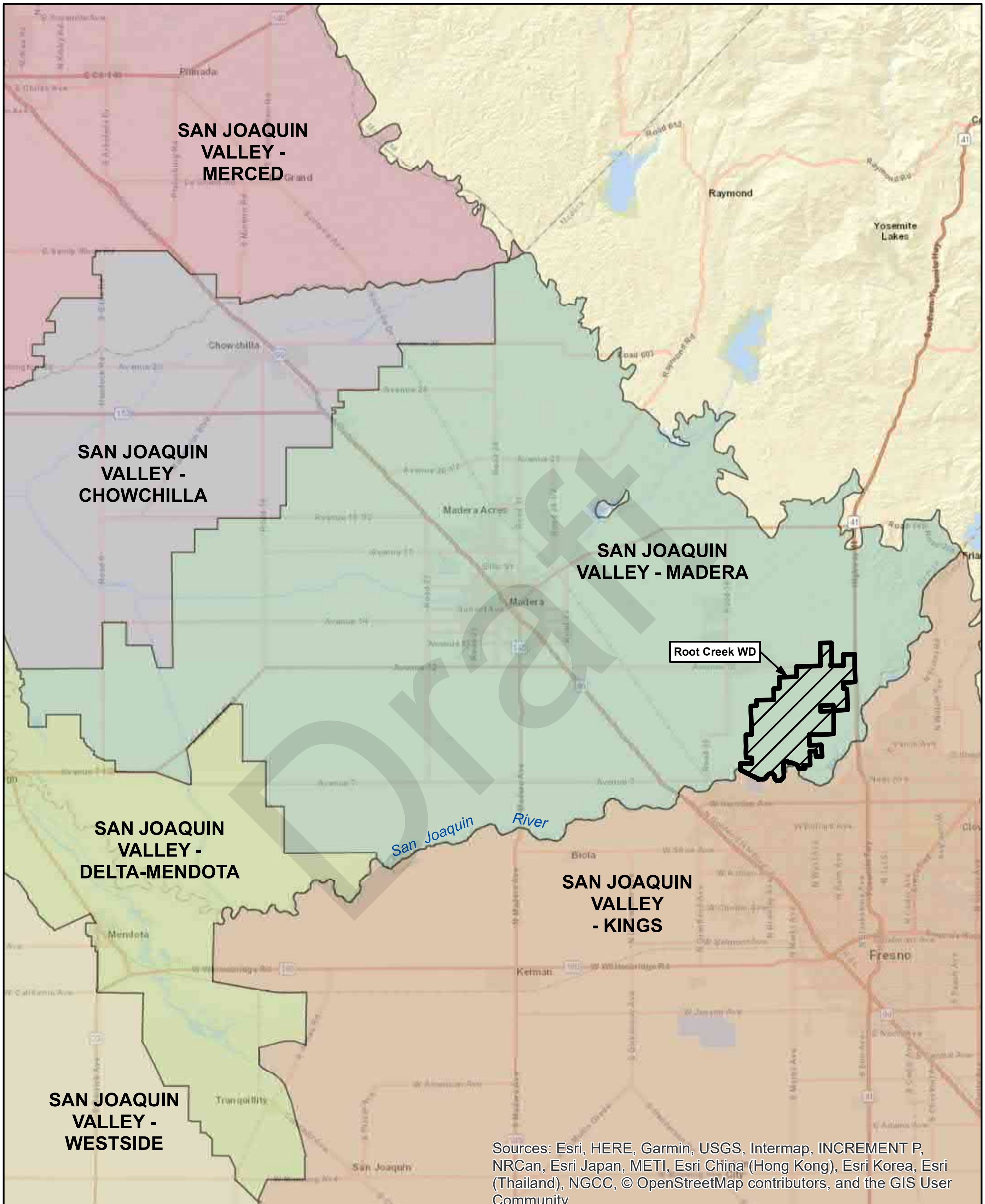
The Agency was established as the GSA under SGMA for the portion of the Madera Subbasin that lies within the boundaries of the Agency, which are shown on **Figure 1-2**. SMGA requires the Agency to develop and implement a GSP to achieve groundwater sustainability management within the territory of the Agency.

The RCWD is the only water purveyor and/or agency throughout the territory of the GSA. Accordingly, the Agency has been deemed the exclusive local agency within the designated territory endowed with powers to comply with SGMA.

Additionally, the RCWD is a local public agency. The District was organized on January 16, 1996 under the California Water District Law, Section 34000 *et seq*. of the California Water Code (CWC) of the State of California. Pursuant to CWC Sections 34000 *et seq.,* the District has the authority to protect and enhance the water resources available to it.

RCWD has the authority to manage the groundwater resources within its service area through CWC, Division 6, Part 2.75 (Sections 10750 et seq.) It is the primary agency responsible for its groundwater management plan, and it provides for management of the groundwater basin within its political boundary. The groundwater management plan complies with CWC, Sections 10750 et seq., as amended January 1, 2003.

The RCWDGSA has the responsibility to monitor for compliance of sustainable groundwater management within its service area. The powers giving to GSAs are enumerated CWC, Division 6, Part 2.74 and include but are not limited to the following: the ability to acquire personal property of any kind such as land, rights-of-way, water rights, etc., the authority to mandate the registration of groundwater extraction facilities, the authority to regulate groundwater extractions, and the ability to impose well operation requirements. Legal authority given to the GSA by SGMA will not be used to its maximum extent unless deemed necessary.



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Root Creek WD

Root Creek WD

Figure 1-2

Agency Boundary

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1.5.3 Cost of Plan Implementation and Sources of Revenue

Regulation Requirements:

§354.6(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

The costs for implementing the plan fall into a number of different categories. These consist of monitoring, facilities, planning and organizational, and purchase of surface water supplies. While SGMA was passed in 2014, the RCWD, with its founding, was intent on balancing groundwater supplies and groundwater levels and as such endeavored to acquire surface water supplies and construct facilities. These efforts have been ongoing since the District was established in 1996 and as such there are past costs as well as future costs associated with the implementation of this plan. **Table 1-1** lists the past and potential future costs associated with the plan:

Table 1-1 Past and Potential Future Costs of Plan Development and Implementation

Description	Past Costs	Present Costs	Future Annual Costs	Total of Future Annual costs to 2040	Total
Monitoring	$ 400,000		$ 45,000	$ 900,000	$ 1,300,000
Planning and Organizational	$2,100,000	$510,000	$ 20,000	$ 400,000	$ 3,010,000
Facilities	$5,300,000	$8,223,000			$13,523,000
Surface water supplies	$4,531,000		$2,500,000	$50,000,000	$54,531,000
Total	$12,331,000	$8,733,000	$2,565,000	$51,300,000	$72,364,000

In April 2016, the RCWD Agency Board of Directors approved a Financial Plan prepared by Bartle Wells and Associates. As an outgrowth of the Financial Plan, Bartle Wells also prepared an Engineer's Report entitled Proposition 218 Procedures for Benefit Assessments, which set forth a proposed budget and increased assessments to fund operation of the District as well as fund the surface water plan described in the Financial Plan. The election was held in July 2016, and it passed with a 95% approval. The Board of Directors subsequently accepted the balloting and approved implementing the assessments and fees and charges. The proposed assessment contained in the Engineer's Report is reproduced in **Table 1-2**.

Table 1-2: Summary of Root Creek WD Assessment, Rates, and Charges

Root Creek Water District				
Financial Master Plan 2016				
Category	**Amount**	**Basis**	**Customer Group**	**Cost of Service Description**
Districtwide				
Special Assessment	$30	$/acre	Annual assessment charged to all parcels within RCWD	Funds RCWD administration
Agriculture				
Recharge Fee	$85	$/AF of groundwater	Agricultural groundwater users	Both groundwater and surface water charges fund District groundwater management and imported surface water costs (fees shown include agricultural water capital costs)
Surface Water Charge	$119	$/AF of surface water	Agricultural surface water users	
Municipal and Industrial (M&I)				
Community Facilities District Tax	$0.15	$/sq ft of development/yr	Municipal and industrial developed parcels	Funds utility construction costs
Connection Fees				
Water	$4,447	$/new dwelling unit	New municipal customers	Funds M&I share of RCWD formation costs, utility construction costs
Wastewater	$11,344	$/new dwelling unit	New municipal customers	Funds utility construction costs
Storm Drain	$1,252	$/new dwelling unit	New municipal customers	Funds utility construction costs
Utility Service Rates				
Water				
Fixed Charge	$16.00	$/month per meter equivalent	Municipal water customers	Municipal water service fixed costs and meter reading costs
Volume Rate				
Tier 1 (1-10 hcf)	$1.30	$/hundred cubic foot	Municipal water customers	Municipal water service variable costs including water purchase costs
Tier 2 (>10 hcf)	$1.83	$/hundred cubic foot	Municipal water customers	
Wastewater	$25.00	$/month per dwelling unit	Municipal wastewater customers	Municipal wastewater service costs
Storm Drain	$3.00	$/month per dwelling unit	Municipal storm drain customers	Municipal storm drain service costs

hcf – hundred cubic foot, 748 gallons
Meter equivalent – up to a 1 ½-inch meter used to serve a single-family residential customer

As is noted in **Table 1-2**, the RCWD has budgeted $85 as a recharge fee and $119 for purchase of surface supplies in 2016 and these fees and charges are indexed to allow for an increase by not more than 3 percent.. The Financial Plan envisioned an average of agricultural pumping of 14,000 af/yr resulting in estimated annual revenue of about $1.2 million. The surface water charge of $119 is charged on surface water deliveries which are estimated to average about $400,000 a year. The municipal development also contributes to half of the water importation costs of the District. The total of the surface water importation costs is shown in the table above. It is recognized that the costs shown above assumes that no grants or other outside funding will be available and so results in the highest authorized charges. Should other funding become available, the Board can consider reducing charges below these levels.

1.6 GSP Organization and Preparation Checklist

This GSP is organized in accordance with the outline in the GSP Guidelines published by DWR.

Section 2 describes the Plan area, including geographic setting, existing water resources planning and programs, relationship of the GSP to other general plan documents within the Agency boundary, and additional GSP components.

Section 3 describes the basin setting. It includes a detailed discussion of the hydrogeologic conceptual model used to prepare the GSP, current and historical groundwater conditions, a discussion of the area groundwater budget, and a description of why there are no management areas.

Section 4 sets forth the Agency's adopted sustainability goals, addresses the mandated undesirable outcomes, defines minimum thresholds for each undesirable outcome, and sets measurable outcomes for both intermediate Plan years and for the Plan's complete implementation.

Section 5 describes the network of monitoring wells and other facilities adopted by the Agency to measure Plan outcomes and assesses the need for improvements to the network in order to provide fully representative data. Monitoring protocols and data analysis techniques are also addressed.

Section 6 lists and describes each project and management action adopted by the Agency in pursuit of sustainability. The section includes project details, required permits, anticipated benefits, project capital and operations/maintenance costs, project schedule, and required ongoing management operations.

Section 7 describes the Plan implementation process, including costs, sources of funding, an overall schedule through full implementation, description of the required data management system, methodology for annual reporting, and how progress evaluations will be made over time.

Section 8 summarizes the references and sources used to prepare and document this Plan.

Table 1-2. Preparation Checklist for GSP Submittal

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 3. Technical and Reporting Standards				
352.2		Monitoring Protocols	• Monitoring protocols adopted by the GSA for data collection and management • Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin	Section 5.2, 5,8 through 5.12 Section 5.2 through 5.7
Article 5. Plan Contents, Subarticle 1. Administrative Information				
354.4		General Information	• Executive Summary • List of references and technical studies	Section ES Section 8
354.6		Agency Information	• GSA mailing address • Organization and management structure • Contact information of Plan Manager • Legal authority of GSA • Estimate of implementation costs	Section 1.5
354.8(a)	10727.2(a)(4)	Map(s)	• Area covered by GSP (**Figure 2-1**) • Adjudicated areas, other agencies within the basin, and areas covered by an Alternative (**Figure 2-3 and Figure 2-10**) • Jurisdictional boundaries of federal or State land (**Figure 2-2**) • Existing land use designations (**Figure 2-5**) • Density of wells per square mile (**Figure 2-9**)	Section 2.0 Section 2.0 N/A—Section 2.0 Section 2.0 Section 2.0

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 1. Administrative Information (Continued)				
354.8(b)		Description of the Plan Area	• Summary of jurisdictional areas and other features	Section 2.1
354.8(c) 354.8(d) 354.8(e)	10727.2(g)	Water Resource Monitoring and Management Programs	• Description of water resources monitoring and management programs • Description of how the monitoring networks of those plans will be incorporated into the GSP • Description of how those plans may limit operational flexibility in the basin • Description of conjunctive use programs	Section 2.2 Section 2.2.1 Section 2.2.2 Section 2.2.3
354.8(f)	10727.2(g)	Land Use Elements or Topic Categories of Applicable General Plans	• Summary of general plans and other land use plans • Description of how implementation of the GSP may change water demands or affect achievement of sustainability and how the GSP addresses those effects • Description of how implementation of the GSP may affect the water supply assumptions of relevant land use plans • Summary of the process for permitting new or replacement wells in the basin • Information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management	Section 2.3 (2.3.1) Section 2.3.2 Section 2.3.3 Section 2.3.4 Section 2.3.5

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 1. Administrative Information (Continued)				
354.8(g)	10727.4	Additional GSP Contents	**Description of Actions related to:** • 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 • Addressing groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects • Efficient water management practices • Relationships with State and federal regulatory agencies • Review of 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	Section 2.4 Section 2.4.1 Section 2.4.2 Section 2.4.3 Section 2.4.4 Section 2.4.5 Section 2.2.3 & 2.4.7 Section 2.4.6 Sections 2.2.1 & 2.2.2 Section 2.4.8 Section 2.4.9 Section 2.3.3 & 2.4.10 Section 2.4.11
354.10		Notice and Communication	• Description of beneficial uses and users • List of public meetings • GSP comments and responses • Decision-making process • Public engagement • Encouraging active involvement • Informing the public on GSP implementation progress	Section 2.5.1 Section 2.5.3 Appendix 2-B Section 2.5.2 Section 2.5.3 Section 2.5.4 Section 2.5.3, 7.5

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 2. Basin Setting				
354.14		Hydrogeologic Conceptual Model	• Description of the Hydrogeologic Conceptual Model • Two scaled cross-sections (Figures 3-9 and 3-10) • Map(s) of physical characteristics: topographic information, surficial geology, soil characteristics, surface water bodies, source and point of delivery for imported water supplies	Section 3.1 Section 3.1.7 Section 3.1.5ff (Figures 3-1, 3-4, 3-5, 3-6, 3-7, 3-8, 3-11)
354.14(c)(4)	10727.2(a)(5)	Map of Recharge Areas	• Map delineating existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas	Section 3.1.12 Figure 3-13 Figures 6-1 and 6-2
	10727.2(d)(4)	Recharge Areas	• Description of how recharge areas identified in the plan substantially contribute to the replenishment of the basin	Section 3.1.12
354.16	10727.2(a)(1) 10727.2(a)(2)	Current and Historical Groundwater Conditions	• Groundwater elevation data • Estimate of groundwater storage • Seawater intrusion conditions • Groundwater quality issues • Land subsidence conditions • Identification of interconnected surface water systems • Identification of groundwater-dependent ecosystems	Section 3.2 (3.2.2&3.2.3) Section 3.2.3 Section 3.2.4 Section 3.2.5 Section 3.2.6 Section 3.2.7 Section 3.2.8 Section 3.2.9
354.18	10727.2(a)(3)	Water Budget Information	• Description of inflows, outflows, and change in storage • Quantification of overdraft • Estimate of sustainable yield • Quantification of current, historical, and projected water budgets	Section 3.3 (3.3.2) Section 3.3.3 Section 3.3.3 Section 3.3.4
	10727.2(d)(5)	Surface Water Supply	• Description of surface water supply used or available for use for groundwater recharge or in-lieu use	Section 3.1.10 through 3.1.12 Figure 3-11

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 2. Basin Setting (Continued)				
354.20		Management Areas	• Reason for creation of each management area • Minimum thresholds and measurable objectives for each management area • Level of monitoring and analysis • Explanation of how management of management areas will not cause undesirable results outside the management area • Description of management areas	Not Applicable
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria				
354.24		Sustainability Goal	• Description of the sustainability goal	Sections 4.1, 4.4.1
354.26		Undesirable Results	• Description of undesirable results • Cause of groundwater conditions that would lead to undesirable results • Criteria used to define undesirable results for each sustainability indicator • Potential effects of undesirable results on beneficial uses and users of groundwater	Sections 4.2.1, 4.3.1, 4.3.2, 4.4.2, 4.4.3, 4.5, 4.6, 4.7
354.28	10727.2(d)(1) 10727.2(d)(2)	Minimum Thresholds	• Description of each minimum threshold and how they were established for each sustainability indicator • Relationship for each sustainability indicator • Description of how selection of the minimum threshold may affect beneficial uses and users of groundwater • Standards related to sustainability indicators • How each minimum threshold will be quantitatively measured	Sections 4.2.2, 4.3.2, and 4.4.3, 4.5, 4.6, 4.7

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria (Continued)				
354.30	10727.2(b)(1) 10727.2(b)(2) 10727.2(d)(1) 10727.2(d)(2)	Measurable Objectives	• Description of establishment of the measurable objectives for each sustainability indicator • Description of how a reasonable margin of safety was established for each measurable objective • Description of a reasonable path to achieve and maintain the sustainability goal, including a description of interim milestones	Sections 4.2.3, 4.3.3, 4.4.4
Article 5. Plan Contents, Subarticle 4. Monitoring Networks				
354.34	10727.2(d)(1) 10727.2(d)(2) 10727.2(e) 10727.2(f)	Monitoring Networks	• Description of monitoring network • Description of monitoring network objectives • Description of how the monitoring network is designed to: demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features; estimate the change in annual groundwater in storage; monitor seawater intrusion; determine groundwater quality trends; identify the rate and extent of land subsidence; and calculate depletions of surface water caused by groundwater extractions • Description of how the monitoring network provides adequate coverage of Sustainability Indicators • Density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends • Scientific rational (or reason) for site selection • Consistency with data and reporting standards • Corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone	Ch 5: Section 5.1 Sections 5.1.1 through 5.1.3 Sections 5.1.3, 5.2-5.7 Sections 5.2.3, 5.3.3, 5.4.3 Sections 5.2.1.1, 5.3.1.1, 5.4.1.1, 5.5.3.4,5.6.3.4 Section 5.8 Sections 5.2.2, 5.3.2, 5.4.2, 5.5.2, 5.6.2

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
			(Monitoring Networks Continued) • Location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used • Description of technical standards, data collection methods, and other procedures or protocols to ensure comparable data and methodologies	Figure 5-4 Section 5.8, 5.9, 5.12 Section 5.9
354.36		Representative Monitoring	• Description of representative sites • Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators • Adequate evidence demonstrating site reflects general conditions in the area	Section 5.10 Section 4.2.2.2
354.38		Assessment and Improvement of Monitoring Network	• Review and evaluation of the monitoring network • Identification and description of data gaps • Description of steps to fill data gaps • Description of monitoring frequency and density of sites	Sections 5.5.3 & 5.6.3 5.2.4, 5.3.4, 5.4.4, 5.4.5, 5.5.3, & 5.6.3

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 5. Projects and Management Actions				
354.44		Projects and Management Actions	• Description of projects and management actions that will help achieve the basin's sustainability goal • Measurable objective that is expected to benefit from each project and management action • Circumstances for implementation • Public noticing • Permitting and regulatory process • Time-table for initiation and completion, and the accrual of expected benefits • Expected benefits and how they will be evaluated • How the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included. • Legal authority required • Estimated costs and plans to meet those costs • Management of groundwater extractions and recharge	Chapter 6 (6.1.1,6.2.1,6.3) Section 6.2.3,6.3.3, Sections 6.2.4,6.3.4, Section 6.1 Section 6.2.5,6.3.5 Section 6.2.6, 6.3.6 Section 6.2.2, 6.3.2, Section 6.2.1 Section 6.1, 6.2.7, 6.3.7 Section 6.2.8, 6.3.8 Section 6.2.9,6.3.9
354.44(b)(2)	10727.2(d)(3)		• Overdraft mitigation projects and management actions	Chapters 6 and 7

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 8. Interagency Agreements				
357.4	10727.6	Coordination Agreements - Shall be submitted to the Department together with the GSPs for the basin and, if approved, shall become part of the GSP for each participating Agency.	**Coordination Agreements shall describe the following:** • A point of contact • Responsibilities of each Agency • Procedures for the timely exchange of information between Agencies • Procedures for resolving conflicts between Agencies • How the Agencies have used the same data and methodologies to coordinate GSPs • How the GSPs implemented together satisfy the requirements of SGMA • Process for submitting all Plans, Plan amendments, supporting information, all monitoring data and other pertinent information, along with annual reports and periodic evaluations • A coordinated data management system for the basin • Coordination agreements shall identify adjudicated areas within the basin, and any local agencies that have adopted an Alternative that has been accepted by the Department	Section 1.3

2 Plan Area

Regulation Requirements:

§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:

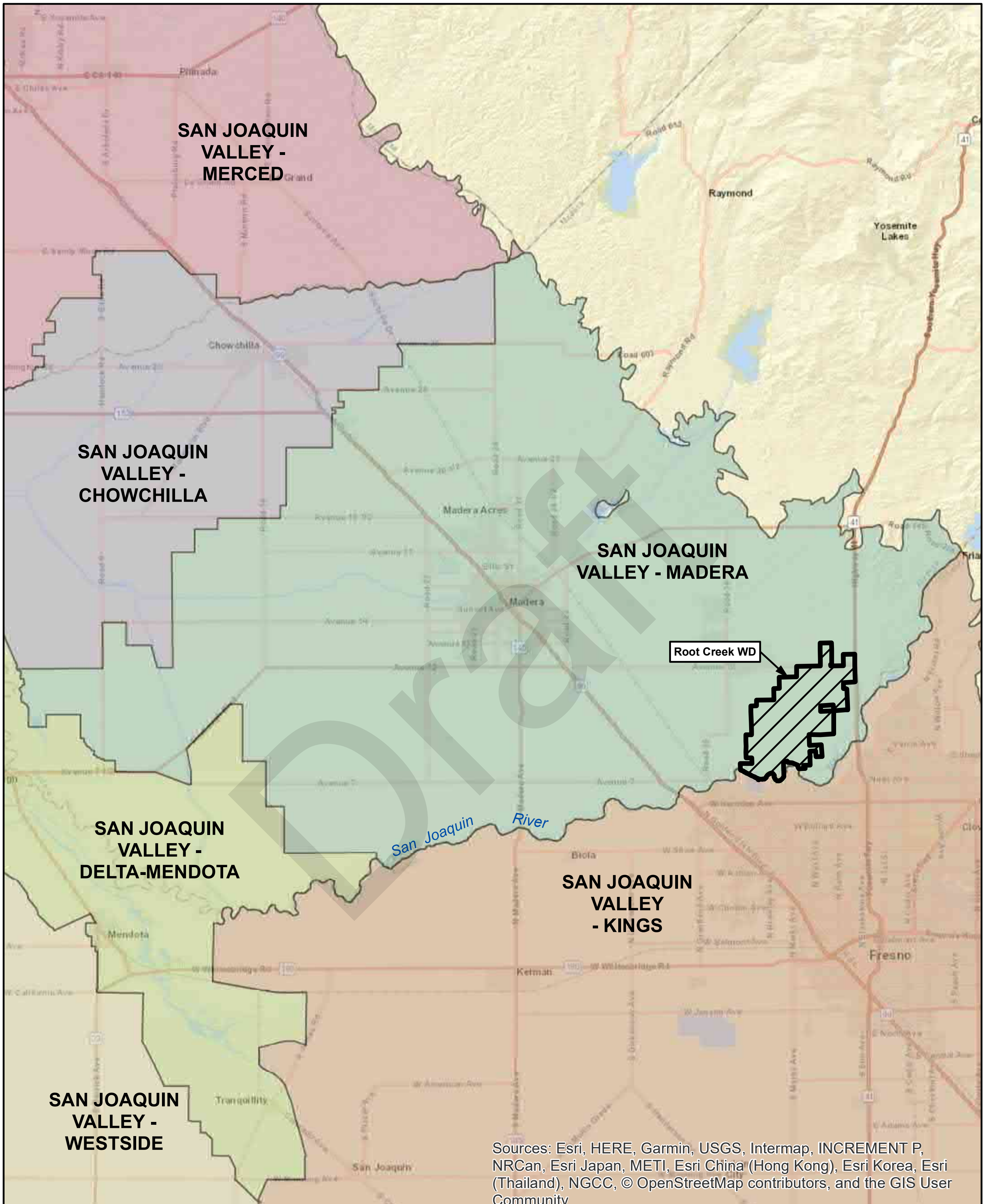
1) The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.
2) Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.
3) Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.
4) Existing land use designations and the identification of water use sector and water source type.
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 best available information.

General:

Root Creek Water District (RCWD) is located within the Madera Groundwater Subbasin, which is the southernmost subbasin in the San Joaquin Valley Basin that is north of the San Joaquin River (**Figure 2-1**). The Madera Subbasin boundary is defined in the DWR Bulletin 118 as DWR Subbasin No. 5-22.06 (2006). The majority of surface water in the subbasin is supplied from the Chowchilla, Fresno, and San Joaquin Rivers. The Sierra Nevada foothills and three groundwater subbasins border the Madera Subbasin north of the San Joaquin River, including the Merced, Chowchilla, and the Delta-Mendota Subbasins. The Kings Subbasin adjoins the Madera Subbasin south of the San Joaquin River.

Figure 2-2 shows the location of the District with regards to state jurisdictional boundaries and is located entirely within Madera County.

Each subbasin contains multiple water agencies. Seven GSAs have formed within the 347,600-acre Madera Subbasin. RCWDGSA contains approximately 10,000 acres, including the acreage annexed to the original northern border in 2017. RCWDGSA is in the southeastern portion of the subbasin and is bounded on the south by the San Joaquin River. **Figure 2-3** shows some of RCWD's neighboring water agencies within the Madera Subbasin. There is no overlap among the surrounding GSAs and there are no adjudicated areas in the groundwater basin.



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Root Creek WD

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Figure 2-1

Groundwater Subbasins

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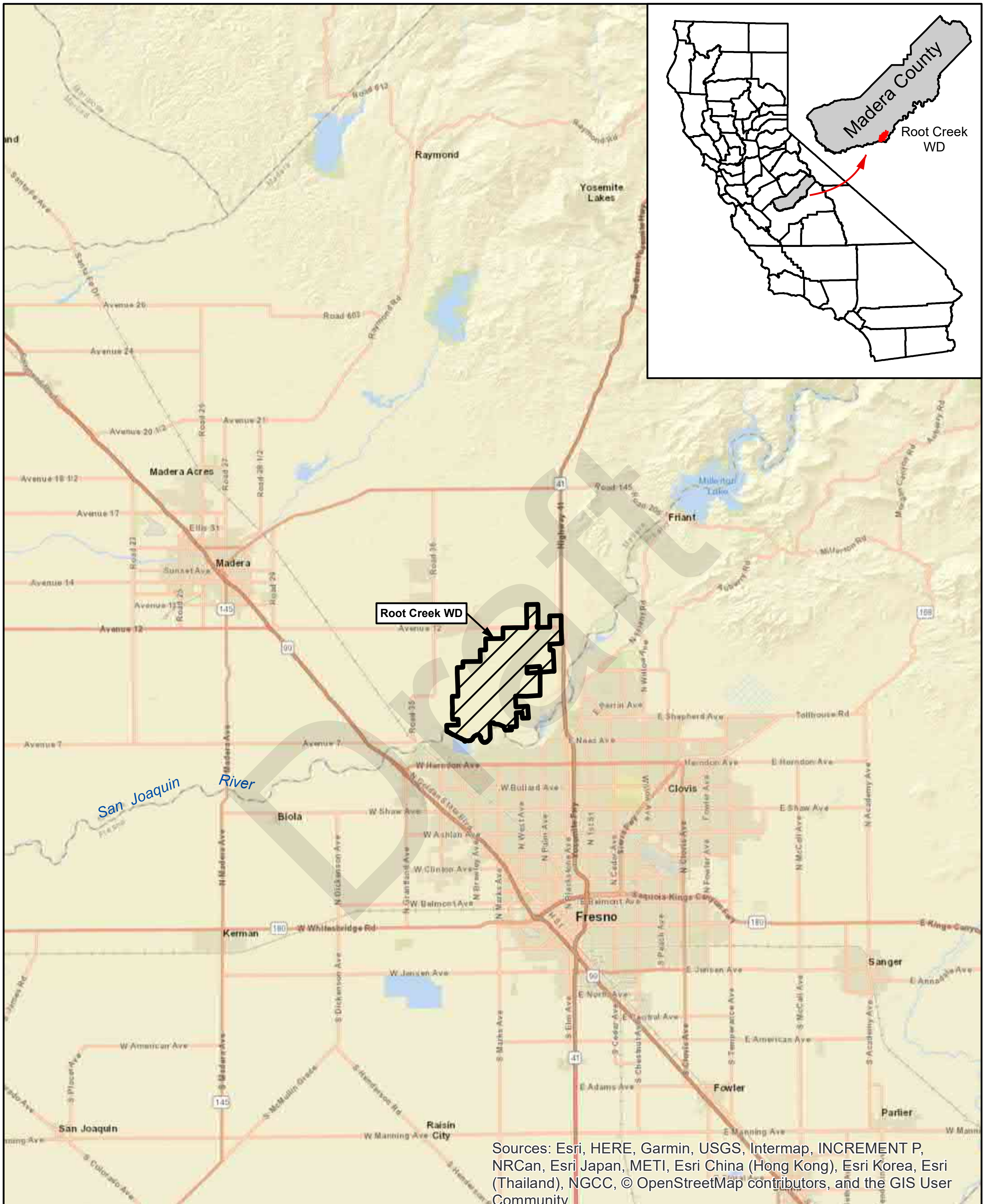

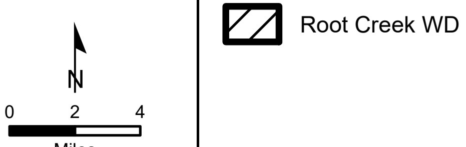

Root Creek WD

Figure 2-2

District Vicinity

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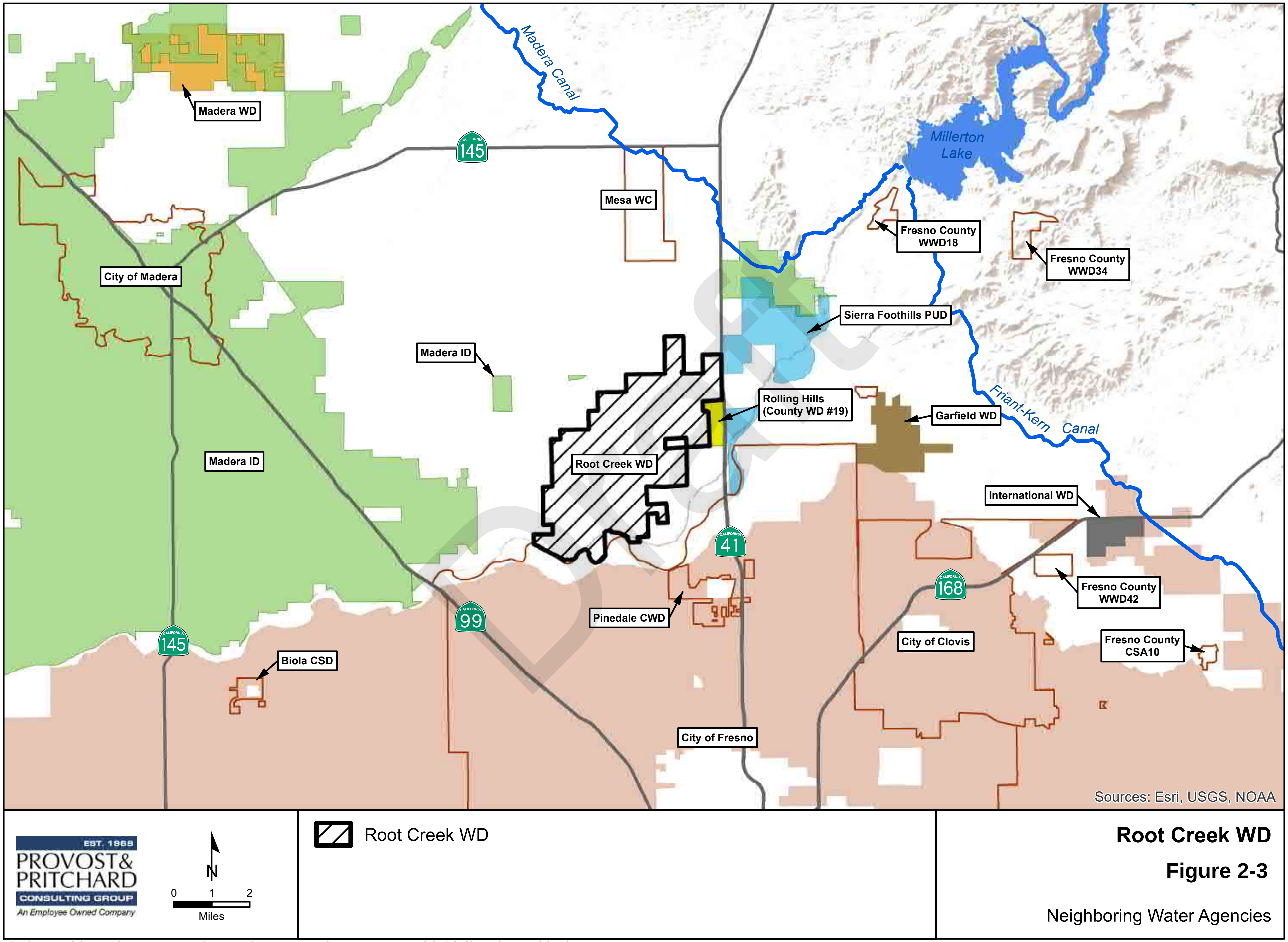

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Figure 2-3

Neighboring Water Agencies

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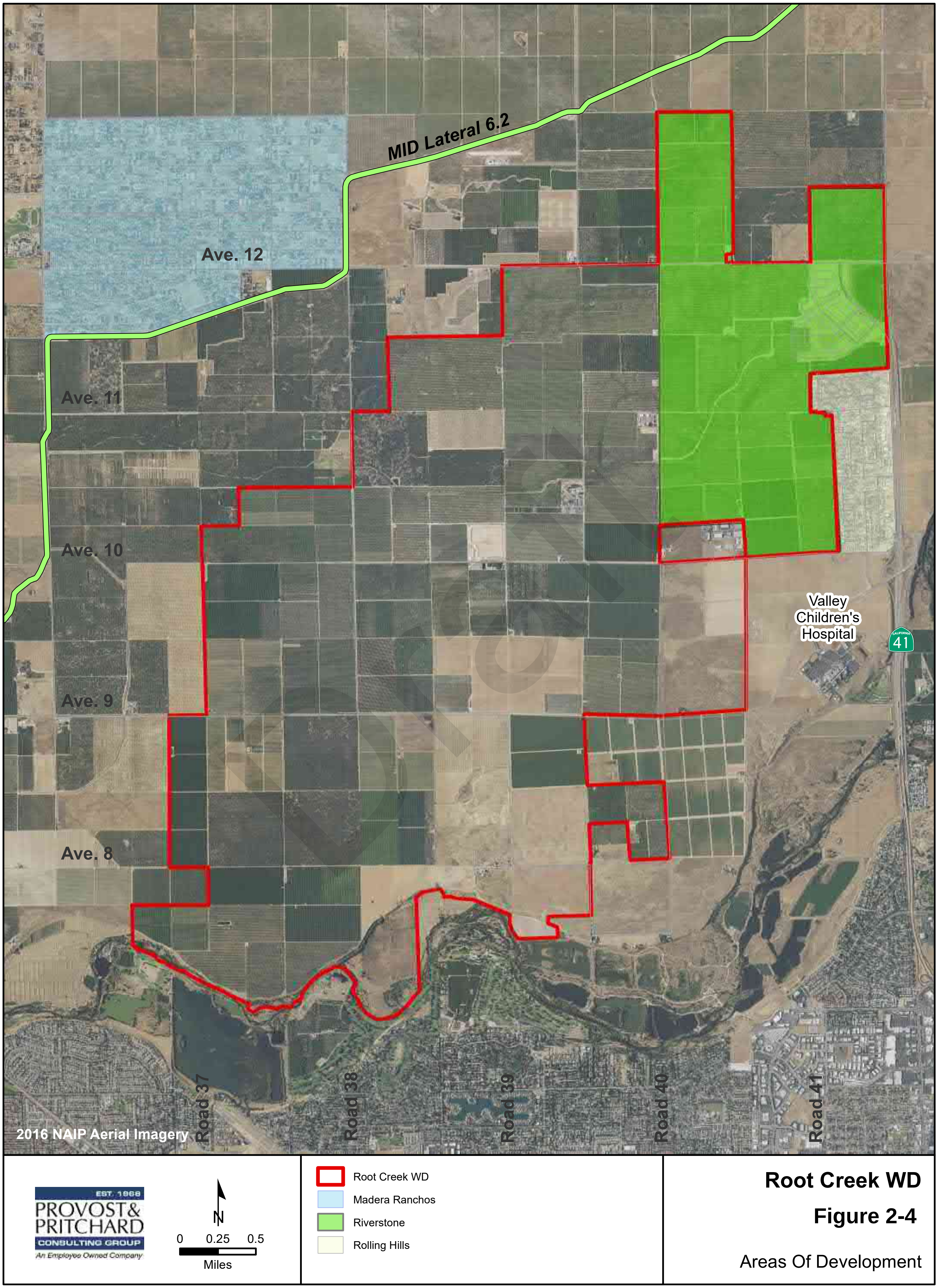
Most of the land immediately surrounding RCWD, north of the San Joaquin River, is unincorporated County land covered by Madera GSA. Minor acreage on the northern border of RCWD is part of the Madera Irrigation District GSA. There are no federal, state, or tribal lands within the RCWD area.

Historically, RCWD has completely been covered in agricultural land, but in September 2007, the Madera County Board of Supervisors adopted Ordinance 627 for Gateway Village (now Riverstone). An Infrastructure Master Plan (IMP) was approved for the community development of approximately 2,062 acres in the northeast portion of the District, seen in **Figure 2-4**.

Near the District are three areas that are not primarily agricultural, including Rolling Hills, Children's Hospital of Central California, and Madera Ranchos (**Figure 2-4**). Rolling Hills is adjacent to the District on the east, consists of 2.5-acre ranchettes that have a community water system, and are on individual septic systems. Children's Hospital is located to the Southeast of the District along the San Joaquin, relies on two wells, and has its own wastewater treatment plant and leach field. Northwest of the GSA are the Madera Ranchos. The large sprawling development of mostly residential properties from 1 to 5 acres relies on both individual wells as well as a community well system and individual septic systems.



Root Creek WD

Figure 2-4

Areas Of Development

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Land Use.
Land use zones for the District based on the County General Plan are mapped in **Figure 2-5** and can be observed on the County interactive map available from:

https://countymadera.maps.arcgis.com/apps/webappviewer/index.html?id=d955f25b15ed4e4e9a7ac4ecad0edd2a

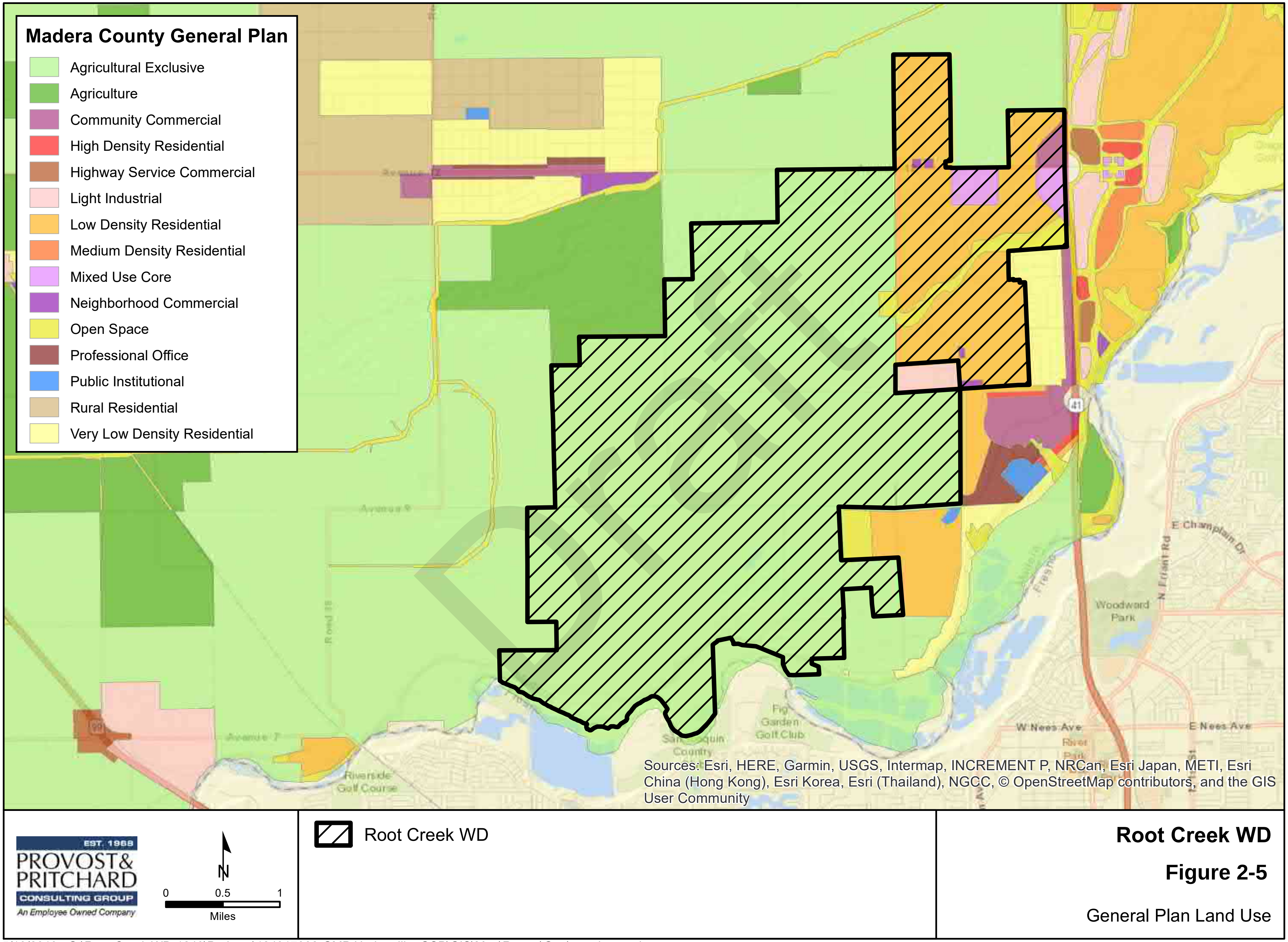
The RCWD area is still mainly comprised of agricultural land use designations with the exception of the Riverstone development, which includes residential and commercial zoning. Therefore, the main water use sectors include irrigation for agricultural use and residential and commercial water use, which requires drinking water quality. For specific cropping patterns in the District, data may be gathered from DWR Land Use Surveys or Madera County Agricultural Commissioner. DWR Land Use Surveys are done by county and provide accurate descriptions of cropping patterns and irrigation use; however, surveys are not completed on an annual basis and the last survey was completed in 2011 for Madera County. The Madera County Agricultural Commissioner provides annual data for cropping within the County, which was used for understanding the most current plantings in the District. **Table 2-1** below contains the estimated cropping acreage for Root Creek over the years 2014, 2015, 2016, and 2017 (based on the Geographic Information System [GIS] digitized boundary over an aerial photo). During the 2014 to 2017 period, the total acreage of almonds increased while grapes and olives decreased in acreage. **Figure 2-6** displays the 2017 crop map for RCWD.

Table 2-1. Cropping in RCWD, 2014-2017

	2014	2015	2016	2017
Crop	Acreage			
Almond	1,740	2,133	2,143	2,171
Cherry	9	9	9	9
Citrus	2,959	2,959	2,960	2,959
Date	1	1	1	1
Grape	384	262	262	220
Nursery Plants	22	22	22	22
Olive	214	93	93	93
Persimmon	1	1	1	1
Pistachio	2,673	2,674	2,674	2,674
Plum	5	5	8	7
Pomegranate	7	7	7	7
Uncultivated	606	455	118	344
Wheat	460	118	100	100
Urban/Residential*	4	4	4	4
Other Non Ag**	132	474	815	605
Total Acreage	**9,217**	**9,217**	**9,217**	**9,217**

Notes:
****Estimated from DWR land use survey 2011***
*****Difference from the sum of the land use and the total area within the RCWD GIS boundary***

***RCWD GIS boundary acreage corrected to aerial:* 9,314**



Root Creek WD

Figure 2-5

General Plan Land Use

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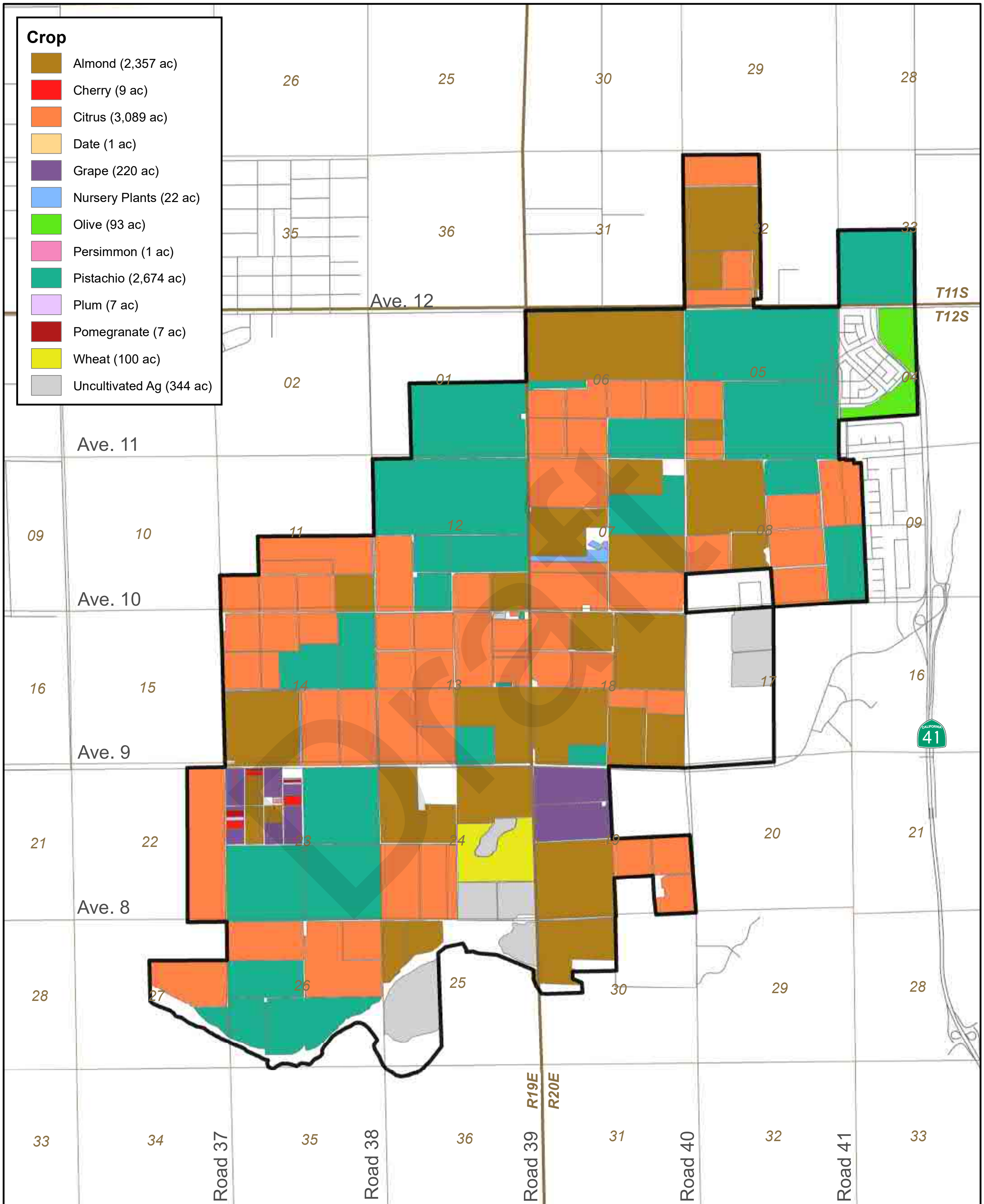

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Miles

Root Creek WD

Root Creek WD
Figure 2-6

Madera County Agricultural Commissioner Crops, 2017

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Water Source. Historically, a portion of the water supply to meet the largely agricultural demand within RCWD's boundary came from two diversions of surface water along the San Joaquin River supplying water to lands located within RCWD's boundary at the southern border. Holding contract agreements allow landowners to divert as much water as can be beneficially used on the parcel of land defined in the contract. The volume of water that could potentially be in the control of holding contract owners was calculated by the crop water demand for the lands that are within the boundaries of the contracts. The remainder of the supply came from groundwater pumping; however, with the completion of the "In-lieu" pipeline in 2014, the District imports surface water supplies acquired from Madera Irrigation District (MID), the United States Bureau of Reclamation (USBR), or others. In 2017, the system was able to take full advantage of the facilities through contracts for surface water supply and was able to deliver 6,636 AF of surface water into the District. Surface water sources and contract agencies are shown below in **Table 2-2**.

Table 2-2. Water Uses and Water Sources

Agency / Water Company	Water Use	Surface Water Source
Riparian or USBR water holding contracts to divert river water	~9,840 AF/yr	San Joaquin River
Westside Mutual Water Company	Up to 7,000 AF/yr	Friant Division of Central Valley Project (deemed non-federal project water)
Madera Irrigation District	Up to 10,000 AF/yr	In excess of MID needs. Surplus and flood water, variable per year, delivered from Lateral 6.2
USBR	Variable	San Joaquin River floodwater (Section 215 water) during flood releases

All of the surface water directed to RCWD originates from the San Joaquin River. Surface water diversions from MID Lateral 6.2, which branches off of the Madera Canal, supply contract waters to the distribution system on the north side of the District. **Figure 2-7** shows the location of surface water diversion points as well as the associated service areas. Included in the map are the locations of the San Joaquin River turnouts used for holding contract lands, the surface water conveyance and distribution system, and the service area of the system.

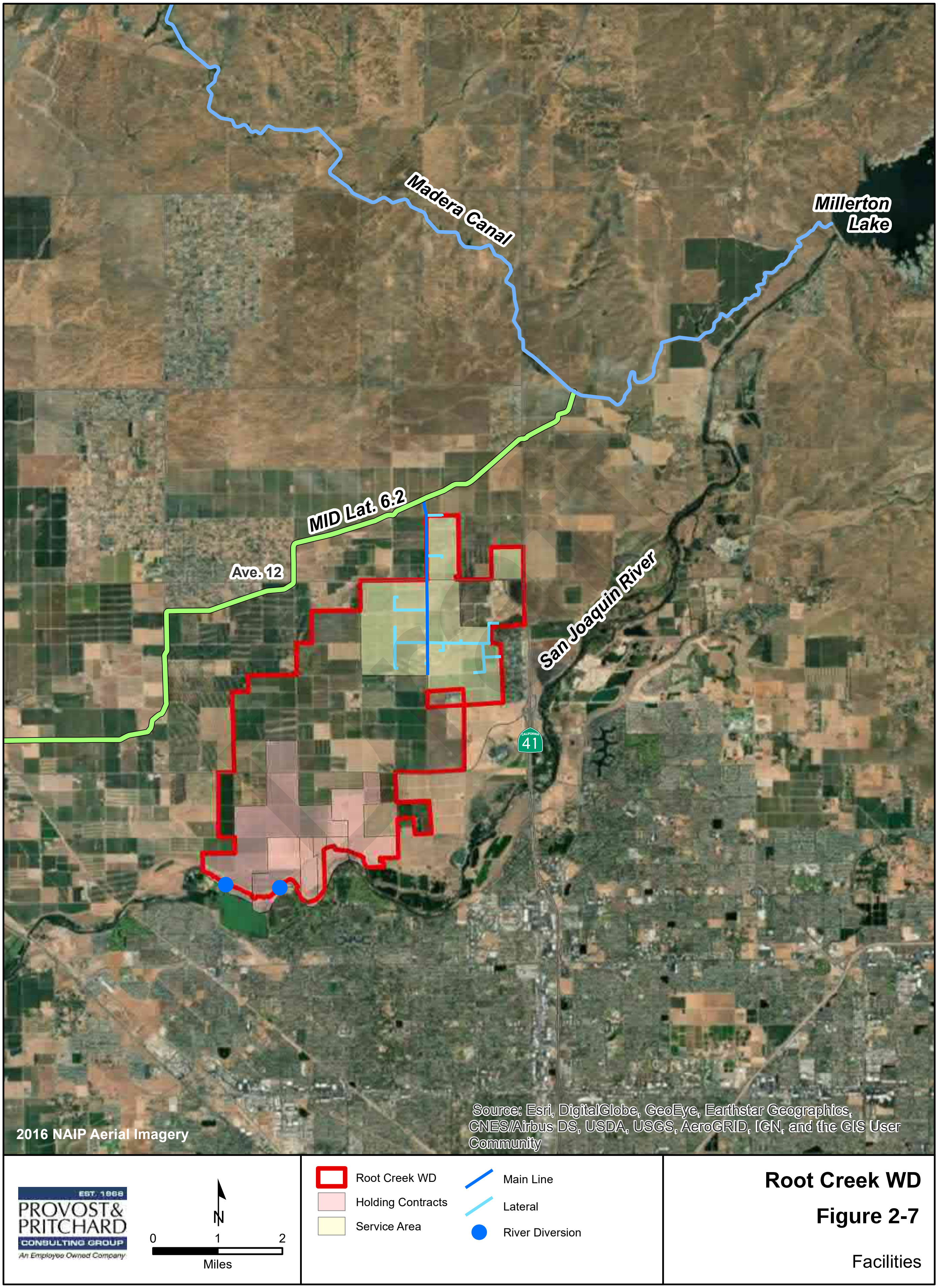

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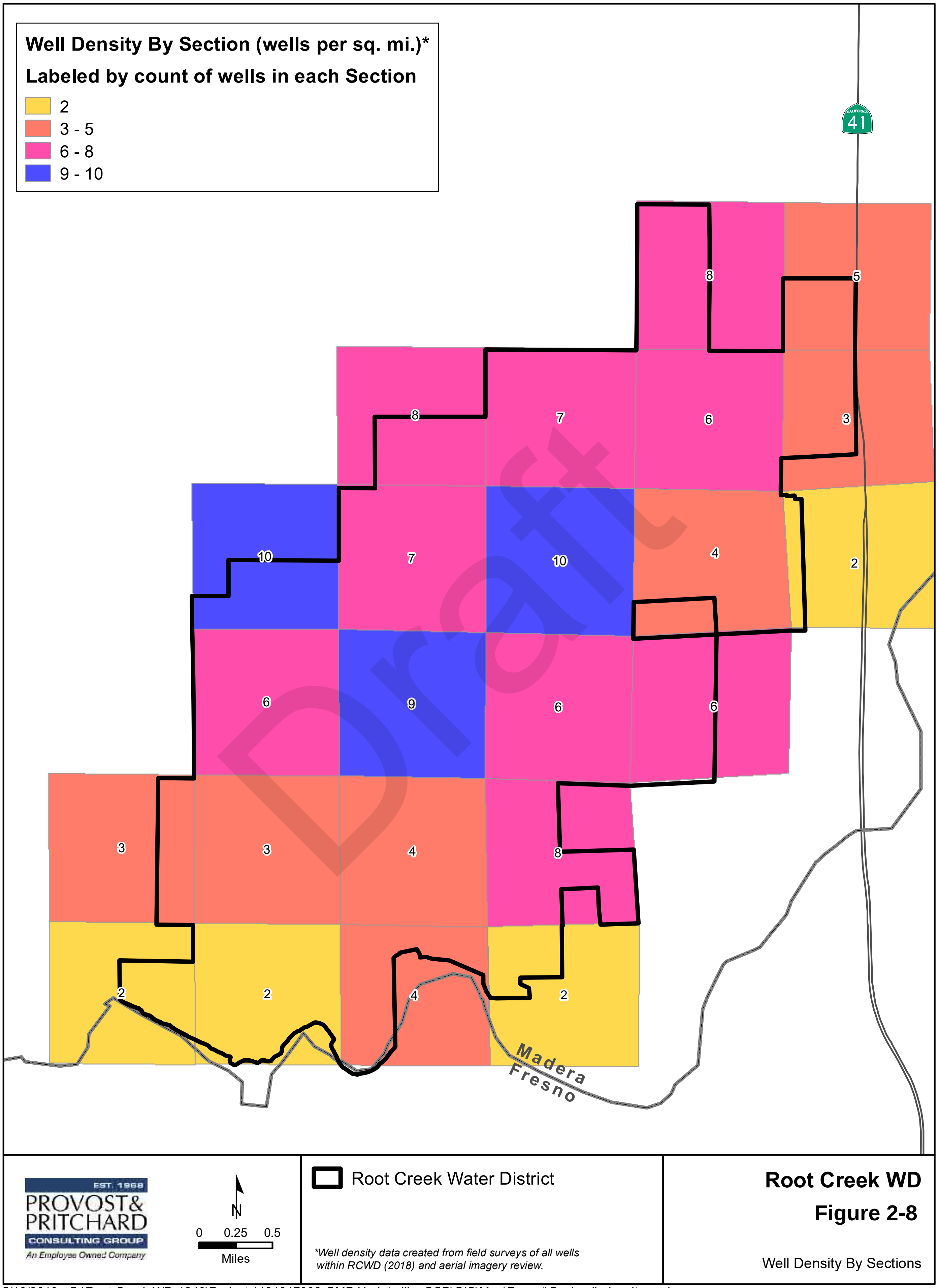
Figure 2-7

Facilities

Density of Wells

The well density within the Subbasin varies.
Figure 2-8 shows the CASGEM well density across Madera County. This map shows there is less dense network in the eastern and western limits of the County. However, it is understood with the significant rural residential properties along the eastern fringe of the basin the well densities are expected to be much higher in these regions and in the Madera Rancho's portion of the basin that is to the Northwest of the RCWD.

The well density in RCWD varies from as little as 1 well per section along the San Joaquin River to as many as 9 wells per section in the middle of the district, as seen in **Figure 2-9**. There are an estimated 80 active wells in the District area according to a recent well canvas performed in February 2018. The well canvas is considered the best available data and includes known well locations for individual landowners as well as municipal wells that serve the Riverstone development. Wells that are no longer in operation but have been retained for monitoring purposes are also included in the map. Well logs from the DWR have been reviewed for construction information, however, due to the lack of information given on well logs, construction data could not be obtained. The map also includes monitoring wells that are considered active and are not removed from the system unless a County permit authorizes their destruction. A discussion of groundwater pumping is included in **Table 3-3** in Section 3.1.8.3. It should be recognized that this is the summary of recharge and pumping that has occurred since the construction of the turnout at Madera ID Lateral 6.2 and the 48-inch pipeline into Root Creek Water District in June 2014. Three municipal wells that service Riverstone Development are shown on **Figure 2-9.**



*Well density data created from field surveys of all wells within RCWD (2018) and aerial imagery review.

Root Creek WD

Figure 2-8

Well Density By Sections

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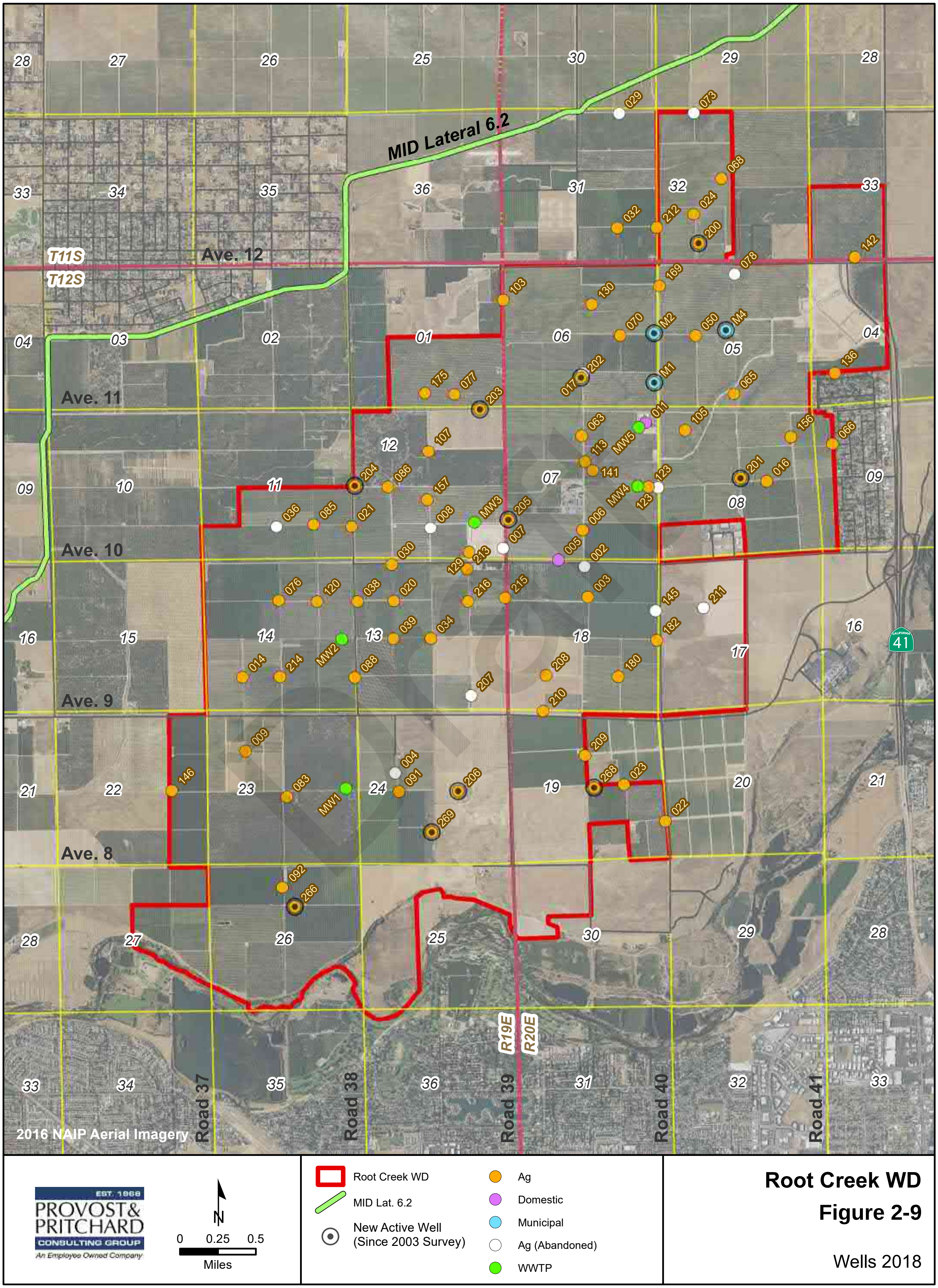


Root Creek WD

Figure 2-9

Wells 2018

2.1 Summary of Jurisdictional Areas and Other Features

Regulation Requirements:

§354.8(b) A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.

Groundwater Basin Boundaries

The Madera Subbasin is a large groundwater subbasin located within the southern part of the San Joaquin Valley Basin whose boundary is defined in DWR Bulletin 118 as Basin No. 5-22.06, covering 394,000 acres. In 1995, DWR estimated the amount of stored groundwater for the entire San Joaquin Valley Basin to a depth of 300 feet at about 12.6 million AF (DWR, 2006). They also state in published literature that the amount of stored groundwater in the subbasin to a depth of 1,000 feet (as of 1961) was about 24 million AF.

Groundwater Management Plan Area

RCWD has had a Groundwater Management Plan (GMP), which was adopted in October 1997 and updated in January 2012 (Provost & Pritchard [P&P], 2012). The area included in the Plan was referenced as 9,217 acres and is approximately five miles long (north-south) by four miles wide (east-west), located in the southeast portion of Madera County. In 2017, RCWD annexed approximately 350 acres into the District, bringing the total acreage to 9,550, shown in **Figure 2-4**. Nearby water agencies include Fresno Irrigation District and Madera Irrigation District (**Figure 2-3**). In addition, private domestic and community wells are used in rural and semi-rural areas throughout the Madera Ranchos located to the northwest and the Rolling Hills development immediate to the east. Non-agricultural groundwater pumping commenced in June 2017 for the Riverstone development.

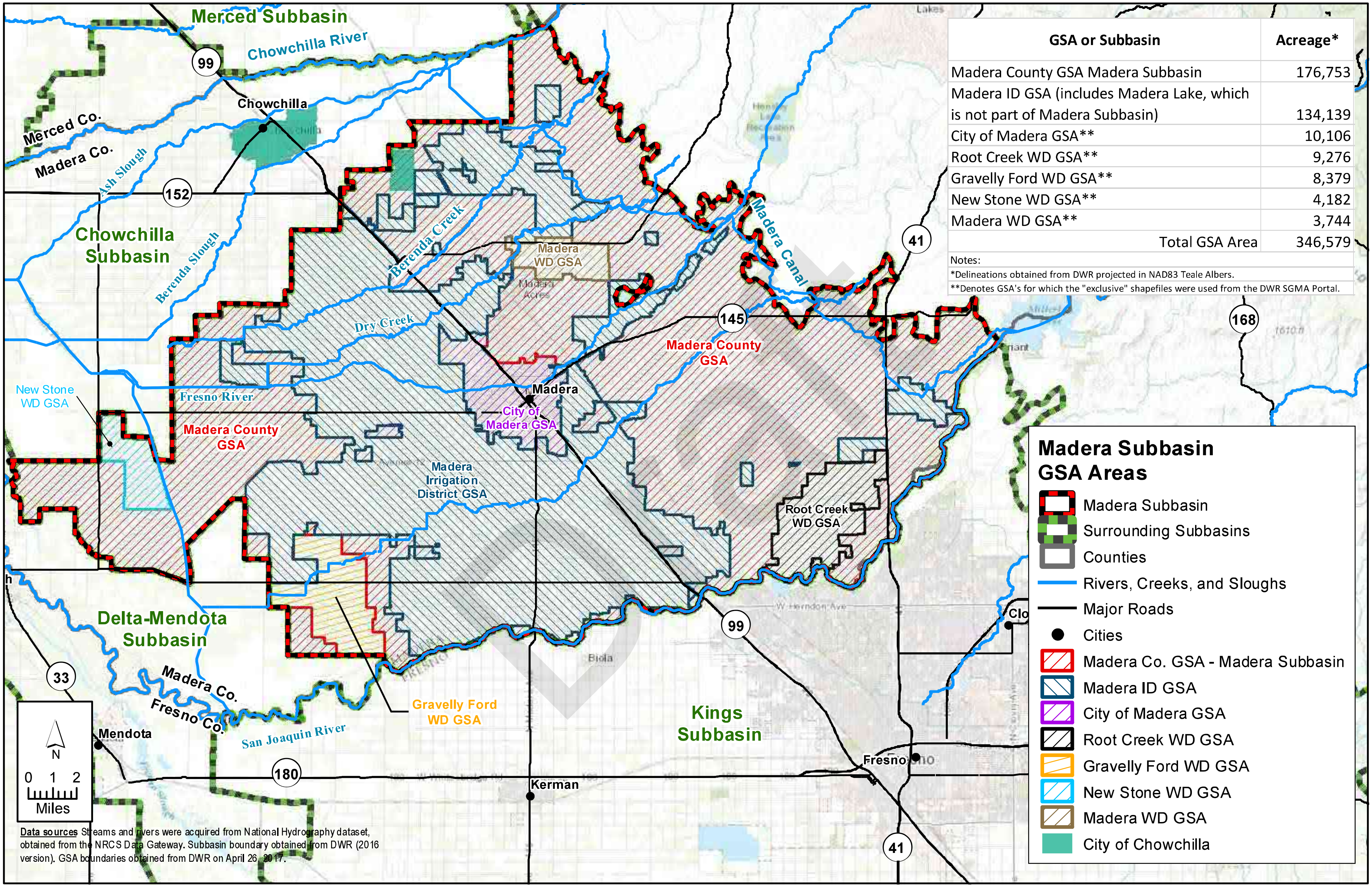
Madera Irrigation District (MID)

Madera Irrigation District (MID) encompasses an area of approximately 139,665 acres (per their web site) and serves primarily agricultural purposes. It operates a primarily gravity irrigation distribution system with approximately 300 miles of open flow canal systems as well as 150 miles of large diameter pipelines. MID has a Central Valley Project (CVP) repayment contract with the USBR providing up to 85,000 AF of Class 1 and 186,000 AF of Class 2 water per year from Millerton Lake. The CVP water is released from Millerton Lake through the Friant Dam and then conveyed through the Madera Canal for delivery into the MID's service area. MID also entered into a CVP repayment contract with the USBR for the yield from Hensley Lake. Under this contract, the average annual supply available is approximately 24,000 AF/yr. MID has Pre-1914 rights to divert water from Big Creek (Big Creek Diversion) and the North Fork of Willow Creek (Soquel Diversion). The Big Creek Diversion originates in Big Creek, a tributary of the Merced River. This Diversion is located just upstream of Fish Camp, CA, where the water is redirected to flow down Lewis Creek, a tributary of the upper Fresno River. The Soquel Diversion originates in North Fork Willow Creek, a tributary of the San Joaquin River. This Diversion is located approximately 9 miles upstream of Bass Lake, where water can be redirected to flow through the Soquel Ditch to Nelder Creek, a tributary of the upper Fresno River. Alternatively, water can be left in North Fork Willow Creek and allowed to flow to Bass Lake and eventually to the San Joaquin River, where it will be directed to Friant Dam. MID also has a Pre-1914 water right on the Fresno River.

Madera County

The County has a contract with the USBR for a small amount of Class 2 surface water supplies which serves the Hidden Lake Estates. **Figure 2-10** from Data Collection and Analysis on the Madera Subbasin (Davids Engineering and Luhdorff & Scalmanini Consulting Engineers, 2017), shows jurisdictional boundaries of the other GSAs and the county. The areas highlighted with blue, black, and yellow hatch are where surface water supplies are delivered. Otherwise, the water supply demand is met by pumping groundwater.

Figure 2-10



GSA or Subbasin	Acreage*
Madera County GSA Madera Subbasin	176,753
Madera ID GSA (includes Madera Lake, which is not part of Madera Subbasin)	134,139
City of Madera GSA**	10,106
Root Creek WD GSA**	9,276
Gravelly Ford WD GSA**	8,379
New Stone WD GSA**	4,182
Madera WD GSA**	3,744
Total GSA Area	346,579

Notes:
*Delineations obtained from DWR projected in NAD83 Teale Albers.
**Denotes GSA's for which the "exclusive" shapefiles were used from the DWR SGMA Portal.

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LUHDORFF & SCALMANINI CONSULTING ENGINEERS

FIGURE ES-1

Madera Subbasin Map

Madera County - Madera Subbasin
SGMA Data Collection and Analysis

2.2 Water Resources Monitoring and Management Programs

2.2.1 Monitoring and Management Programs

Regulation Requirements:

§354.8(c) Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan.

Groundwater Level Monitoring

California State Groundwater Elevation Monitoring Program (CASGEM)

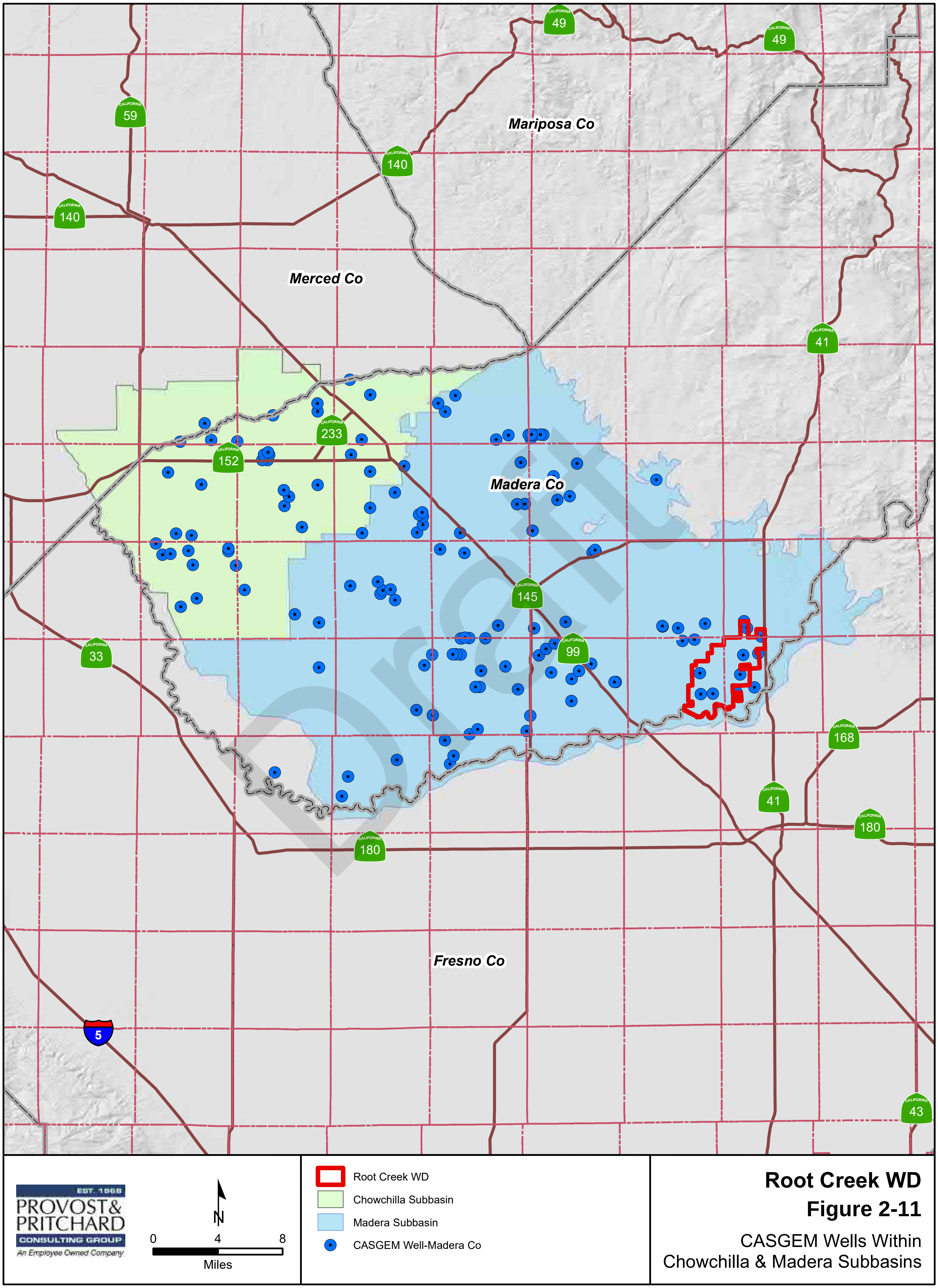
CASGEM began in 2009 as a voluntary program to track seasonal and long-term groundwater elevation trends. In 2010, DWR approved the Madera-Chowchilla Basin Groundwater Monitoring Group as a local monitoring entity. As part of this group, RCWD helped to establish a regional monitoring network and will submit groundwater level data each spring and fall to DWR through the CASGEM program. The total monitoring area covers 789 square miles and includes all the Madera Subbasin and most of the Chowchilla Subbasin as shown in **Figure 2-11**. The nine wells RCWD monitors for CASGEM are included as part of the local network monitored for District uses. Some of these wells have groundwater level data dating back to the 1970s.

In addition, Davids Engineering in their Data Collection and Analysis Technical Memorandum (2017) suggested additional dedicated monitor wells sites in the basin identified on **Figure 2-12**. None were suggested in the area of RCWD.

District-wide Groundwater Level Monitoring

According to the 2012 GMP, RCWD has monitored spring and fall groundwater levels since 1998 in about 23 wells. The data obtained in the spring reflects the "seasonal high" water table, as the measurements are made prior to pumping for irrigation, and the fall measurements are taken after a full season of crop irrigation pumping. RCWD also collects some groundwater level data just outside the District to better understand groundwater conditions on its borders. The District uses this data to generate semi-annual groundwater contour maps that show water table elevation over distance and estimate direction of water movement. Future efforts will include utilization of data from others on the borders of the District and estimating change in groundwater storage to evaluate the benefits of future surface water imports.

RCWD will continue district-wide groundwater level monitoring throughout the planning and implementation phase of the Plan. Current and historical groundwater elevation data will be presented in Section 3.2.1 including contour maps and hydrographs. It is the intention of RCWD to continue using wells with historical data for the monitoring network. For information on the chosen monitoring network for future data collection, refer to Chapter 5.

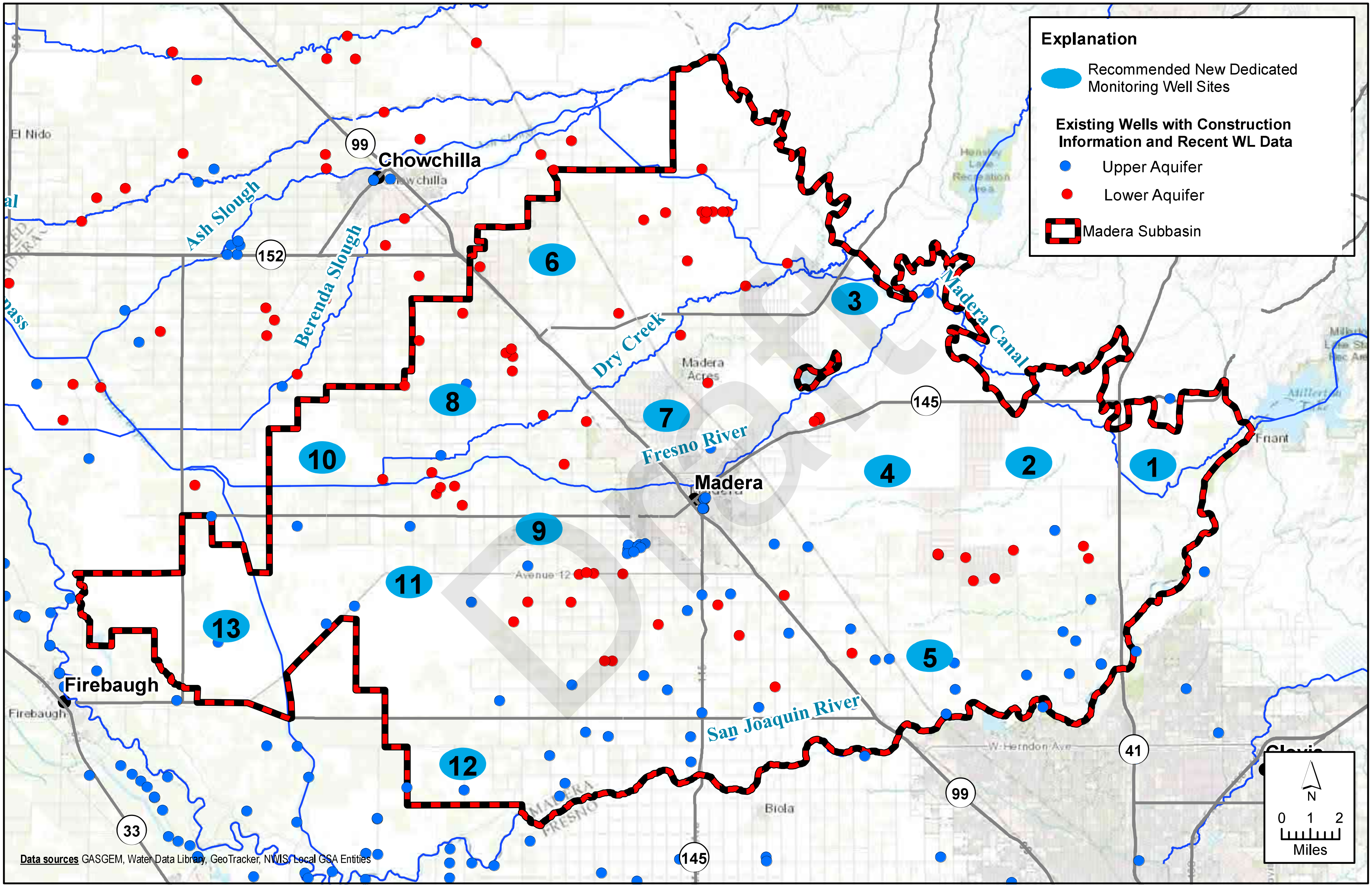


Root Creek WD
Figure 2-11

CASGEM Wells Within
Chowchilla & Madera Subbasins

5/13/2019: G:\Root Creek WD-1249\Projects\124917002-GMP Update like GSP\GIS\Map\Report\Gen\CASGEM_Wells_Subbasins.mxd

Figure 2-12



X:\2016\16-119 Madera Co. - Chowchilla & Madera Subbasins SGMA Support\GIS\Maps\FinalMapsForTM\Madera Subbasin\Figure 5-5 update.mxd

DAVIDS ENGINEERING, INC

LUHDORFF & SCALMANINI CONSULTING ENGINEERS

FIGURE ES-2

Preliminary Recommendations for New Dedicated Monitoring Well Sites

Madera County: Madera Subbasin
SGMA Data Collection and Analysis

Groundwater Quality Monitoring

Groundwater quality monitoring is an important aspect of groundwater management basin wide. Prior to the beginning of the Riverstone development, RCWD was entirely made up of agricultural lands with private irrigation and domestic wells, which do not require monitoring. However, at build-out, Riverstone will include numerous connections to the water supply, requiring consistent water quality monitoring. Monitoring groundwater quality serves the following purposes:

1. Allows for spatial characterization of water quality according to soil types, soil salinity, geology, surface water quality, depth, and land use
2. Allows for comparison of constituent levels at a specific well over time (i.e., years and decades)
3. Determine the extent of groundwater quality problems in specific areas
4. Identify groundwater quality protection and enhancement needs
5. Determine water treatment needs
6. Identify impacts of recharge and surface water use on water quality
7. Identify suitable crop types that are compatible with the water characteristics
8. Monitor the migration of contaminant plumes

Water quality monitoring and data for the basin are documented in a number of recent investigations. Included herein are discussions of the existing groundwater quality monitoring programs and reports documenting water quality data.

<u>Data Collection and Analysis Report on Madera Subbasin</u>
Included in this technical memorandum are descriptions and summaries of current groundwater quality conditions gathered from various data sources and reports. Data and mapping of total dissolved solids (TDS) was done by the regional CV-SALTS project. Luhdorf & Scalmanini (LSCE) conducted groundwater quality mapping for the San Joaquin Valley including constituents such as TDS, nitrate, arsenic, vanadium, uranium, DBCP/fumigants, herbicides, solvents, and perchlorate (Davids & LSCE, 2017). The Regional Groundwater Management Plan (Provost & Pritchard, 2014) summarizes quality conditions in the subbasin as generally good and describes sources of water quality data.

<u>Irrigated Lands Regulatory Program</u>
Pollutants, such as fertilizers and salts, from runoff of irrigated lands can migrate into groundwater over time. At high enough concentrations, these pollutants can make water unusable for drinking or agricultural uses. The Irrigated Lands Regulatory Program (ILRP) was initiated in 2003 to prevent agricultural runoff from impairing surface waters, and in 2012, groundwater regulations were added to the program. Waste discharge requirements (WDRs), which protect both surface water and groundwater, address irrigated agricultural discharges throughout the Central Valley.

RCWD is located within the East San Joaquin Water Quality Coalition (the Coalition or ESJWQC) boundary. The Coalition is a group of agricultural interests and growers formed to represent all “dischargers” who own or operate irrigated lands east of the San Joaquin River within Madera, Merced, Stanislaus, Tuolumne, and Mariposa Counties and portions of Calaveras County. The ESJWQC has been approved by the Executive Officer of the Central Valley Regional Water Quality Control Board (CVRWQCB) to serve as a third-party group to conduct water quality monitoring and reporting on behalf of its enrolled grower members to meet requirements of ILRP. In fulfillment of required reports and monitoring, the ESJWQC completed a Groundwater Assessment Report, which evaluated readily available groundwater quality data and assessed areas within the Coalition boundary with increased potential to influence groundwater quality.

The Coalition has collected surface water quality data since 2004 and more recently began collecting groundwater quality data as part of a long-term trend monitoring program. This information is summarized annually and submitted to the CVRWQCB in compliance with requirements of the ILRP.

District Monitoring

RCWD performed extensive groundwater quality testing in 2003 (KDSA, 2003) as part of a Local Groundwater Assistance Grant from DWR. The District measures electrical conductivity in monitoring wells each year and will periodically perform detailed testing to verify that the water quality is not degrading. Groundwater monitoring is described in the RCWD GMP and in the Madera Integrated Regional Groundwater Management Plan (Provost & Pritchard, 2014). The testing concluded that the water quality is acceptable for agriculture with a few exceptions in limited areas. The locations of tested wells are mapped on **Figure 2-13** and the data is presented in **Table 2-3**.

Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)

In 2006, the Central Valley Water Board, the State Water Board, and stakeholders began a joint effort to address salinity and nitrate problems in the Central Valley. The resulting program, known as the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS), is a collaborative basin planning effort aimed at developing and implementing a comprehensive salinity and nitrate management program. The goal of CV-SALTS is to maintain a healthy environment and a good quality of life for all Californians by protecting water.

The Central Valley Salinity Coalition (CVSC) was formed in 2008 to represent stakeholder groups working with the RWQCB on the CV-SALTS effort. CVSC coordinates the meetings of the CV-SALTS committees, maintains an independent web site, and manages the projects originating from this effort. Information and materials regarding the stakeholder committees and other activity, including the meeting schedule, are posted on their website: www.cvsalinity.org.

In January 2017, CV-SALTS developed and submitted a Central Valley-wide Salt and Nitrate Management Plan (SNMP) to the RWQCB. In March 2017, the RWQCB adopted a resolution accepting the SNMP and directing RWQCB staff to initiate Basin Plan Amendments to incorporate recommendations from the SNMP into the Basin Plans. The basin plan amendment is currently going through the State Water Resources Control Board adoption process and will be followed with the California Office of Administrative Law (OAL) and U.S. Environmental Protection Agency (EPA) (as appropriate) adoption processes.

At the time of writing, the CV-SALTS Groundwater Monitoring Program has yet to be established; however, Resolution R5-2018-0034 indicates that the Groundwater Monitoring Program will need to include an approach to assess ambient water quality conditions and water quality trends for TDS/EC and Nitrate as Nitrogen in the Upper, Lower and Production Zones for each groundwater basin/subbasin included in the Groundwater Monitoring Program. Note that IRLP Trend Monitoring is only for the upper groundwater zone.

Landowner Monitoring

Many landowners test the water quality of their domestic and irrigation wells on a regular basis. Some landowners may provide the test results to RCWD; however, the results are proprietary, and the landowners may ask that RCWD use the data for its information only and not release it to the public.

Other Agency Monitoring

Numerous other agencies have important roles in the monitoring and mitigation of groundwater quality. These agencies include the Regional Water Quality Control Board, Environmental Protection Agency, Department of Toxic Substances Control, Madera County, USGS, and State Water Resources Control Board. RCWD intends to review pertinent water quality data published by these agencies.

Data collected from each of the agencies and current programs listed above are discussed in further detail in the Groundwater Conditions section of Chapter 3.

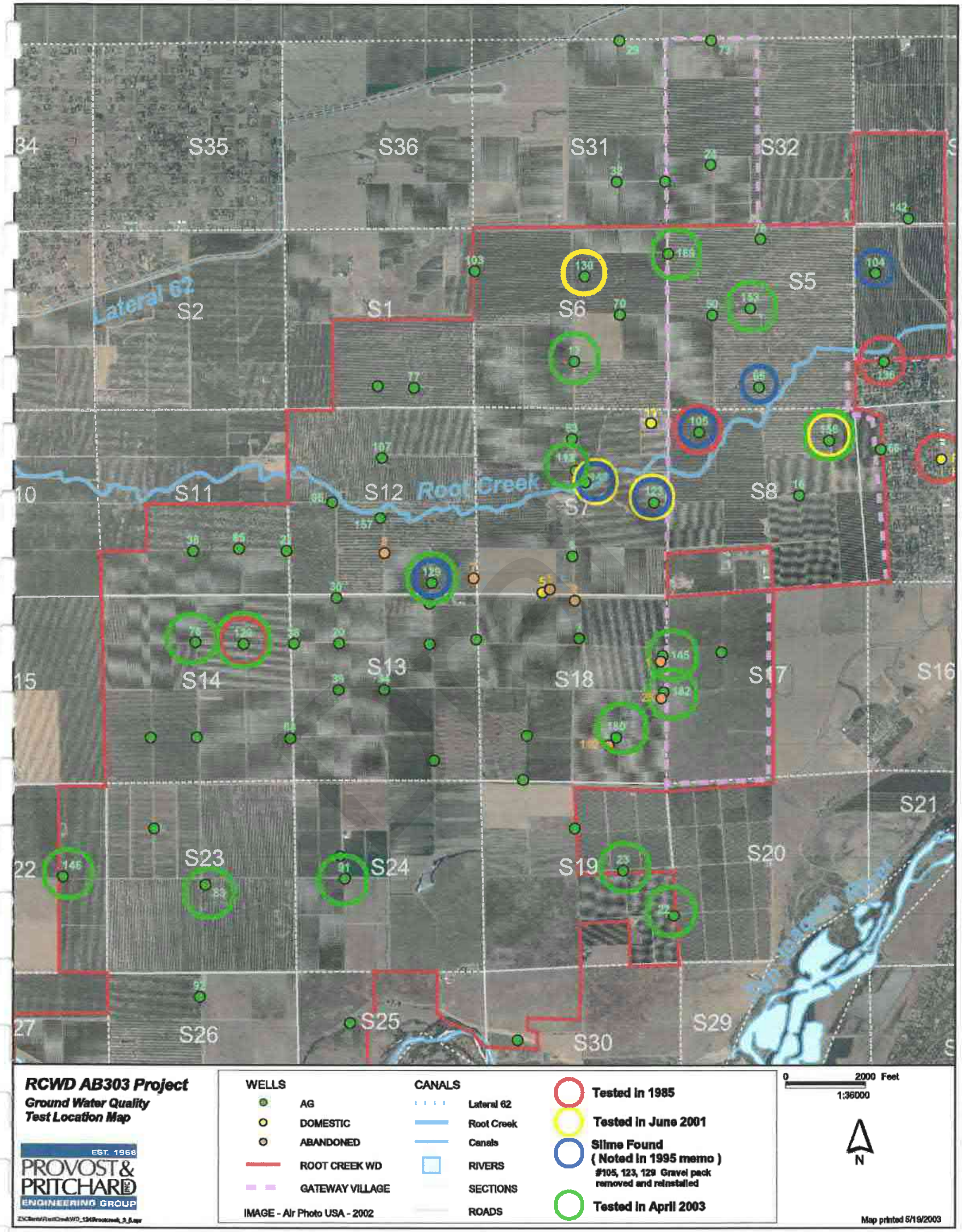

RCWD AB303 Project
Ground Water Quality
Test Location Map
EST. 1968
PROVOST & PRITCHARD
ENGINEERING GROUP
WELLS
AG
DOMESTIC
ABANDONED
ROOT CREEK WD
GATEWAY VILLAGE
IMAGE - Air Photo USA - 2002
CANALS
Lateral 62
Root Creek
Canals
RIVERS
SECTIONS
ROADS
Tested in 1985
Tested in June 2001
Slime Found
(Noted in 1995 memo)
#105, 123, 129 Gravel pack removed and reinstalled
Tested in April 2003
0
2000 Feet
1:36000
N
Map printed 5/19/2003
Lateral 62
Root Creek
S35
S36
S31
S32
S2
S1
S6
S5
S11
S12
S7
S8
S14
S13
S18
S17
S16
S21
S23
S24
S19
S20
S26
S25
S30
S29

Figure 2-13

Table 1 - Chemical Quality Samples of Wells in Root Creek Water District

	S&J Ranch Well Number																
	17	22	76	83	91	113	120	129	145	146	153 [1]	153-2 [1]	156	169 [2]	169-2 [2]	180	182
Calcium (mg/L)	17	19	18	20	14	10	17	38	13	10		26	22		42	16	14
Magnesium (mg/L)	6	6	7	9	6	4	8	12	6	5		9	8		14	4	3
Potassium (mg/L)	4	3	5	5	6	5	6	6	5	4		7	3		7	4	2
Sodium (mg/L)	22	13	20	20	27	15	20	102	20	12		35	34		42	47	65
Carbonate (mg/L)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10		<10	<10		<10	<10	<10
Bicarbonate (mg/L)	120	120	70	150	130	60	80	170	100	70		120	160		140	170	190
Sulfate (mg/L)	2	3	3	6	3	3	3	<1	4	3		14	8		8	2	<1
Chloride (mg/L)	20	5	38	8	15	10	35	172	11	9		52	22		106	22	31
Nitrate (mg/L)	3	3.8	25.6	11	3.8	22.1	21.8	1.3	10.1	9.5		5.8	<0.4		4.6	0.9	<0.4
Fluoride (mg/L)	0.2	<0.1	<0.5	<0.5	<0.5	0.2	<0.5	<0.1	0.2	<0.5		0.2	<0.1		<0.1	<0.1	<0.1
Boron (mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	<0.05		<0.05	<0.05	<0.05
Iron (mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	<0.05		<0.05	<0.05	0.1
Manganese (mg/L)	0.51	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.3	<0.01	<0.01		<0.01	0.63		<0.01	<0.01	0.16
pH	6.7	6.9	6.7	7.1	7.2	7	6.6	7.1	6.8	7.6		6.8	7.2		6.9	7.3	7.5
Electrical Conductivity @25°C (umhos/cm)	256	217	280	282	261	184	278	807	220	168		395	342		587	326	374
SAR	1.2	0.7	1	0.9	1.5	1	1	3.7	1.2	0.8		1.5	1.6		1.4	2.7	4.1
TDS by summation (mg/L)	190	170	190	230	200	130	190	500	170	120		270	260		360	270	300
Arsenic (ug/L)	13	<2	<2	<2	<2	2	2	59	<2	<2		5	32		4	21	109
Alpha (pCi/L)	0.5	4.9	1.0	1.0	0.8	5.0	0.0	3.0	0.4	3.0		1.2	6.4		2.3	1.9	0.4
HPC (CFU/ml)	10	10	9	11	2	11	12	160	4	7	16	6	17	900	820	11	9
DBCP (ug/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01	<0.01	<0.01
EDB (ug/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01	<0.01	<0.01
Upper Perf. Depth (ft)	**200**		**232**	**240**	**240**	**240**	**260**	**280**	**224**	**240**		**462**	**374**		**450**	**340**	**414**
Lower Perf. Depth (ft)	**380**		**628**	**492**	**414**	**492**	**600**	**810**	**444**	**472**		**730**	**796**		**780**	**485**	**772**
Date Sample Collected	04/08/03	04/10/03	04/08/03	04/08/03	04/08/03	04/10/03	04/08/03	04/10/03	04/08/03	04/10/03	04/07/03	04/10/03	04/10/03	04/07/03	04/08/03	04/08/03	04/10/03

Notes:
(1) #153 and #153-2 are for the same well. #153 was collected during first 15 minutes of operation after being shutdown, #153-2 was collected after well had been pumping for more than one day
(2) #169 and #169-2 are for the same well. #169 was collected during first 15 minutes of operation after being shutdown, #169-2 was collected after well had been pumping for more than one day
(3) Inorganic constituents and alpha activity analysis by FGL Environment of Santa Paula
(4) DBCP and EDB analysis by Appl, Inc. of Fresno
(5) HPC analysis by Twining Laboratories, Inc. of Fresno

Land Surface Subsidence Monitoring

Historically, the District itself has not monitored for land subsidence, however data is available from National Aeronautics and Space Administration (NASA) and United States Geological Survey (USGS). USGS and NASA have maps on their websites that show the subsidence for a defined time period. RCWD stated in their 2012 GMP that staff and landowners have not observed obvious signs of subsidence to irrigation facilities.

Surface Water Monitoring

Surface water monitoring for the basin is shown on **Figure 2-14**, which comes from Davids Draft Preliminary Basin Boundary Water Budget dated February 2018. Surface water sources in RCWD include Root Creek, the San Joaquin River, and surface water deliveries through Lateral 6.2 (owned by MID) and the RCWD conveyance pipeline, which can be seen on **Figure 2-7**.

Root Creek. Root Creek is a small intermittent stream that flows east to west through the northern portion of RCWD. Stream flow does not always occur in a defined stream bed and, in some portions, the stream has been altered or directed by people. The USGS estimates 1,500 AF of runoff per year for the whole watershed. Flows tend to come in the winter over short time periods when irrigation water demands are low. As a result, the creek waters are not used as a water supply; therefore, RCWD does not monitor creek flows or water quality.

San Joaquin River. San Joaquin River water is stored in Millerton Lake and impounded by Friant Dam. USBR operates Friant Dam and monitors water releases, reservoir levels, and water quality. Some riparian landowners in RCWD have various appurtenant water rights through holding contracts on the San Joaquin River. These landowners can take as much San Joaquin River water as they can beneficially use on the property with the appurtenant rights. In many cases, data on surface water diversions by landowners with holding contracts is difficult to obtain. The San Joaquin River Restoration Program has piezometers for collecting data on the connectedness of the surface water and groundwater systems. RCWD anticipates analyzing this data during the planning and implementation period as part of the monitoring network, discussed further in Chapter 5.

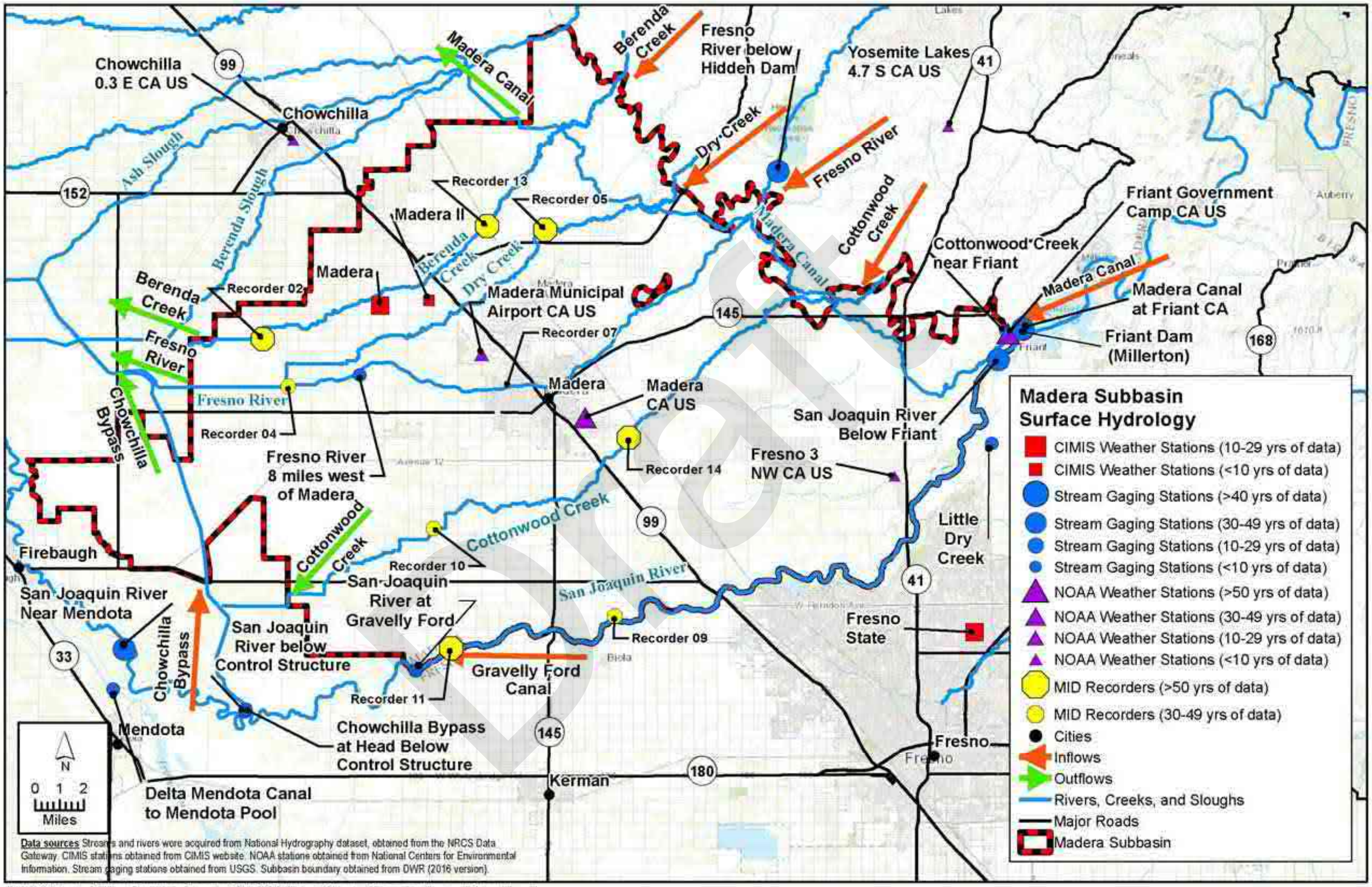
Surface Water Quality. Individual RCWD landowners participate in the ESJWQC, under ILRP. The goals of the coalition include:

1) Filing the required reports with the CVRWQCB to provide conditional waiver coverage for members of the coalition
2) Developing and implementing an economical and scientifically valid water monitoring program for area rivers and agricultural drains (as required by the waiver)
3) Spreading costs equitably among farm landowners/operators who are coalition members
4) Communicating to landowners where water monitoring indicates problems and working to solve those problems

GSP Monitoring and Management Plans

RCWDGSA will be responsible for collecting data or using existing programs to monitor the various groundwater conditions. The monitoring network and its goals are described in detail in Chapter 5 of this Plan.

DRAFT PRELIMINARY ANALYSES AND RESULTS TO BE REFINED DURING GSP DEVELOPMENT.



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Preliminary Madera Subbasin Inflows and Outflows

Figure 2-14

2.2.2 Impacts to Operational Flexibility

Regulation Requirements:

§354.8(d) A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.

The development of relationships between RCWD, various regulatory agencies, and other local water agencies is an important part of an effective groundwater sustainability plan. The Madera groundwater subbasin extends beyond many political boundaries and includes other municipalities, irrigation districts, water districts, private water companies, and private water users. This emphasizes the importance of inter-agency cooperation, and the District has historically made efforts to work conjunctively with many other regulatory agencies. Due to the various agencies and programs, several existing water management constraints impact the operational flexibility of this plan. These programs are described below including possible measures to adapt to them.

Contaminant Plumes

Groundwater within RCWD is generally of good quality. The GSA has not developed an in-depth accounting of the water quality issues but continues to acquire and review information on water quality. The USGS from 2005 to 2006 performed their Groundwater Ambient Monitoring and Assessment (GAMA) program which undertook investigation to characterize the groundwater condition in the Southeast San Joaquin Valley (Burton et al., 2012). There are no known contaminant plumes in the area currently; however, should one be discovered or created, the monitoring and management of the plume may impact the operational flexibility of this plan in the following ways:

1. New wells may not be installed in specific areas because they may capture contaminated water or cause a plume to migrate.
2. Some existing wells may not be used and may either be abandoned or placed on standby.
3. Groundwater recharge basins may not be constructed in specific areas because they may cause a plume to migrate.
4. Wellhead treatment may be required at some wells, thus increasing the cost to produce water. These wells are often put on stand-by and only used to help meet peak demands.

Flood Control Operational Limitations

Storm facilities have been included in the Riverstone design plans prior to construction of the development in the northeast portion of the GSA. Root Creek Water District is currently planning an off-stream recharge facility that would take peak flows from Root Creek, providing a flood protection benefit (Provost & Pritchard, 2014). This may improve operational flexibility if recharge of groundwater occurs.

The monitoring and management of the Friant Dam may affect the operational flexibility of the groundwater pumping in the District due to changes in volume of surface water supplies. In wet water years, based on river hydrology, the USBR will release more water making Section 215 flows (flood water) available. When this occurs, it is possible for RCWD to redirect some of the flow into the District for recharge or irrigation purposes. This situation also increases the likelihood that MID water demands will be met and exceeded by water supply, thus offering RCWD the ability to purchase excess water.

San Joaquin River Restoration Program

In 2006, after an 18-year court session, the Friant CVP contractors entered into the San Joaquin River Restoration (SJRR) settlement agreement. The agreement increases flows to the River to benefit fisheries resulting in a significant reduction in water deliveries to the Friant Contractors.

The San Joaquin River Restoration Program (SJRRP) is currently in the development phase. The SJRRP Revised Framework for Implementation (USBR, 2015) estimates full restoration flows will begin between 2025 and 2029. Restoration water supply impacts to the Friant contractors were estimated by Provost & Pritchard (2009) including a water delivery impact to Madera ID as a reduction of about 27,500 AF annually. However, the impacts are not expected to be fully realized until 2025 or later. That being said, in a critically dry year, it is not required that restoration flows occur in the River.

Several mitigation programs were established as part of the restoration settlement, intended to partially reduce the water supply impacts from the river restoration program, and include the following:

1. Recirculated Water: Some restoration flows could be recaptured in the Lower San Joaquin River or Delta for use by the Friant Contractors. These waters will either be sold, exchanged for other water supplies, or, when feasible, delivered directly back to some Friant contractors.
2. Part 3 Water (formerly Title 3 or T3 water): Part 3 water is generated out of the facilities and programs built to increase groundwater recharge and recovery using the funds authorized as part of Title III of the San Joaquin River Restoration Act.
3. 16(b) Water (also known as $10 water): This program allows the impacted parties to buy floodwater at $10/AF to the extent they have been impacted. This is less than the cost of purchasing other floodwaters from the San Joaquin River.
4. Unreleased Restoration Flows: Designated restoration flows that are not used will be sold to the Friant contractors, who can use them directly for irrigation or domestic use. Restoration flows may not be used for a variety of reasons, including operational limitations, flood control releases, facility maintenance and construction, etc.

The Friant contractors have no control over the implementation of the SJRRP; however, they can use the mitigation programs as much as feasible. These programs will only partially compensate for the water losses, so Friant contractors may attempt to develop new water supplies through water transfers, recharge, recycling, reuse, and conservation to make up for the reduced water deliveries. The construction of new storage projects, including the Temperance Flat reservoir on the Upper San Joaquin River, can help to mitigate the impacts of the river restoration and restore some operational flexibility.

2.2.3 Conjunctive Use Programs

Regulation Requirements:

§354.8(e) A description of conjunctive use programs in the basin.

Conjunctive use is the coordinated and planned management of both surface and groundwater resources to maximize efficient use. Conjunctive use is a strategy to improve water supply reliability and environmental conditions, reduce groundwater overdraft and land subsidence, and protect water quality. It includes balancing the use of surface water, when it is available, with the use of groundwater in order to sustainably meet the needs of all beneficial users. Conjunctive use also includes cyclic storage where surplus surface waters are recharged during wet years to offset the groundwater pumped during dry periods. This strategy should include a robust monitoring program to help prevent negative impacts and verify the quantity of water in storage.

The RCWD GMP (Provost & Pritchard, 2012) stated that the District (at that time) needed to develop additional storage and extraction facilities before they could implement a conjunctive use program. The program focused on developing infrastructure to bring in more surface water supplies for irrigation purposes. Due to direct use of surface water supplies, groundwater pumping should be offset in an equivalent amount, which is retained in the aquifer for a drier year. It should be noted that the Madera and Chowchilla Subbasins implement conjunctive use, meaning groundwater and surface water are used collectively for municipal and agricultural purposes. The groundwater basin is essentially a storage reservoir. During wet years, less groundwater pumping is required and recharge is practiced so that excess surface water supplies can be added to below-ground storage. In dry years, less surface water is available, more groundwater is pumped to meet demands, and groundwater levels decline. Because of this variable use, it is expected that water levels will rise and fall, but in a balanced groundwater basin those levels will be relatively stable over a longer period (P&P, 2014).

2.3 Relation to General Plans

2.3.1 Summary of General Plans/Other Land Use Plans

Regulation Requirements:

§354.8(f) A plain language description of the land use elements or topic categories of applicable general plans that include the following: 1) A summary of general plans and other land use plans governing the basin.

California Government Code (§65350-65362) requires that each county and city in the state develop and adopt a general plan. Land use planning activities in unincorporated areas of Madera County are performed by the County of Madera's Planning Department and are overseen by the Madera County Planning Commission. The General Plan is a comprehensive long-term plan for the physical development of the county or city. In this sense, it is a "blueprint" for development. RCWD does not have land use planning authority; therefore, regional and local land use planning activities will remain with the appropriate agencies. However, when appropriate, RCWD will comment on proposed land use plans that may impact the local groundwater quantity or quality.

A General Plan must contain seven state-mandated elements along with any other elements that the legislative body of the county or city wishes to adopt. The seven mandated elements are: Land Use, Open Space, Conservation, Housing, Circulation, Noise, and Safety. The General Plan may be adopted in any form deemed appropriate or convenient by the legislative body of the county or city, including the combining of elements. The General Plan document materials for Madera County can be accessed by element at the following web page:

https://www.maderacounty.com/government/community-economic-development-department/divisions/planning-division/planning-forms-and-documents/-folder-269

The General Plan Policy Document for Madera County was adopted October 24, 1995. Other elements and updates or amendments have been added since then.

Specific Plan:

Approved in 2002, General Plan Amendment 96-07 (GP# 96-07) approved the Gateway Village Area Plan and designated Gateway Village as a "new growth area." It comprehensively converted the general plan land uses from primarily agricultural land uses to urban uses including residential, commercial, employment center, and parks and public uses (see **Figure 2-15)**. An EIR (SCH No. 96062020) was certified for the Area Plan in 2002 and contained mitigation measures that were included in a Mitigation Monitoring Program.

Section 65450 et seq. of the Government Code sets forth basic requirements and provision for specific plans. The Government Code states:

"After the legislative body has adopted a general plan, the planning agency may, or if so directed by the legislative body, shall prepare specific plans for the systematic implementation of the general plan for all or part of the area covered by the general plan."

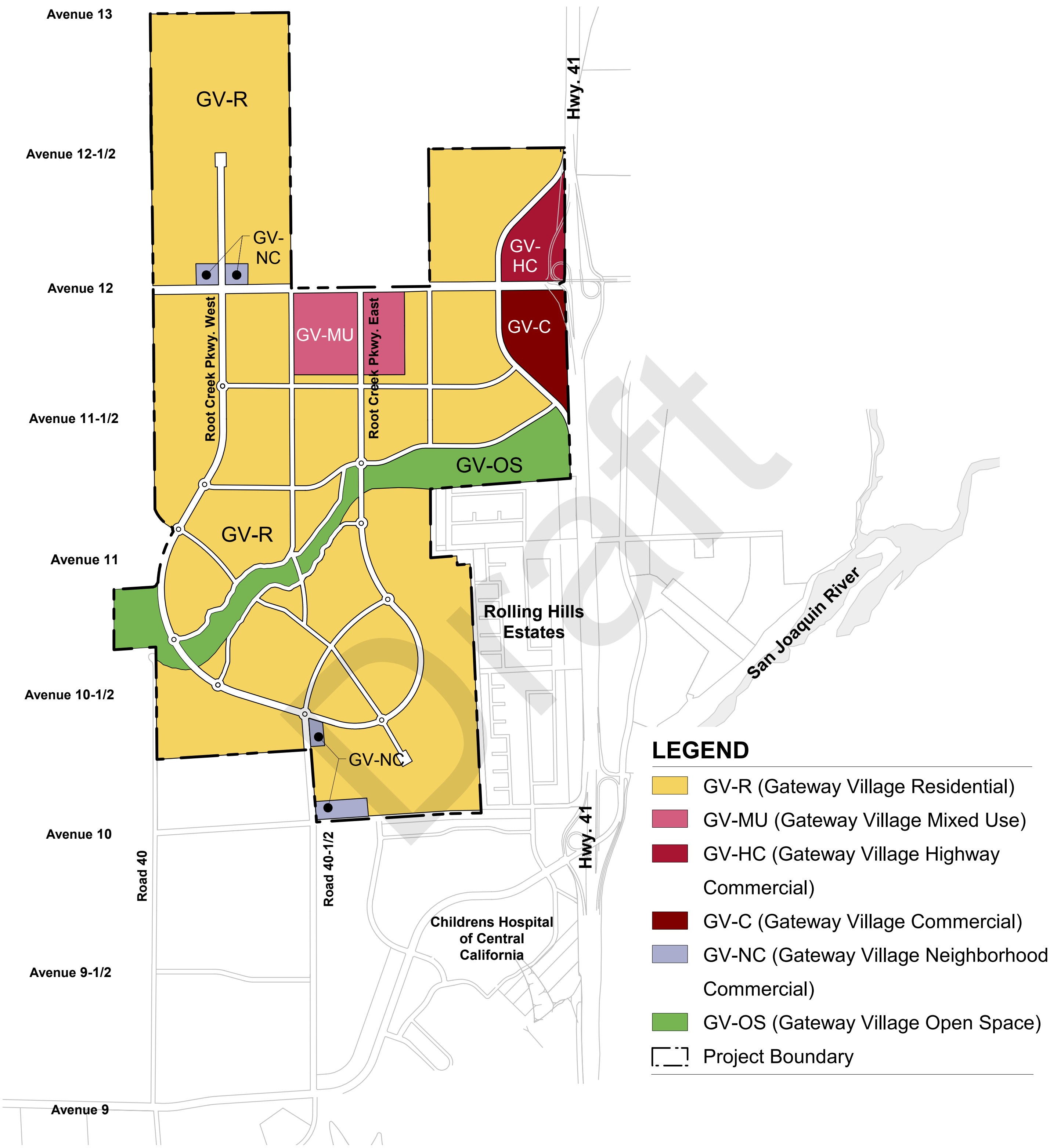
Section 65451 of the Government Code requires that specific plans include text and a diagram or diagrams that specify all of the following:

- The distribution, location, and the extent of the uses of land, including open space within the area covered by the plan.
- The proposed distribution, location, and extent and intensity of major components of public and private transportation, sewage, water, drainage, solid waste disposal, energy, and other essential facilities proposed to be located within the area covered by the plan and needed to support the land uses described in the plan.
- Standards and criteria by which development will proceed, and standards for the conservation, development, and utilization of natural resources, where applicable.
- A program of implementation measures including regulations, programs, public works projects, and financing measures necessary to carry out the project.
- A statement of the relationship of the specific plan to the general plan.

The Gateway Village Specific Plan is designed to meet the requirements of the State of California Government Code and the Madera County General Plan.

The Gateway Village Specific Plan includes land use regulations, development standards, and design guidelines to provide the framework for a high-quality, master planned community. The purpose of the Gateway Village Specific Plan is:

- To implement the concurrent General Plan amendment;
- To implement the goals and policies of the Madera County General Plans;
- To establish a land use plan and design principles for the plan area;
- To implement zoning for the plan area that distinguish it as a unique community in Madera County;
- To serve as a guideline for the amenities provided and the quality of development within the Specific Plan area; and
- To ensure that the area develops in a comprehensive and coordinated fashion with adequate consideration of infrastructure, services, public safety, site and resource management, and project financing.



not to scale

Zoning Map

Gateway Village Specific Plan

2.1

2.3.2 Impact of the Madera General Plan on Water Demands

Regulation Requirements:

§354.8(f) (2) A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects.

The Madera County General Plan consists of two documents: *Background Repor*t and the *Policy Document*. In addition, the adopted Housing Element addresses housing issues on a countywide basis. The Background Report inventories and analyzes existing conditions and trends in Madera County. It provides the formal supporting documentation for general plan policy, addressing ten subject areas: land use; population; economic conditions and fiscal considerations; transportation and circulation; public facilities; public services; recreational and cultural resources; natural resources; safety; and noise.

The Madera County General Plan was adopted prior to the development of the GSA and the SGMA; however, updates have been made since then, and land use in the RCWD area is projected to change. The land use plan makes assumptions for urban development, and this GSP uses the same land use change assumptions identified in the general plans for forecasting the anticipated water budget, described later in this GSP.

The Riverstone development is a medium density residential community planned to cover about 2,000 acres in the northeast corner of RCWD. The water demand of the community will be replacing the water demand of agricultural land including pistachios, olives, citrus, and almonds. Therefore, water quantity demand will remain relatively equal or less. In addition, the Riverstone development is committed to helping the District mitigate the groundwater overdraft by assisting with the construction of recharge facilities. Any new land use changes would most likely be the conversion of agriculture to residential areas. With that in mind, it is required that new developments with more than 500 dwelling units must prepare a water supply assessment proving the sufficiency of water supply sources (SB 610, Water Code Section 10910). Hence, the Madera General Plan should have little to no effect on the ability of the RCWDGSA to achieve sustainable groundwater management in accordance with SGMA.

2.3.3 Impact of GSP on Land Use Plan Assumptions

Regulation Requirements:

§354.8(f) (3) A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.

Several Madera County General Plan sections that cover water supply are summarized below. As noted, Madera County General the Plan was developed prior to the development of the GSP.

The Public Facilities and Services, Section 3 of the Madera County General Plan, discuss various topics including water supply and delivery in Section 3.C. The primary goal in this Section is to ensure the availability of an adequate (i.e., sustainable) and safe water supply and the maintenance of high-quality water in water bodies and aquifers used as sources of domestic and agricultural water supply. The relevant policies for domestic supply (some of which are also agriculture water supply policies) are listed below:

- PF Policy 3.C.1 - The County shall approve new development only if an adequate water supply to serve such development is demonstrated.

- PF Policy 3.C.3 - The County shall limit development in areas identified as having severe water table depression to uses that do not have high water usage or to uses served by a surface water supply.
- PF Policy 3.C.7 - The County shall promote the use of reclaimed wastewater to offset the demand for new water supplies.
- PF Policy 3.C.8 - The County shall support opportunities for groundwater users in problem areas to convert to surface water supplies.
- PF Policy 3.C.9 **-** The County shall promote the use of surface water for agricultural use to reduce groundwater table reductions.

This Plan intends to support the assumptions and policies made in the Madera County General Plan by encouraging surface water use whenever available and planning for the use of recharge facilities. Implementation of this Plan means supporting conjunctive water use by increasing surface water supplies and using groundwater when necessary. Wastewater from the treatment plant may be used for recharging the groundwater system, which would affect the assumption of recycled use. The water would not be reused directly; however, recharged wastewater will still help maintain water levels. Since development of the GSP followed development of the Madera County General Plan, most land use assumptions and future water demand assumptions for the GSP align with, and therefore do not have a large effect on the water supply assumptions listed above.

2.3.4 Permitting New or Replacement Wells

Regulation Requirements:

§354.8(f) (4) A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.

The RCWD GMP (P&P, 2012) identifies in Section 8 (Groundwater Operations) well construction policies (Sec. 8.1). Permitting of new or replacement wells is managed by the Madera County Community and Economic Development, Environmental Health Division. Madera County adheres to state requirements for the construction of new or replacement wells and, in addition, adopted Ordinance No. 674 requiring that all new or replacement wells must be equipped with a flow meter and a sounding tube. The ordinances require a water flow meter and water level meter permit be submitted and approved by Public Works prior to equipping the well. The County Water Well Program details and permit applications can be reviewed at:

https://www.maderacounty.com/government/community-economic-development-department/divisions/environmental-health-division/water-well-program

In January of 2015, the County adopted the ordinance regarding flow meters on new or rehabilitated wells and the requirements for those meters, adding two new chapters to the Madera County Code:

- 13.101—Installation of Water Flow Meters and Water Level Meters Regulations
- 13.28—Standards of Water Meters and Measuring Devices

The RCWD, on September 20, 2017, adopted the Agriculture Water Flow Meter and Water Level Measurement Policy that was structured on the County's ordinance and requires all wells within the District to be outfitted with a measurement device and sounding tube. It further recognizes that groundwater pumping quantities will be based upon metered well pumping records. Should a meter not be available, it recognizes that energy use will be used to estimate pumping and, absent either type of information, cropping records will be used to estimate groundwater pumping. A copy of the policy can be found in **Appendix 2-A**

2.3.5 Land Use Plans Outside the Basin

Regulation Requirements:

§354.8(f) (5) To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.

The County General Plan was amended in 2008 to include a Dairy Element. Key issues to siting a new dairy would include potential impacts to groundwater and surface water quality from the dairy effluent. Chapter 3 of the Dairy Element discusses goals, policies, and programs for new and existing dairies, which include buffer zones between developed or development areas, avoiding flood zones and wetlands as well as high groundwater areas, etc. The County requires submittal of technical reports for new or expanding dairy operations for review and approval that environmental and other concerns are met or mitigated.

Plan Developments
Besides the Madera Ranchos, several residential plan developments exist around RCWDGSA. Area plans include Liberty Groves, Rio Mesa (Tesoro Viejo and Northshore at Millerton Lake), Gunner Ranch, Riverstone, and Southeast Madera County Area Plans. All developments will have to meet or exceed water requirements of the General Plan for their planned or existing populations. There are no known land use plans that will impede the ability of RCWD to achieve sustainable groundwater management.

2.4 Additional GSP Components

Regulation Requirements:

§354.8(g) A description of any of the additional Plan elements included in the Water Code Section 10727.4 that the Agency determines to be appropriate.

2.4.1 Saline Water Intrusion

Saline (or brackish) water intrusion is the induced migration of saline water into a freshwater aquifer system. Saline water intrusion is typically observed in coastal aquifers where over pumping of the freshwater aquifer causes saltwater from the ocean to encroach inland, contaminating the fresh water aquifer. The distance of the GSA area from the Pacific Ocean negates the possibility of saltwater intrusion from the ocean into the freshwater aquifer.

However, groundwater with naturally occurring elevated concentrations of salts exists at deeper depths in the local aquifers. The base of freshwater, or the depth at which elevated specific conductance is encountered, has been characterized as the boundary where the concentration of specific conductance is over 3,000 µS/cm (Page, 1973). The base of freshwater varies throughout the GSP area and is discussed in detail in Section 3.1 – Hydrogeologic Conceptual Model. As wells are drilled deeper, pumping can cause upconing (i.e., upward vertical migration) of saline water thus increasing salinity in the freshwater aquifer. However, RCWD is not concerned about the potential of upconing since the bottom of the freshwater aquifer is mostly defined by the depth to bedrock within the RCWD area.

2.4.2 Wellhead Protection

A Wellhead Protection Area (WHPA) is defined by the Safe Drinking Water Act Amendment of 1986 as "the surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield." The WHPA may also be the recharge area that provides the water to a well or wellfield. Unlike surface watersheds that can be easily determined from topography, WHPAs can vary in size and shape depending on subsurface geologic conditions, the direction of groundwater flow, pumping rates, and aquifer characteristics.

The Federal Wellhead Protection Program was established by Section 1428 of the Safe Drinking Water Act Amendments of 1986. The purpose of the program is to protect groundwater sources of public drinking water supplies from contamination, thereby eliminating the need for costly treatment to meet drinking water standards. The program is based on the concept that the development and application of land use controls, usually applied at the local level, and other preventative measures can protect groundwater.

Under the Act, States are required to develop an EPA-approved Wellhead Protection Program. To date, California has no state-mandated program, but instead relies on local agencies to plan and implement programs. Wellhead Protection Programs are not regulatory in nature, nor do they address specific sources. They are designed to focus on the management of the resource rather than control a limited set of activities or contaminant sources.

Contaminants from the surface can enter an improperly designed or constructed well along the outside edge of the well casing or directly through openings in the wellhead. A well is also the direct supply source to the customer, and such contaminants entering the well could then be pumped out and discharged directly into the distribution system. Therefore, essential to any wellhead protection program are proper well design, construction, and site grading to prevent intrusion of contaminants into the well from surface sources.

Wellhead protection is performed primarily during design and can include requiring annular seals at the well surface, providing adequate drainage around wells, constructing wells at high locations, and avoiding well locations that may be subject to nearby contaminated flows. Wellhead protection is required for potable water supplies and is not generally required, but is still recommended, for agricultural wells.

Municipal and agricultural wells constructed in the RCWD are designed and constructed in accordance with DWR Bulletin 74-81 (1981) and 74-90 (1991). Also, a permit is needed from the County to construct a new well. In addition, the County requires landowners to follow the same standard for privately owned wells. DWR Bulletins 74-81 and 74-90 provide specifications pertaining to wellhead protection, including:

- Methods for sealing the well from intrusion of surface contaminants
- Covering or protecting the boring at the end of each day from potential pollution sources or vandalism
- Site grading to assure drainage is away from the wellhead

2.4.3 Migration of Contaminated Groundwater

Groundwater within the GSA Area is generally of good quality for agricultural use. However, serious water quality problems in certain areas of the subbasin exist due to high concentrations of certain constituents. Information on existing contaminant plumes is limited. However, some of the main constituents of concern in the County include nitrate, Dibromo-Chloropropane (DBCP), Ethylene-Dibromide (EDB), 1,2,3-Trichloropropane (TCP) and petroleum hydrocarbons. Contamination of groundwater can result in poor drinking water quality, loss of water supply, degraded surface water systems, high cleanup costs, high costs for alternative water supplies, and/or potential health problems. Several federal laws help protect groundwater quality.

In addition, several State of California online databases provide information and data on known groundwater contamination, planned and current corrective actions, investigations into groundwater contamination, and groundwater quality from select water supply and monitoring wells. These databases are discussed below:

California Water Resources Control Board: The State of California Water Resources Control Board (SWRCB) maintains an online database that identifies known contamination cleanup sites, known leaky underground storage tanks, and permitted underground storage tanks. The online database contains records of investigation and actions related to site cleanup activities at:

http://geotracker.waterboards.ca.gov.

The Department of Toxic Substances Control
The State of California Department of Toxic Substances Control (DTSC) provides an online database with access to detailed information on permitted hazardous waste sites, corrective action facilities, as well as existing site cleanup information. Information available through the online database includes investigation, cleanup, permitting, and/or corrective actions that are planned, being conducted, or have been completed under DTSC's oversight. The online database can be accessed at:

http://www.envirostor.dtsc.ca.gov.

Groundwater Ambient Monitoring and Assessment Program
The State Water Resources Control Board GAMA program collects data by testing untreated raw water for naturally occurring and man-made chemicals and compiles all of the data into a publicly accessible online database. The online database can be accessed at:

http://geotracker.waterboards.ca.gov/gama/

Currently, the District is not aware of contaminant plumes in the area. The District will regularly review groundwater quality data from other sources and remain alert to the possibility of contaminated groundwater migration into RCWD.

2.4.4 Well Abandonment/Well Destruction Program

Well abandonment generally includes properly capping and locking a well that has not been used in over a year. Well destruction includes completely filling in or removing portions of a well in accordance with standard procedures. Proper well destruction and abandonment are necessary to protect groundwater resources and public safety. Improperly abandoned or destroyed wells can provide a conduit for surface or near surface contaminants to reach the groundwater. In addition, undesired mixing of water with different chemical qualities from different strata can occur in improperly destroyed wells.

The administration of a well construction, abandonment, and destruction program has been delegated to the Counties by the State legislature. Madera County requires that wells be abandoned according to State standards documented in DWR Bulletins 74-81 and 74-90. Due to staff and funding limitations, enforcement of the well abandonment policies is limited.

2.4.5 Replenishment of Groundwater Extractions

Replenishment of groundwater is an important technique in management of a groundwater supply to mitigate groundwater overdraft. Groundwater replenishment occurs naturally through rainfall, stream/river seepage, and through intentional means including deep percolation of crop and landscape irrigation, wastewater effluent percolation, and intentional recharge. The primary local water sources for groundwater replenishment in RCWD include precipitation, San Joaquin River, and various local streams.

As noted, there is significant groundwater recharge activity within the GSA. For more information, refer to Section 2.2.3 - Conjunctive Use Programs or refer to Section 3.3 - Water Budget Information for discussions on stream seepage and how groundwater recharge is credited to different agencies.

2.4.6 Well Construction Policies

The RCWD GMP (Provost & Pritchard, 2012) presents in Section 8 (Groundwater Operations) well construction policies (Sec. 8.1). It states that Madera County has enacted and is responsible for enforcing a County Well Ordinance that regulates well construction. As previously stated, DWR also has well construction standards documented in DWR Bulletins 74-81 and 74-90. RCWD does not have its own well construction policies, but rather follows State and County standards.

2.4.7 Groundwater Projects

The RCWD is responsible for development and operation of recharge, storage, conservation, water recycling, and extraction projects. The RCWDGSA develops projects to help meet the District's water demands and will develop additional future projects to meet sustainability goals. Developing more groundwater recharge and banking projects is considered key to stabilizing groundwater levels. Chapter 6 – Project and Management Actions provides descriptions, estimated cost, and estimated yield for the main project focus. The role of the RCWDGSA is to promote cooperation and sharing of information and ideas between interested parties as well as implementing projects to assure sustainability.

The GSA will also support measures to identify funding and implement regional projects that help the region achieve groundwater sustainability. This can include recharge projects that take advantage of local areas conducive to recharge and areas where recharge provides the most benefits to the GSA.

2.4.8 Efficient Water Management Practices

Water conservation has been and will continue to be an important tool in water management, as well as a key strategy in achieving sustainable groundwater management. The RCWD practices various water conservation strategies including water use restrictions, water metering, conservation education, tiered rates, in-lieu recharge, etc. These water conservation strategies were tested during the 2014 - 2015 drought, which included State mandated urban water restrictions for the first time.

Details of water conservation programs can be found in various documents including Urban Water Management Plans and USBR Water Management Plans. The RCWD also has multi-stage water shortage contingency plans to help conserve water during droughts. Efficient water management practices will include maximizing the beneficial uses of water along with recycled water use as it can replace potable water use in some instances. Future efforts will include an increased focus on elevating awareness on groundwater overdraft, land subsidence, and explaining the requirements of SGMA. Some or all these conservation efforts will be necessary to achieve groundwater sustainability.

2.4.9 Relationships with State and Federal Agencies

Several member agencies receive San Joaquin River water from the Friant Division of the CVP. The Friant Dam is owned and operated by the USBR. The USBR is also the lead agency for the San Joaquin River Restoration, which has resulted in significant delivery curtailments to Friant contractors. The member agencies communicate often with USBR staff on water deliveries, water allocations, progress on the SJRRP, and the Water Management Program for the SJRRP that is intended to help mitigate water losses to Friant contractors.

Many of the member agencies receive grants from various agencies for water related projects. Grants are obtained from the California DWR, SWRCB, USBR, and others. The member agencies work closely with these State and Federal agencies to track grant programs and administer and implement grant contracts.

2.4.10 Land Use Planning

Land use policies are documented in various reports, such as General Plans, Specific Plans, and plans for proposed developments. Updating some of these plans is a multi-year process, and not all could be fully updated concurrently with the GSP development. These plans are expected to be modified gradually over time to be consistent with the goals and objectives of this GSP. Some smaller communities have no formal land use policies or rely on County policies. These smaller communities will need to develop new policies and long-term plans as part of the SGMA process.

2.4.11 Impacts on Groundwater Dependent Ecosystems

This Plan will have little to no impact on groundwater dependent ecosystems (GDEs), which are natural communities that depend on shallow groundwater levels for their existence. The goal of the Plan is to mitigate groundwater overdraft by maintaining stable groundwater levels over long-term trends, which will indirectly benefit GDEs. Furthermore, most of the GDEs located in the District are along the San Joaquin River, which is controlled by USBR and flows are maintained due to the SJRRP, holding contracts, and water rights holders. More discussion on the status of GDEs is located in Section 3.2.9.

2.5 Notice and Communication

2.5.1 Description of Beneficial Uses and Users

Regulation Requirements:

§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:

(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.
(b) A list of public meetings at which the Plan was discussed or considered by the Agency.
(c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.

Pursuant to California Water Code Section 10723.2, the RCWDGSA shall consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing a GSP. Beneficial users of groundwater include growers, residential users, commercial users or industry, and GDEs. Primary beneficial use of water within RCWDGSA includes irrigation, potable water use for residential and commercial spaces, and shallow groundwater for vegetation near the San Joaquin River. Each of the water use sectors are represented by individuals that are a part of the sector (i.e., individual growers, shop owners, homeowners, etc.) and show up for public workshops and meetings or provide comments on the GSP. Engagement with groundwater users occurs in the following phases of the development and implementation of the GSP:

1. Formation of the GSA
2. Development of the Draft GSP
3. Finalization of the GSP
4. Implementation of the GSP

<u>Formation of the GSA:</u>
To form the RCWDGSA, stakeholders gathered over several months in 2016 and subsequently prepared their Notification of Intent to Develop a GSP, dated July 7, 2016. The RCWDGSA has continued to work in concert with the six GSAs in the subbasin and on the formation of a coordination agreement. Public workshops have been conducted in the process of forming the GSA.

<u>Development of the Draft GSP:</u>
Pursuant to California Water Code Section 1073.2, the RCWDGSA shall consider the interests of the beneficial uses and users of groundwater, as well as those responsible for implementing a GSP. To this end the RCWDGSA has help public workshops and participated in workshops sponsored by the other agencies within the Subbasin that are preparing a joint GSP.

Within the RCWD GSA, most of the GSA's area is composed of agricultural users. Agricultural users are represented on the RCWDGSA Board of Directors. The RCWDGSA continues to improve blanket mailing lists which were used to notice several landowner outreach events. These lists, as well as email lists, will continue to be expanded and maintained leading into the development of a GSP to ensure overlying users stay informed and have a reasonable opportunity to participate in the process. There are approximately three rural residential wells in the district that rely on groundwater to meet their municipal needs. The District continues to reach out to these individuals. Lastly, there are three municipal wells that serve the growing demand of Riverstone. Much of the board of directors is composed of these representatives and the homeowner's association continues to convey the water supply information to this constituency.

Once the administrative draft is of sufficient form to provide information on both the historic and future plans of the GSA, then it will be shared for review and dialogue with these various beneficiaries as well as the GSA's within the Subbasin.

<u>Finalization of the GSP</u>
Upon receipt of public comments by individuals and other agencies, the GSA will respond and make revisions to the draft GSP. The draft GSP was presented to the GSA on August 12, 2019 and then made available immediately thereafter. A summary of the main comments and RCWDGSA's responses can be seen in **Appendix 2-B**.

<u>Implementation of the GSP</u>

In reality, the RCWD started on this road to sustainability with its formation in 1996. After the district was formed, the district has contracted for surface water supplies, constructed over 4.3 miles on irrigation pipeline with completion in 2014, and since 2017 imported approximately 16,000 af of water for an average of more than 5,300 af/year. The RCWD is not planning for sustainability, it is practicing sustainability. The actions and activities in the plan continue the implementation of what was initiated approximately 10 years ago.

2.5.2 Decision-Making Process

Regulation Requirements:

§354.10 (d) A communication section of the Plan that includes the following: 1) An explanation of the Agency's decision-making process.

The RCWD decided to become a GSA in July 2016. The RCWDGSA is currently working with and independently of other GSAs in the Madera Subbasin to develop and implement a GSP in order to comply with SGMA requirements. The DWR was notified that RCWDGSA intended to develop a GSP in a letter dated November 20, 2017.

The RCWDGSA worked in concert with the other six GSAs in Madera Subbasin on developing a single GSP. The RCWDGSA entered into agreement with five other GSA's and were granted funds from DRW to develop a single GSP. Late in 2018, a number of issues surfaced while in the development of the GSP, that were concerning to the RCWDGSA and the RCWDGSA removed from the agreement and initiated development of its own GSP and continues to coordinate with the GSP being developed by the Madera Irrigation District GSA, the City of Madera GSA, the County of Madera GSA, and the Madera Water District GSA. To this end the RCWDGSA has continued to be involved in the development of a basin wide model being developed by the Davids/Luhdorf and Scalmanini consultant team.

2.5.3 Public Engagement / Public Outreach Plan

Regulation Requirements:

§354.10 (d)(2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.

The development of the RCWDGSP has consisted of involvement with the Madera County GSA's to be an inclusive, transparent effort requiring ongoing engagement with a variety of stakeholders to allow public input and response during various stages of development. It should be recognized that this GSA is small and most all of the owners know one another. They communicate daily and weekly regarding the struggles they face. As the addition of urban homeowners has been occurring, there continues to be outreach to these new owners regarding the District, water supply and the issues regarding sustainability. A list of public meetings can be found in **Appendix 2-C**.

The overarching goal is to inform, engage, and build stakeholder support for RWCDGSA GSP metrics and thresholds. A diverse, active, engaged public will help better identify issues, form solutions, and create a partnership between the RCWDGSA Board and stakeholders. Progress on implementation of this GSP will be presented at public meetings and through the RCWDGSA website.

2.5.4 Encouraging Active Involvement

Regulation Requirements:

§354.10 (d)

3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of 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.

RCWDGSA has and will continue to initiate outreach activities and produce outreach materials to encourage active engagement by all stakeholders in GSP development. This Plan will guide the Board to implement consistent and coordinated public involvement and outreach. RCWDGSA seeks to actively solicit information, feedback, and opinions from stakeholders and beneficial users to inform program implementation decisions. To meet this objective, RWCDGSA will engage with stakeholders in new and existing venues.

Interested Person's List
RCWDGSA has been developing an Interested Persons since January 2015. The list is used to notify and encourage stakeholders and beneficial users to get involved in Board meetings and attend outreach events and workshops. The list will be used to also provide updates after each Board

meeting and notices of informational workshops and meetings. This list will allow for tracking of stakeholder engagement. Expansion of the Interested Persons list is ongoing.

Informational Briefings Through Existing Stakeholder Engagement Venues
RWCDGSA will use outreach opportunities to open lines of communication with interested and affected stakeholders about the program, let them know the future opportunities for input, establish communication channels and receive feedback on the process. Alternative venues may be a viable alternative to the previous briefings. Venues will be selected based on efficiency and effectiveness in reaching out to stakeholder populations and beneficial users.

2.6 References

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Appendix 2-A Ag Water Flow Meter and Water Level Measurement Policy

Root Creek Water District
Agriculture Water Flow Meter and Water Level Measurement Policy

Adopted: September 20, 2017

Purpose and Scope
The purpose of this policy is to enact Root Creek Water District's (the "District") Agriculture Meter guidelines to ensure that groundwater pumping within the District is documented.

Policy Statement
This policy details how the District requires permits, reviews, inspects, and documents groundwater pumping within the District boundaries. To ensure clarity of understanding of obligations of this policy and to provide a consistent procedure for the construction and installation of groundwater wells and associated infrastructure, the Board establishes this policy to guide the District in carrying out its duties.

The County sets ordinances and requirements for the construction of wells. The District has accepted these standards for construction of wells within its boundaries. Most recently the County of Madera enacted Ordinance No. 674 on December 2, 2014, requiring the installation of flow meters and water level meters on new wells or repaired or reconstructed wells. Consistent with the County Ordinance, the County finds and the District recognizes the following:

The State of California has recently found and declared that:

(a) The people of the state have a primary interest in the protection, management, and reasonable beneficial use of the water resources of the state, both surface and underground, and that the integrated management of the state's water resources is essential to meeting its water management goals.
(b) Groundwater accounts for more than one-third of the water used by Californians in an average year and more than one-half of the water used by Californians in a drought year when other sources are unavailable.
(c) Excessive groundwater extraction can cause overdraft, failed wells, deteriorated water quality, environmental damage, and irreversible land subsidence that damages infrastructure and diminishes the capacity of aquifers to store water for the future.
(d) When properly managed, groundwater resources will help protect communities, farms, and the environment against prolonged dry periods and climate change, preserving water supplies for existing and potential beneficial use.
(e) Failure to manage groundwater to prevent long-term overdraft infringes on groundwater rights.
(f) Groundwater resources are most effectively managed at the local or regional level.
(g) Groundwater management will not be effective unless local actions to sustainably manage groundwater basins and sub-basins are taken.
(h) Local and regional agencies need to have the necessary support and authority to manage groundwater sustainably.
(i) Information on the amount of groundwater extraction, natural and artificial recharge, and groundwater evaluations are critical for effective management of groundwater.

The State has, through enactment of legislation namely the Sustainable Groundwater Management Act, Assembly Bill 1739, Senate Bill 1168 and Senate Bill 1319, authorized and directed that local agencies, including water districts, adopt and implement effective monitoring and management plans to protect, preserve and maintain sustainable groundwater levels and water supply for long-term reliability.

The District recognizes that groundwater levels in the District generally have lowered due to increased drafts of water and the effects of drought. In 2001, in connection with adoption of Chapter 13.100 pertaining to groundwater banking, the Board of Supervisors already made finding that the Madera, Chowchilla, and Delta-Mendota Basins "were severely overdrafted". Since 2001, the situation has significantly worsened. Unabated and unmanaged, the lowering of groundwater basin water levels will continue which would be detrimental to the health, safety, and general welfare of the District.

Therefore, the District finds that developing, implement and maintaining an effective monitoring and management of the groundwater in the District are matters of essential local concern.

Further, the District finds that adopting and implementing a policy requiring the installation of water flow meters and water level measurement on new water wells, well repairs or well reconstruction, is in the best interest of the District, and its farm, businesses, and residents.

Finally, for reasons set forth above, the District finds that the adoption of this policy will promote the health, safety, and general welfare of the District

REQUIREMENTS

Consistent with County Ordinance No. 674, any new well, repaired well, or reconstructed well will install a flow meter and allow for water level measurement. The flow meter will be installed to acceptable District measurement standards. Measurements from these devices will be transmitted to the District semi-annually.

Pumps Installed prior to Ordinance No 674

For those installations that have been constructed prior to the Ordinance, when repairs or replacements are made to the pump, the requirements to install the measurement devices will occur.

A. In the absence of a flowmeter and level device, the requirement to provide an estimate of the groundwater pumping can be made by the following:
   i. Landowner or well owner to submit electrical use numbers for a pump with a pump test that determines the power consumption related to water produced from a well.
   ii. Satellite imagery and associated estimation of irrigation use from the Cal Poly Irrigation and Training Institute evapotranspiration system or using tools or system from approved alternatives.

iii. Estimate of pumping using an estimate of cropped acreage, a local evapotranspiration rate for the crop and estimated irrigation efficiency.

Attachment: Madera County Ordinance No. 674

Appendix 2-B Comment Summary Form

Comment Response Summary

GSA	Root Creek Water District GSA		
Date:		**Job No.:**	2843-18-001

No.	Section.	By	Review Comments	Date Received	Response	Response Date
1.						
2.						
3.						
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Appendix 2-C Root Creek WD GSA List of Outreach Meetings

Root Creek Water District GSA (RCWD GSA) - Madera Subbasin Outreach
Informing the Public about GSP Development Progress

Meeting/Event	Meeting/Event date	Topics presented	E-blast to Interested Parties list? Which list and when?	Flyer created?
RCWD GSA Board Meeting	October 11, 2017			
RCWD GSA Board Meeting	November 13, 2017			
RCWD GSA Board Meeting	December 11, 2017			
RCWD GSA Board Meeting	January 8, 2018			
RCWD GSA Board Meeting	February 12, 2018			
RCWD GSA Board Meeting	March 12, 2018			
RCWD GSA Board Meeting	April 9, 2018			
RCWD GSA Board Meeting	May 14, 2019			
Madera Subbasin Workshop	May 24, 2018	Management areas, base period, GSA water budgets, & management actions	Yes	Yes
RCWD GSA Board Meeting	June 11, 2018			
RCWD GSA Board Meeting	July 9, 2018			
MWDGSA Board Meeting	August 8, 2018	Overview of SGMA		
MWDGSA Landowner Meeting	August 15, 2018	SGMA requirements & potential impacts	Yes	Yes

Root Creek Water District GSA (RCWD GSA) - Madera Subbasin Outreach
Informing the Public about GSP Development Progress

Meeting/Event	Meeting/Event date	Topics presented	E-blast to Interested Parties list? Which list and when?	Flyer created?
RCWD GSA Board Meeting	August 13, 2018			
SGMA Technical workshop	August 16, 2018		Yes	Yes
RCWD GSA Board Meeting	September 10, 2018			
RCWD GSA Board Meeting	October 8, 2018			
SGMA Technical workshop	October 18, 2018	Future of groundwater, projects, & management actions	Yes	Yes
RCWD GSA Board Meeting	November 15, 2018			
RCWD GSA Board Meeting	December 10, 2018			
RCWD GSA Board Meeting	January 14, 2019			
RCWD GSA Landowner Meeting	January 15, 2019	2018-19 Water Year Recap; Land-Based Assessments; Water Flow Meter Policy; GW Recharge Fee; SGMA Update		
SGMA Technical workshop	February 7, 2019		Yes	Yes
RCWD GSA Board Meeting	February 11, 2019			
RCWD GSA Board Meeting	March 11, 2019			
SGMA Technical workshop	March 21, 2019	Groundwater modeling, importance of coordination	Yes	Yes
RCWD GSA Board Meeting	April 8, 2019			

Root Creek Water District GSA (RCWD GSA) - Madera Subbasin Outreach
Informing the Public about GSP Development Progress

Meeting/Event	Meeting/Event date	Topics presented	E-blast to Interested Parties list? Which list and when?	Flyer created?
RCWD GSA Board Meeting	May 13, 2019			
SGMA Technical workshop	May 29, 2019		Yes	Yes
RCWD GSA Board Meeting	July 8, 2019			
Madera Farm Bureau Water Forum	July 9, 2019	Waters of US vs Waters of the State; CVSALTS/Water Quality; SJV Blueprint/BiOps; SGMA; Metering Technology; Water Markets		
RCWD GSA Board Meeting	Scheduled August 12, 2019			

Unless otherwise noted: **RCWD GSA Board Meetings are held at The Lodge at Riverstone: 370 Lodge Road South, Madera, CA 93636**

3 Basin Setting

3.1 Hydrogeologic Conceptual Model

3.1.1 Introduction

Regulation Requirements:

§354.14(a) Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.

The purpose of a Hydrogeologic Conceptual Model (HCM) is to provide an easy to understand description of the general physical characteristics of the regional hydrology, land use, geology, geologic structure, water quality, principal aquifers, and principle aquitards in the basin setting. Once developed, an HCM is useful in providing the context to develop water budgets, monitoring networks, and identification of data gaps.

An HCM is not a numerical groundwater model or a water budget model; it is a written and graphical description of the hydrologic and hydrogeologic conditions that lays the foundation for future water budget models. The model is based on previous studies and information obtained from past research of public documents. Refer to Section 3.3 for information on the District's water budget.

This HCM has been written by adhering to the requirements set forth in the California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5, Subarticle 2 (§354.14). Several topics are addressed in the HCM, including groundwater quality, groundwater flow, surface water interactions, and soil characteristics.

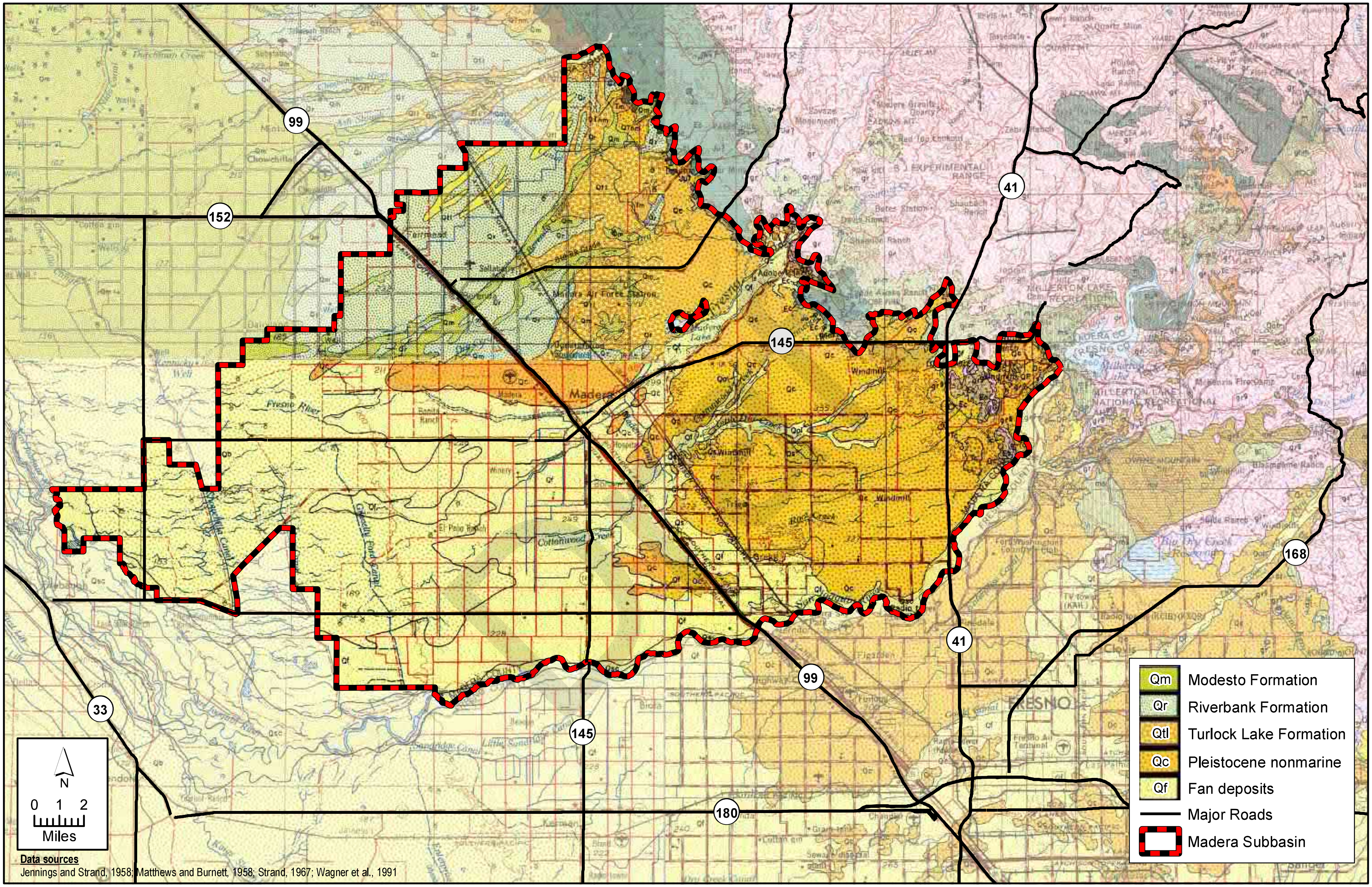
The narrative HCM description provided in this chapter is accompanied by graphical representations of the RCWD portion of the Madera Subbasin that have attempted to clearly portray the regional geology, basin geometry, and general water quality. This HCM has been prepared utilizing published studies and resources and will be periodically updated as data gaps are addressed, and new information becomes available.

3.1.2 Lateral Basin Boundaries

Regulation Requirements:

§354.14(b)(2) The hydrogeologic conceptual model shall be summarized in a written description that includes lateral basin boundaries, including major geologic features that significantly affect groundwater flow.

The Madera Subbasin (DWR Subbasin NO 5-22.06) is generally comprised of relatively flat topography that slopes gently downward to the west. The subbasin is bounded on the east by the Sierra Nevada Mountains and on the south by the San Joaquin River. The bedrock is shallower in the east, closer to the mountains, which restricts vertical movement of groundwater flow and helps push it westward. The San Joaquin River affects groundwater flow by seepage. Water infiltrates through the bottom of the channel and flows outward causing groundwater elevations to be higher closer to the river, thus affecting the direction of flow due to the groundwater elevation gradient. Topographic elevations vary from about 250 feet above mean sea level (MSL) in the east to about 150 feet MSL in the west over a distance of about 20 miles. The major geomorphic features of the subbasin are the alluvial fan and floodplain associated with sediment deposition from the Fresno and San Joaquin Rivers (Mitten, LeBlanc, & Bertoldi, 1970). A surface geology map is provided in **Figure 3-1**. The surficial geology of the Madera Subbasin is dominated by younger and older alluvium (generally equivalent to Modesto, Riverbank, and Turlock Lake Formations).



X:\2016\16-119 Madera Co. - Chowchilla & Madera Subbasins SGMA Support\GIS\Maps\FinalMapsForTM\Madera Subbasin\Figure 3-4 Madera Subbasin Surficial Geology Map.mxd

DAVIDS ENGINEERING, INC

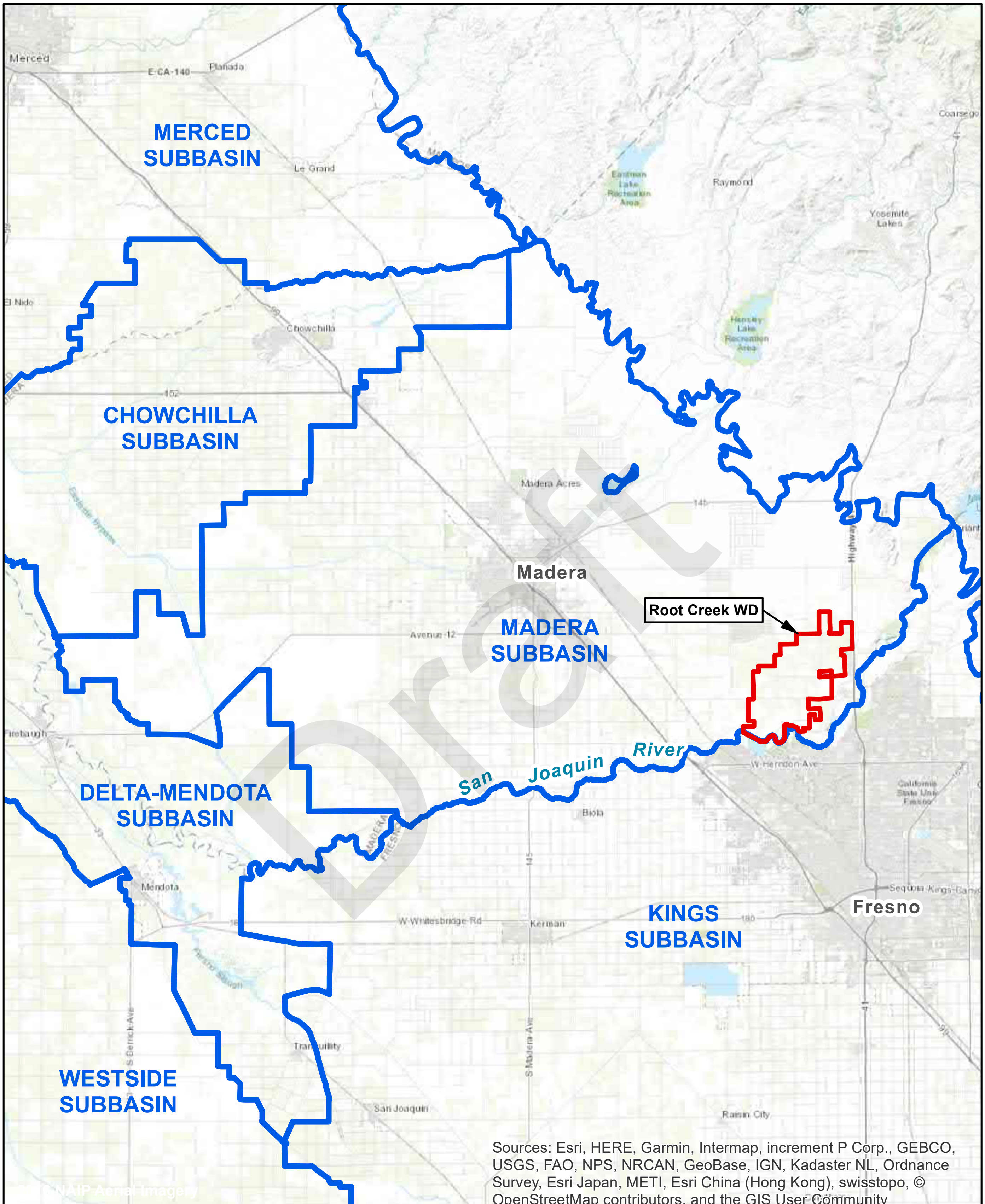
LUHDORFF & SCALMANINI CONSULTING ENGINEERS

Surface Geology Map

Figure 3-1

Madera County: Madera Subbasin
SGMA Data Collection and Analysis

As shown in **Figure 3-2**, the RCWD area is entirely in Madera County in the southeastern portion of the Madera Groundwater Subbasin, north of the San Joaquin River and west of Highway 41. This area of the basin is bounded on the east by the foothills of the Sierra Nevada, which defines the eastern boundary of the alluvial groundwater aquifer system and the San Joaquin River on the south. The aquifer thins to the northern portion of the District, where it abuts lands within Madera ID and Madera County GSAs. The major features that affect groundwater flow are the San Joaquin River and the basement complex (i.e., bedrock) of the Sierra Nevada Mountains. Significant amounts of seepage, termed stream depletion, occurs along the San Joaquin River causing groundwater to flow down and away from the River (California Department of Water Resources (DWR), 2006). River losses due to seepage is recharge for the area's groundwater aquifers. According to DWR (2006), groundwater flow in the Madera Subbasin is generally southwestward in the eastern portion and northwestward in the southern portion. There do not appear to be horizontal barriers to groundwater flow within the subbasin.



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Groundwater Subbasin (DWR 2017)

Root Creek WD

Root Creek WD

Figure 3-2

Groundwater Subbasins

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3.1.3 Regional Geologic and Structural Setting

Regulation Requirements:

§354.14(b)(1) The hydrogeologic conceptual model shall be summarized in a written description that includes the regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.

§354.14(b)(3) The hydrogeologic conceptual model shall be summarized in a written description that includes the definable bottom of the basin.

The Madera Groundwater Subbasin lies within the San Joaquin Valley, which comprises the southern portion of the Great Central Valley of California. The San Joaquin Valley is a structural trough that is up to 200 miles long and 70 miles wide. It is filled with as much as 32,000 feet of marine and continental sediments deposited during periodic inundation by the Pacific Ocean and by erosion of the surrounding mountains, respectively. Continental deposits shed from the surrounding mountains form an alluvial wedge that thickens from the valley edges toward the axis of the structural trough. This depositional axis is slightly west of the series of rivers, lakes, sloughs, and marshes, which mark the current and historic axis of surface drainage in the San Joaquin Valley (DWR, 2006). **Figure 3-3** is a regional cross-section schematic across the San Joaquin Valley, perpendicular to the trough illustrating topography and subsurface features (Faunt, 2009).

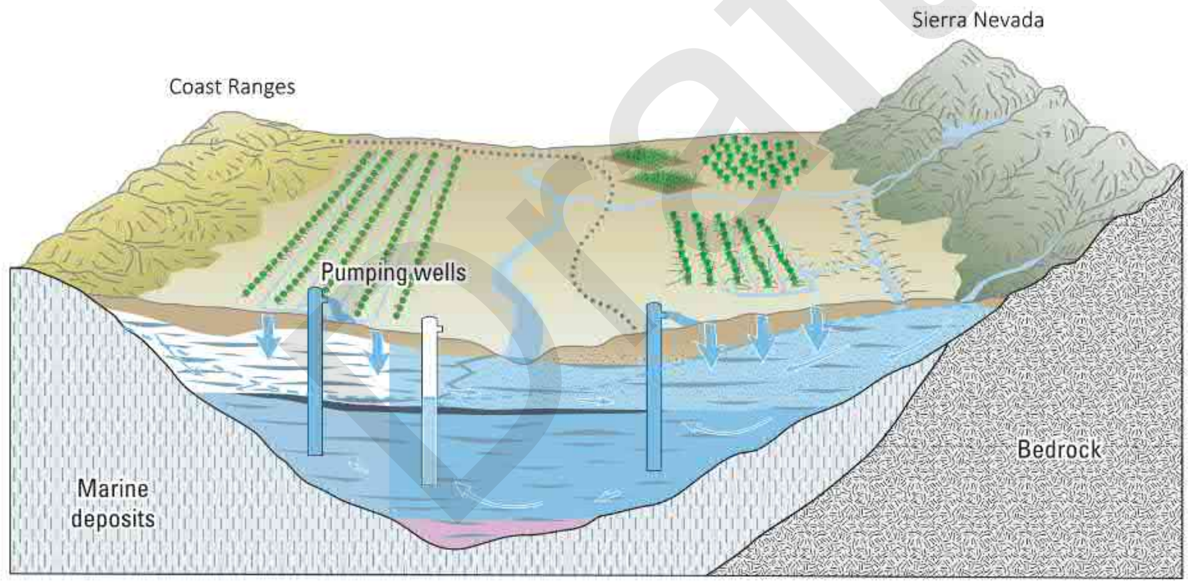


Figure 3-3. Generalized Cross-section of the San Joaquin Valley

Geologic units in the District area consist of unconsolidated deposits underlain by older consolidated rocks. The consolidated rocks are comprised of a pre-Tertiary age basement complex of Cretaceous (145 to 66 million years ago) and Tertiary (66 to 2.6 million years ago) age rocks. The unconsolidated deposits are of both Tertiary and Quaternary age (2.6 million years ago to the present).

The Madera Groundwater Subbasin has been extensively studied by Mitten, LeBlanc, and Bertoldi (1970) as part of a larger study area. **Figure 3-3** shows an example of the basement complex cropping out along the eastern boundary, which is what it would look like in Madera County of the Mitten et al. study. The current basin boundary along the foothills has a long strip of basement complex mapped outside the basin. The basement complex comprises a large portion of the Sierra Nevada and other regional mountain ranges that are composed of a mass of plutonic and metamorphic rocks commonly referred to as the Sierra Nevada batholith. The surface of the basement complex slopes to the southwest from the foothills to beneath the valley floor.

The USGS (Mitten et al., 1970) identified the consolidated basement rock materials beneath RCWDGSA as metamorphic and igneous (granitic) rocks that can be observed in outcrop in the foothills of the Sierra Nevada. Depth to basement rock in the RCWD area occurs at a depth greater than 700 feet (interpolated from Plate 1 of Mitton et al., 1970). The basement floor lies at great depth near the axis of the valley; at its deepest point, the basement rock is 32,000 feet deep. Because they are largely impermeable, the rocks of the basement complex are of little importance as a source of water supply (Davis, Green, Olmsted, & Brown, 1959). As for RCWDGSA, the definable bottom of the aquifer basin is congruent to the depth to the basement rock.

The unconsolidated sedimentary deposits present in the RCWD area overlie the basement complex rocks that increase in depth to the west. These continental deposits primarily formed large alluvial fans bordering both sides of the valley and flood basin deposits formed primarily along the axis of the valley. In general terms, alluvial fans are fan or cone-shaped deposits of sediment deposited by streams. Alluvial fans are narrower at the head than at the toe and slope with decreasing gradient from head to toe. The fans coalesce with distinctive deposits in the fan and interfan areas. The alluvial fans are characterized by generally coarse, permeable deposits in the upper portions of the fan and consist largely of tongues and lenses of sand and gravel that almost extend to the topographic trough of the valley.

A sedimentary layer of both regional and local importance is the Corcoran Clay (E-clay). The lake in which the clays were deposited was known as Lake Corcoran or Lake Clyde. It was widely extensive, ranging from 10 to 40 miles wide and more than 200 miles long, covering much of the valley floor; however, its deposits were west of the RCWD area. The Corcoran Clay is essentially an impermeable barrier creating a confined aquifer underneath where it is present, which has been one of the primary sources of water in the area. Regionally, groundwater flow beneath the Corcoran Clay is both from the west and east towards the axis of the valley. The Sierran source groundwater is of higher quality than the Coastal Range source groundwater. The Coast Range groundwater passes through sediments derived from marine source rocks and contains a higher quantity of salts and other mineral matter that may be deleterious to crop growth. Wells drilled beneath the Corcoran Clay, in areas closer to the axis of the valley, show a stronger influence from the Coastal Ranges with lower quality water.

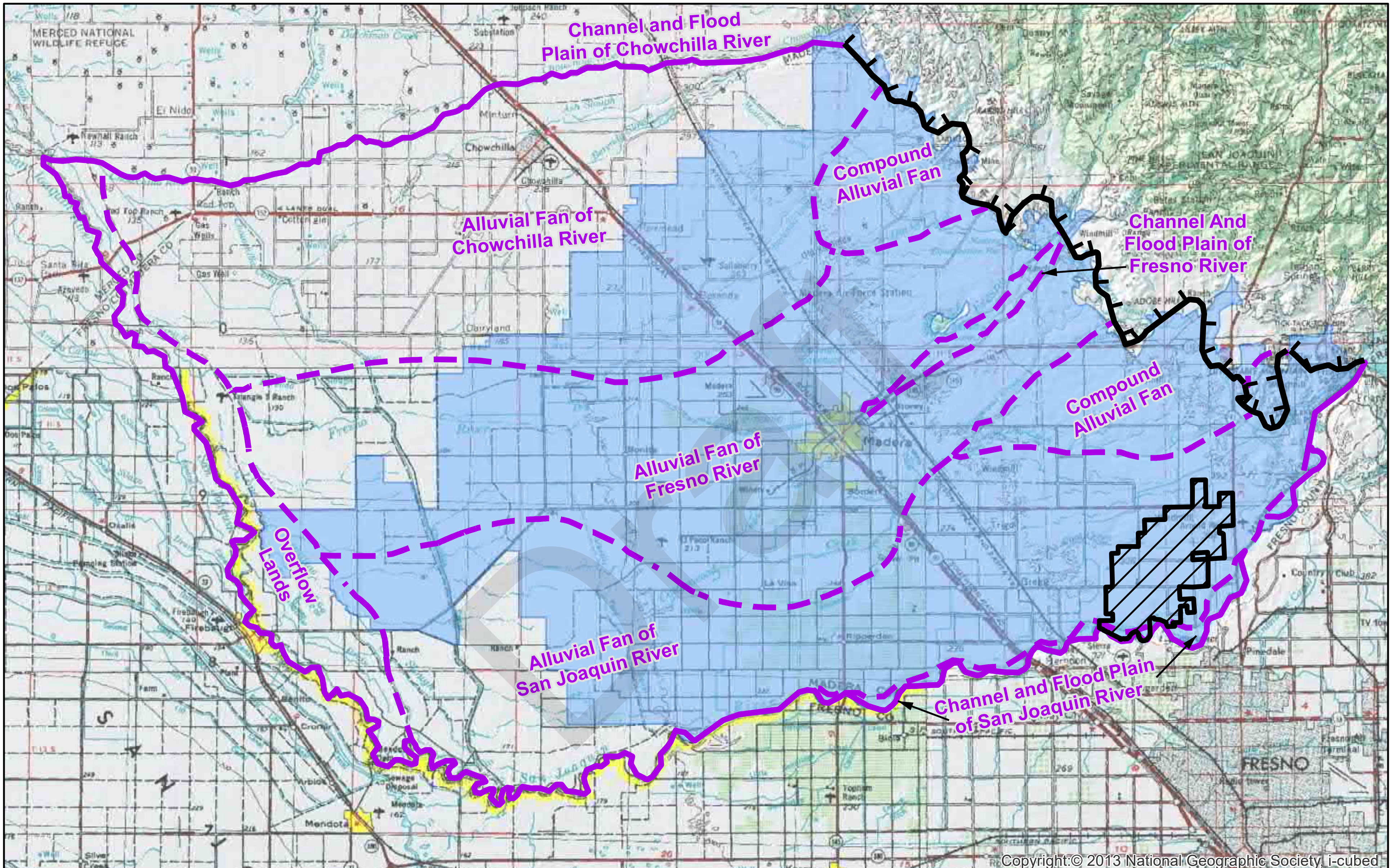
3.1.4 Topographic Information

Regulation Requirements:

§354.14(d)(1) Physical characteristics of the basin shall be represented on one or more maps that depict topographic information derived from the U.S. Geological Survey or another reliable source

Geomorphic features of the RCWD area and surrounding areas in the Madera Groundwater Subbasin were mapped by Mitten et al. (Plate 1, 1970). As shown in **Figure 3-4**, the landscape of this area is dominated by overlapping alluvial fans of the Chowchilla, Fresno, and San Joaquin Rivers and the compound alluvial fans of the intermittent streams between the major rivers. The RCWD area is bounded to the east by the foothills and mountains of the Sierra Nevada which provide the source of the sediment for the alluvial fan deposits.

A topographic map of the subbasin area is presented in **Figure 3-5** and the quadrangle topographic map of the RCWD area is presented in **Figure 3-6.** The highest point in the basin is in the east along the northeastern edge of the RCWD area, near Highway 41 at approximately 400 feet above MSL. The lowest elevations (approximately 250 feet above msl) are found in the southwestern corner of the District at the San Joaquin River. Relatively steep slopes exist in RCWD along the San Joaquin River; however, the overall topography of the greater RCWD area slopes gently to the west-southwest.



Root Creek WD

Madera Groundwater Subbasin (DWR 2017)

Geological Basement Boundary

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Root Creek WD

Figure 3-4

Geomorphic Features
Adapted from Mitten et al 1970

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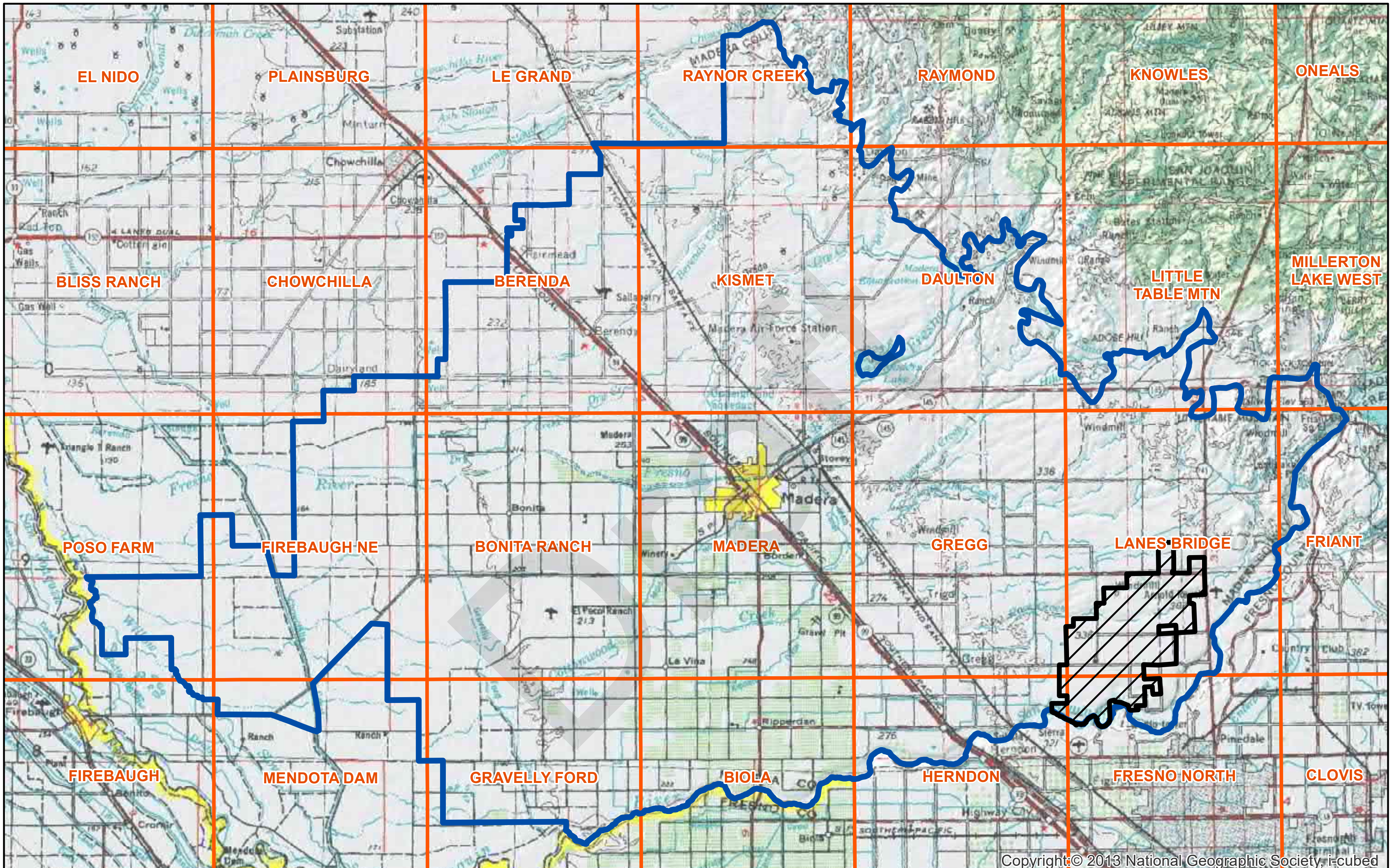

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Root Creek WD

Topo Quad

Madera Groundwater Subbasin (DWR 2017)

Root Creek WD

Figure 3-5

USGS Topo of Madera Groundwater Subbasin

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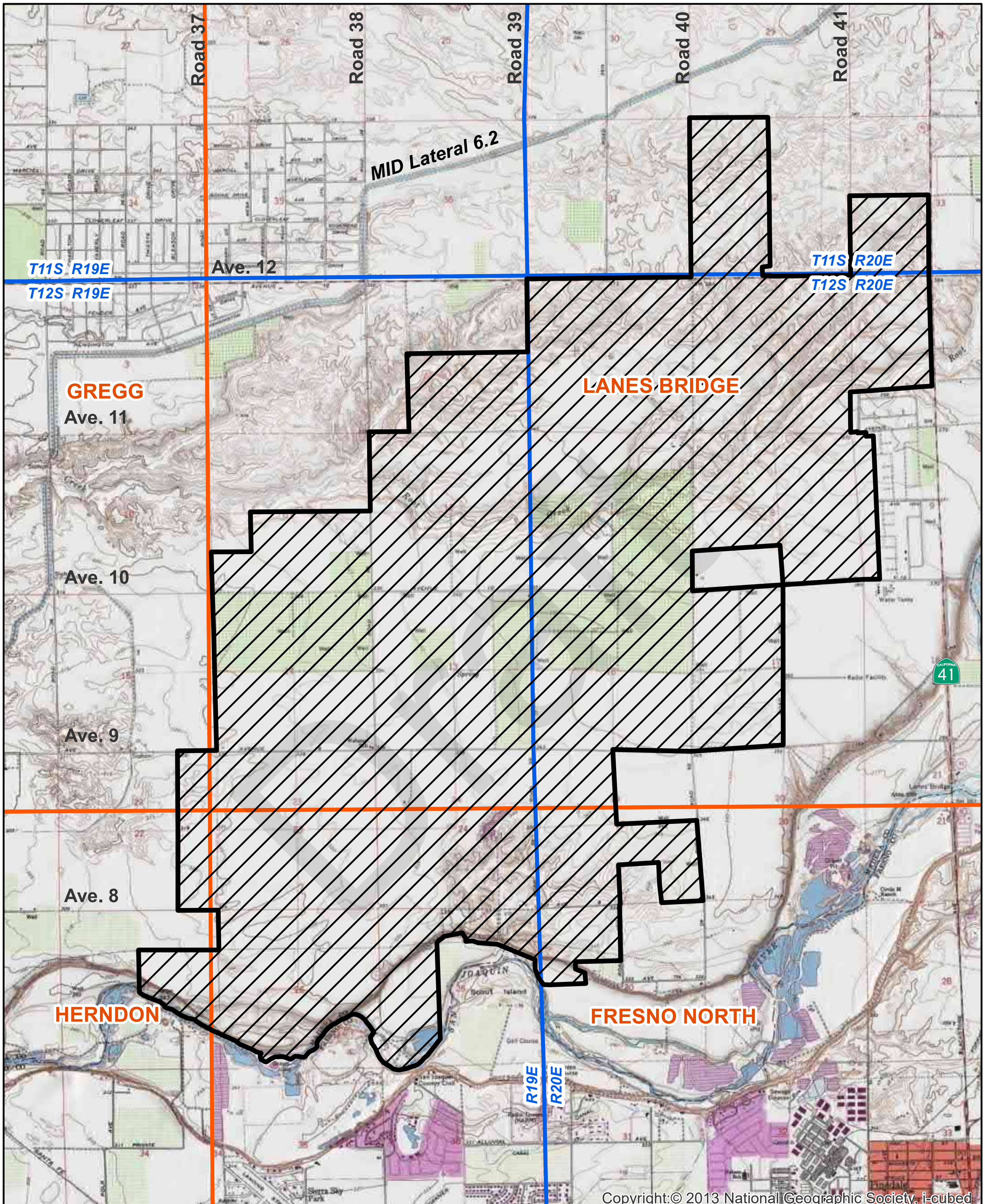

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Root Creek WD
Township/Range
Topo Quad

Root Creek WD
Figure 3-6
USGS Topo

3.1.5 Surficial Geology

Regulation Requirements:

§354.14(d)(2) Physical characteristics of the basin shall be represented on one or more maps that depict surficial geology derived from a qualified map including the locations of cross-sections required by this Section

Within RCWDGSA, surface materials are comprised solely of Quaternary age deposits (younger than about 1.8 million years old) which have been categorized by Mitten et al. (1970) as Quaternary Older Alluvium (Qoa) (between 10,000 and 1.8 million years old). The subbasin consists mostly of Qoa and Quaternary Younger Alluvium (Qya) (younger than about 10,000 years old) with a small section of Flood Basin Deposits (Qb) (younger than about 10,000 years old). Quaternary alluvium within the subbasin is a result of erosion of the Sierra Nevada range to the east and subsequent deposition on the valley floor. Qoa covers the largest area within the subbasin. Thin bands of Qya are located adjacent to modern day stream channels and rivers (i.e., San Joaquin River, Fresno River, and Chowchilla River, and the small intermittent creeks that drain the foothills). Large deposits of Qya formed in the southwest paths of the rivers, primarily west of US Hwy 99. Younger Alluvium is generally limited to 50 feet thickness and typically unsaturated. The Older Alluvium consists of up to 1,000 feet of interbedded clay, silt, sand, and gravel. Older Alluvium becomes finer-grained with depth and is underlain by the generally finer-grained Continental deposits of Tertiary and Quaternary age (Mitten et.al., 1970). Only a minor portion of the western boundary of Madera Subbasin is composed of flood basin deposits. **Figure 3-7** visually displays the extent of the surface materials along with several minor subsurface geologic features of significance, including Ione Formations (Ti) and Terrace Deposits (Qt)

3.1.6 Soil Characteristics

Regulation Requirements:

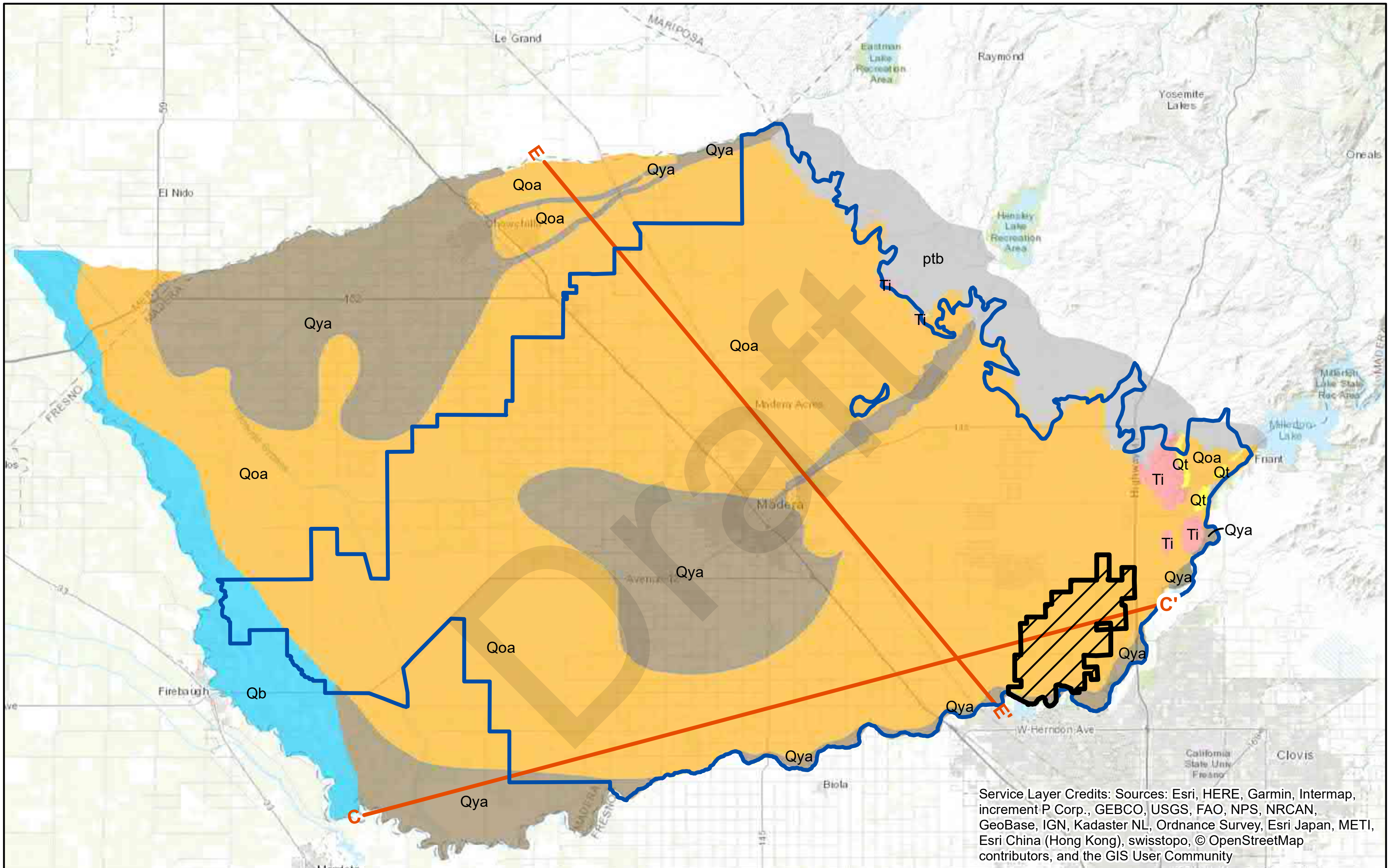
§354.14(d)(3) Physical characteristics of the basin shall be represented on one or more maps that depict soil characteristics as described by the appropriate Natural Resource Conservation Service soil survey or other applicable studies.

A topsoil map based on Natural Resource Conservation Service (NRCS) soil textural classes is presented as **Figure 3-8**. Within the RCWDGSA area, the NRCS has generally described soils to depths of five to seven feet. In general, the dominant soil textural class in the northern uplands and along the San Joaquin River are fine sandy loam to sands in long westerly bands. The central and south-central portions of the older alluvial fan in the GSA are clay loam and narrow bands of very fine sandy loam. The local drainage channels tend to be coarser than the adjacent soils.

Saturated hydraulic conductivity (Ksat) classes refer to the ease with which pores in a saturated soil transmit water. The NRCS categorizes Ksat into classes from slow in the clay loam to more rapid in the coarser soils of the northern area and southeast corner of the GSA.

Based on NRCS soil descriptions, restrictive layers (i.e., any abrupt structural or textural change) in the soil column less than six feet in depth have also been identified. More than 85% of RCWDGSA soils have a restrictive layer less than 6 feet (<200 cm) below the surface. Areas shown on **Figure 3-8** that do not have a restrictive layer above six feet tend to be where washes or channels have cut through the surface finer grain alluvial soil. The restrictive layers are chiefly comprised of duripan soil horizons (i.e., hardpan), which for the purposes of this document are assumed to have largely been broken up through deep tillage related to historic agricultural operations throughout the area.

These soil characteristics can be useful for initial screening of potential recharge and groundwater banking sites but should be confirmed with on-site investigations before projects are pursued.



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Legend		
Cross Section	Qb - Flood-basin deposits	Qya - Younger alluvium
Root Creek WD	Qoa - Older alluvium	Ti - Ione Formation
Madera Subbasin	Qt - Terrace deposits	ptb - Basement complex

Root Creek WD

Figure 3-7

Surficial Deposits
Adapted from Mitten et al 1970

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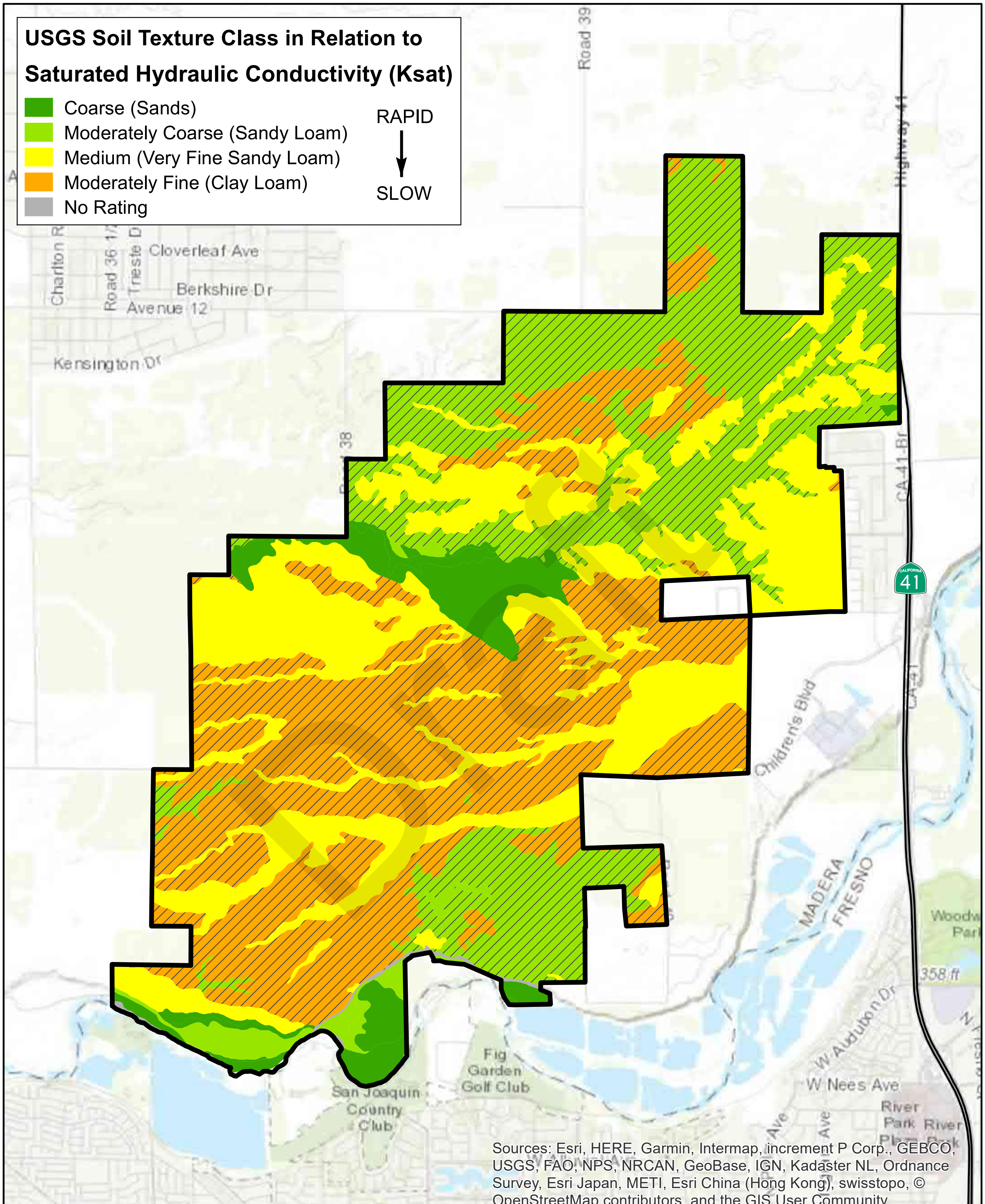

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Root Creek Water District
Depth to Restrictive Layer < 200 cm

Source: USDA Soil Conservation Service.

Root Creek WD

Figure 3-8

Soil Texture and Saturated Hydraulic Conductivity

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3.1.7 Cross-Sections

Regulation Requirements:

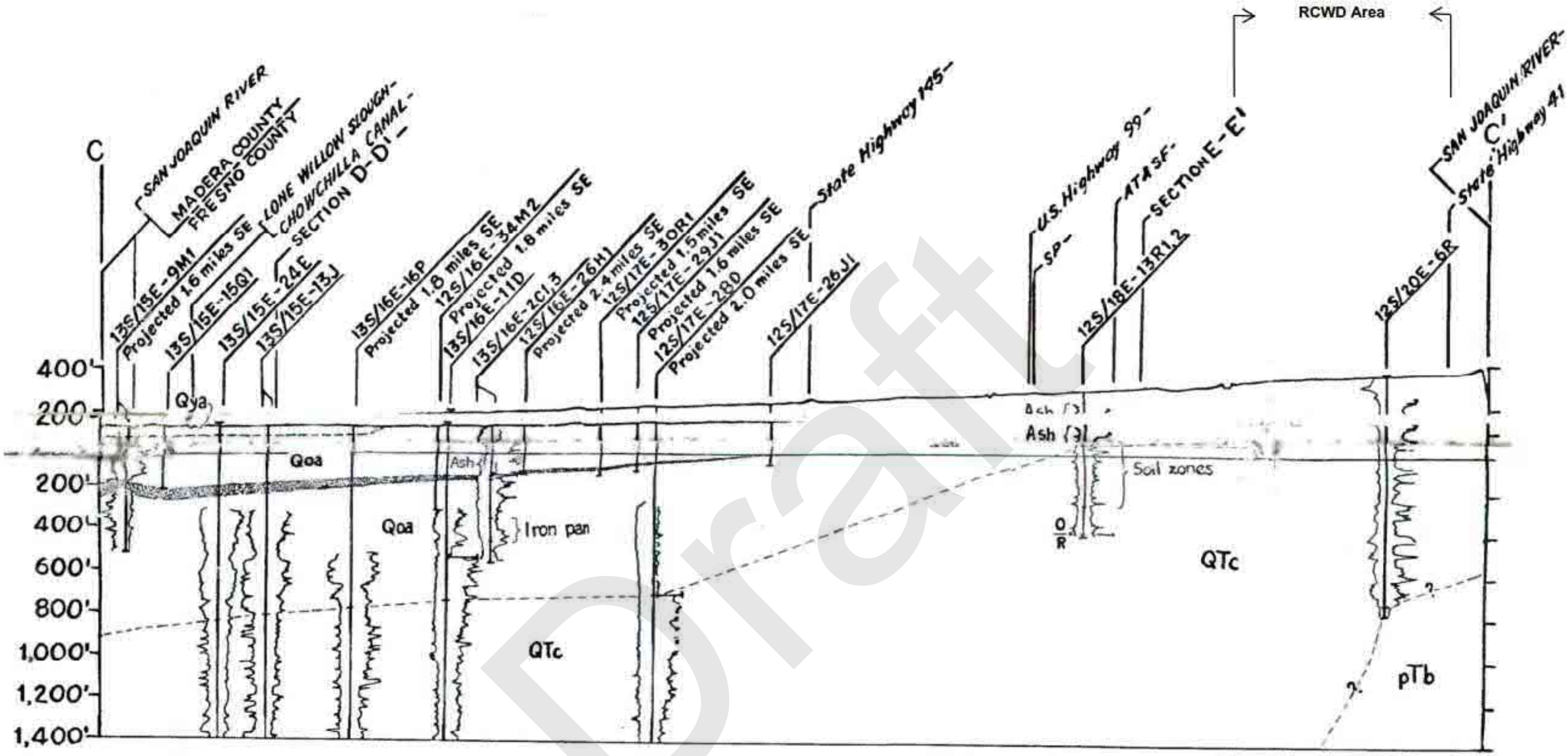
§354.14(c) The hydrogeologic conceptual model shall be represented graphically by at least two scaled cross-sections that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin.

Cross sections by Mitten et al. (1970) that transverse or are close to the RCWDGSA area are presented as **Figure 3-9** and **Figure-3-10**. The two cross sections are roughly perpendicular to each other and are shown on the Surficial Deposits (geological) map **Figure 3-7**. The two regional cross-sections presented herein represent only a portion of the original regional cross sections in order to more prominently display the subsurface conditions within the RCWD.

Regional cross-section C-C' transverses southwest to northeast through Madera County and through the central part of the GSA. Regional cross-section E-E' is slightly west of the GSA and transverses northwest-southeast through Madera County. On cross-sections C-C' (**Figure 3-9**), a shallow band of Quaternary Younger Alluvium (Qya) is located at relatively shallow depths immediately adjacent to the San Joaquin River channel in the northeast.

The Quaternary Older Alluvium (Qoa) is inferred from limited data to exist from the surface to a depth of approximately 250 feet in the southwest and up to 300 feet in the northeast. In the regional cross-section E-E' (**Figure-3-10**), downslope from the RCWD area, the Qoa extents to a depth of approximately 200 feet in the southeast near the San Joaquin River and becomes thinner to the northwest (less than 200 feet thick). Quaternary and Tertiary age continental deposits (QTc) lie below the Qoa to depths of at least 1,800 feet. In the northeast portion of the GSA, the QTc deposits may be underlain by basement complex (pTb) at about 1,800 feet.

Mitten et al. (1970) indicates, in general terms, that the most important aquifer in the area is the older alluvium (Qoa). It consists mostly of lenses of clay, silt, sand, and some gravel but is generally fine grained over most of the area. While the Qoa may be the most important portion of the aquifer, there are now a larger number of deeper wells pumping water from below the Qoa than in the 1960s.



Source: Mitten, et al., 1970

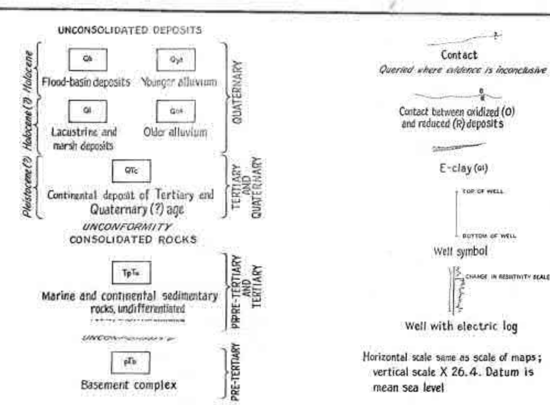
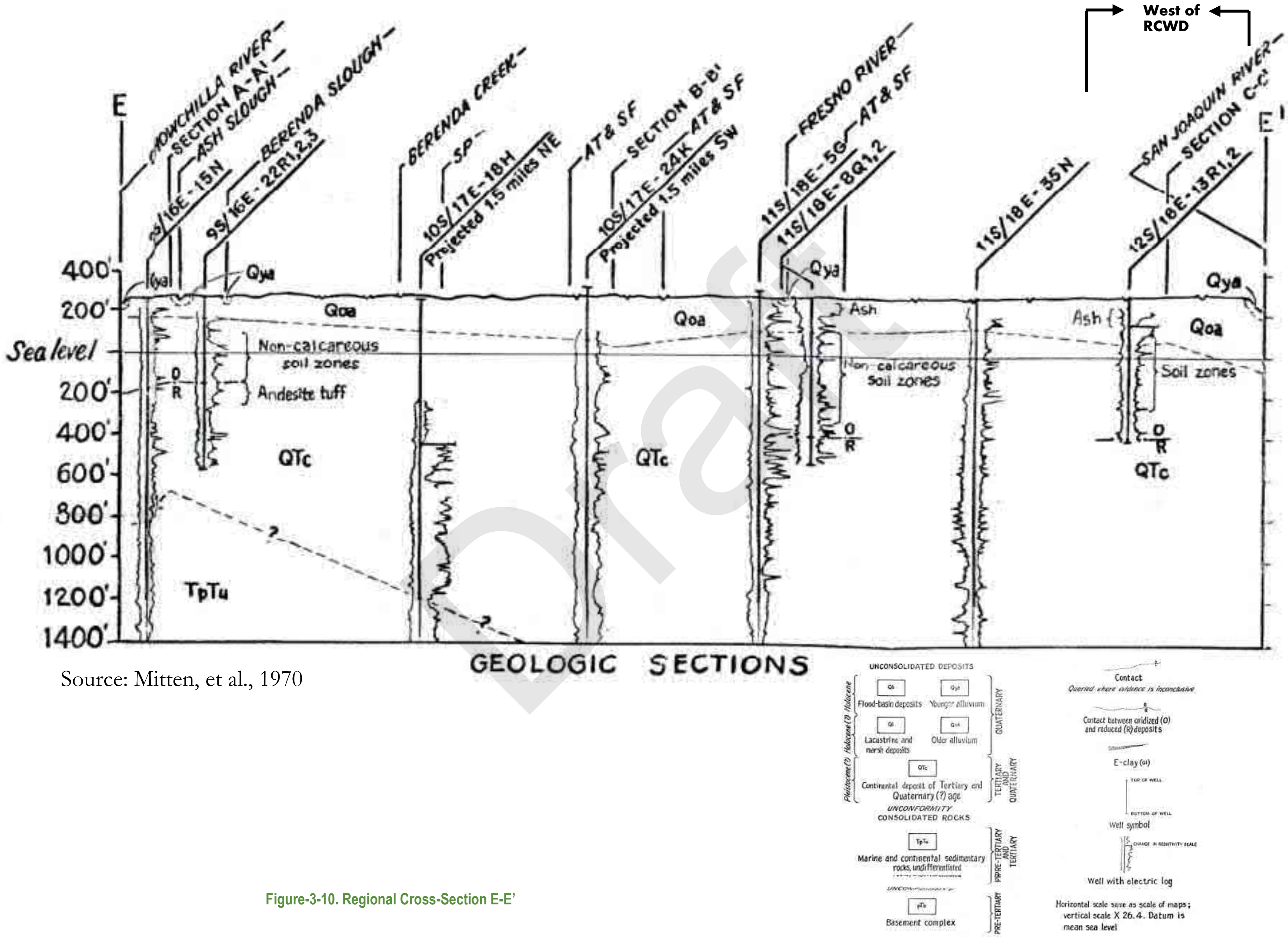


Figure 3-9. Regional Cross-Section C-C'



Source: Mitten, et al., 1970

Figure-3-10. Regional Cross-Section E-E'

3.1.8 Aquifer System

Regulation Requirements:

§354.14(b)(4) The hydrogeologic conceptual model shall be summarized in a written description that includes the principal aquifers and aquitards.

§354.14(b)(4)(c) Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.

The RCWD encompasses a small portion of the southeastern-most part of the Madera Groundwater Subbasin. The subbasin aquifer system consists of unconsolidated continental deposits of older series Tertiary (66 to 2.6 million years ago) and Quaternary (2.6 million years ago to the present) age sediments overlain by thin accumulations of younger series deposits of Quaternary age. The Quaternary age deposits are divided into older alluvium (Qoa), lacustrine (lake) and marsh deposits, terrace deposits, younger alluvium (Qya), and flood-basin deposits (Mitten et al., 1970). Lacustrine and marsh deposits do not crop out but tend to underlie the western portion of the Madera Groundwater Subbasin (DWR, 2006).

Mitten et al. (1970) states that subsurface water-bearing characteristics of the Qoa deposits are highly variable due to changes in lithology. These deposits consist mostly of interbedded layers of silts, silty/sandy clays, clay lenses, clayey and silty sands, sands, gravels, and cobbles. It contains much of the water that occurs in the unconfined aquifers in the Madera Subbasin. In the RCWD area, below depths of about 300 feet older QTc continental deposits occur. Many wells in the area of the RCWD extend below the Qoa at depths greater than about 300 feet and into the older QTc continental deposits. QTc deposits continue to form the unconfined aquifer, with no real aquitard layer until bedrock is reached. In the east portion of the subbasin and in the RCWD area, the base of the unconfined water body is the basement complex, which is estimated by Mitten et al. (1970) at greater than 1,000 feet deep.

3.1.8.1 Geologic Formations

Regulation Requirements:

§354.14(b)(4)(a) Formation names, if defined.

Marchand (1976) contains a set of geologic maps of the Madera area. The relatively flat surface areas of RCWD are primarily mapped as Quaternary Riverbank Formation (middle unit). Where this formation is incised by drainage channels, areas of underlying, older Turlock Lank Formation (upper unit) are exposed. The Riverbank is described as alluvial sand, silt, and gravel, where the Turlock Lake unit is alluvial arkosic sand with minor gravel, overlying stratified fine sand silt and minor clay. The Riverbank Formation contains an extensive iron-silica hardpan horizon present at the surface and in the subsurface. This hardpan horizon is can encountered in the RCWD and as such is an important consideration for recharge. The Turlock Formation includes extensive and hydraulically important subsurface deposits throughout the San Joaquin Valley. This formation extends to the trough of the valley where it interfingers with the E-clay. See Sections **3.1.5** to **3.1.7** for more detailed discussions of the soils and geology.

3.1.8.2 Aquifer Characteristics and Properties

Regulation Requirements:

§354.14(b)(4)(b) Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.

Vertical Extent

In their discussion of the groundwater reservoir in the Madera subbasin, Mitten et al. (1970) divided the system into 1) the shallow water body, 2) the unconfined water body, and 3) the confined water body. In the 1960s, they mapped the boundary of the shallow water body in the southwest part of the area, just east of Mendota and far from the District. The unconfined water body is mostly in the older alluvium above and east of the E-clay; however, it does extend downward into the Tertiary and Quaternary age undifferentiated and continental deposits (QTc). This water body extends east past Highway 41 where it eventually pinches out in the eastern foothills, east of RCWD. In the western portion of the subbasin, the vertical boundary is the base of the freshwater, which has been defined as groundwater with a TDS content of less than 2,000 mg/L. In RCWD, the bottom of the freshwater boundary is not well defined and is likely at contact with the bedrock complex. The unconfined water body is the principal groundwater source in the District. Local areas in the unit can exhibit semiconfined conditions due to localized permeability differences. The confined water body exists below areas of the E-clay, several miles west of the RCWD area.

Aquifer Characteristics

Aquifer characteristics of importance to RWCD are mainly transmissivity, hydraulic conductivity, and storativity. Storativity relates to how much space is available in the aquifer system for storage of groundwater. More specifically, storativity is the volume of water that a permeable unit will absorb or expel from storage per unit surface area per unit change in head (Fetter, 1994). In unconfined aquifers, the storativity is approximately equal to the specific yield. Therefore, as most of the published sources consulted for this HCM provide information on specific yield, this portion of the report discusses specific yield as a close approximation of storativity in the unconfined aquifer.

Hydraulic conductivity is the rate at which water can move through a permeable medium, and the transmissivity is the amount of water that can be transmitted horizontally throughout the saturated thickness of the aquifer under a hydraulic gradient of one. These two properties are related such that transmissivity is the hydraulic conductivity multiplied by saturated aquifer thickness, thus the following discussion focuses on transmissivity values alone as a representation of both these characteristics.

Specific Yield of the Deposits

Specific yield values are highly related to soil textures which are determined by geomorphic units. Davis et al. (1959), Mitten et al. (1970), Williamson et al. (1989), and DWR (2006) all provide estimates of specific yields in the Madera area based on texture of the deposits. These estimates of specific yield are based on textural descriptions of deposits, electric logs, laboratory analysis of soils samples, and a relatively simple and transparent methodology.

Davis et al. (1959) sorted classification of materials from drillers' logs into five major groups and assigned specific yields to each based on results of previous studies conducted on samples collected in California. The assigned specific yield values range from 3% for clay deposits to 25% for medium to coarse sand and gravel deposits. For the San Joaquin River storage unit, including the San Joaquin River alluvial plain and the valley plain west of Madera, the average specific yield between depths of 10 to 200 feet is 11.9% (Davis et al.). Davis et al. includes a table of estimated groundwater storage capacity units, by township subunits, sorted by depths of 10 to 50, 50 to 100, and 100 to 200 feet. RCWD spans two townships: T12S R19E and T12S R20E. The specific yields for the two townships between 10 and 200 feet are summarized in **Table 3-1**. For RCWD as a whole, the average specific yield from shallow to deep is 14.6%, 13.4%, and 12.8%.

Mitten et al. (1970) reported water bearing properties of the soil profile based on USGS laboratory analyses of surface samples of both older and younger alluvium in the Madera study area. Results show that specific yields are highly variable in the older alluvium, and the younger alluvium is more permeable. Specific yields for older alluvium ranged from 0.5% to 22.4% in silts and 14.0% to 23.4% in sands.

Williamson et al. (1989) also estimated specific yield for the thickness of the aquifer using a model. From his study, specific yield for the District area averages between 11 and 13% for the thickness of the aquifer. Since specific yield tends to decrease with depth due to finer grained soils, the low end of the estimate is recommended. Lastly, DWR (2006) estimates the average specific yield of the Madera Groundwater Subbasin is 10.4%; however, this value will not be used due to the high spatial variance in specific yield. Recommended specific yield values at varying aquifer depths for use in this GSP in the RCWD area based upon Davis, et al. and Williamson et al., are summarized in **Table 3-1**.

Table 3-1 Summary of Specific Yield Estimates

Township	Estimated Specific Yield (percent)				
	10-50 feet[1]	50-100 feet[1]	100-200 feet[1]	All zones[1]	200-300 feet[2]
T12S R19E	15.6%	15.1%	10.3%	12.7%	11%
T12S R20E	13.5%	11.7%	15.3%	14.0%	

1. Source: Davis et al. (1959)
2. Source: Williamson et al. (1989)

<u>Hydraulic Conductivity and Transmissivity</u>

Estimates of transmissivity are available from published sources including Davis, Lofgren, and Mack (1964). Davis et al. (1964) provide information for numerous short-term pump tests in the area including specific capacity (discharge in gallons per minute [gpm] divided by drawdown) by township. Thomasson et al. (1960) developed an empirical relationship between specific capacity and transmissivity, which is also discussed by Driscoll (1986) and more recently by Abbott (2015). Transmissivity can be approximated by multiplying specific capacity by a factor of 1,500 for unconfined aquifers and 2,000 for confined aquifers. At the time that these studies were done, it is likely that most wells in the San Joaquin Valley were shallow and open bottom; therefore, the resultant transmissivities are probably more valid for the shallower portion of the aquifer comprised of Older Alluvium. In general, transmissivity values are higher for the older alluvium than the underlying deposits. Transmissivity values of 50,000 to 250,000 gallons per day (gpd)/ft would normally apply for the older alluvium, while transmissivity values of 10,000 to 30,000 gpd/ft would be more representative of underlying deposits due to the fine-grained texture. Transmissivity values can also be high in paleo channel deposits and low in deposits dominated by floodplain clays.

Short-term pump tests performed by PG&E in the San Joaquin Valley have also been compiled by the USGS (Davis et al., 1964). The primary two townships that encompass RCWD have average discharge rates and specific capacities of 733 gpm and 77 gpm per foot (gpm/ft) and 645 gpm with a specific capacity of 41 gpm/ft for T12S/R19E and T12S/R20E, respectively. Using the common conversion factor of 1,500 for unconfined aquifer conditions, the aquifer transmissivities would be 115,500 gallons per day per foot (gpd/ft) and 61,500 gpd/ft for T12S/R19E and T12S/R20E, respectively. These are likely pump tests of wells screened in the younger and older alluvial soils.

Data from 2014 and 2015 aquifer testing in two RCWD wells published by Davids & LSCE (2017), showed slightly lower results to the PG&E short-term pump tests described above. Specific capacity in Riverstone

Well 1 ranged from approximately 33 to 36 gpm/ft and had a transmissivity of 48,000 gpd/ft, while deeper Well 2 specific capacity was calculated at approximately 10 gpm/ft and transmissivity at 15,000 gpd/ft. The results are summarized in **Table 3-2**.

Table 3-2 Summary of Transmissivity Estimates

Publication	Estimate of Transmissivity (gpd/ft)	Description/Notes
Davis et al. (1964)	115,500 61,500	Averages for T12S/R19E and T12S/R20E, respectively.
Davids et al. (2017)	48,000 15,000	Based on pump tests conducted on RCWD wells.

3.1.8.3 Aquifer Uses

Regulation Requirements:

§354.14(b)(4)(e) Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.

The aquifer in the RCWDGSA area is used primarily for irrigation but is increasing in domestic and municipal water supply purposes for the new Riverstone development. **Table 3-3** below provides a summary of estimated groundwater pumping in the District from 2014 through 2017. Further discussion of pumping is presented in Section 3.3 – Water Budget.

Table 3-3 Summary of Groundwater Pumping in RCWD

Year	Groundwater Pumping (AF)		
	Agricultural Demand Estimate	Actual Residential / Municipal	Total
2014	20,851	0	20,851
2015	21,119	0	21,119
2016	21,142	0	21,142
2017	16,234	70	16,304
		Average (4 years)	*19,854*

3.1.9 General Groundwater Quality

Regulation Requirements:

§354.14(b)(4)(d) General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.

The discussion presented below is intended to be a generalized overview of groundwater quality in the Madera Subbasin and RCWD area. A more detailed discussion on groundwater quality is included in Groundwater Conditions, Section 3.2.6.

Groundwater quality of the Madera Subbasin is described by Mitten et al. (1970) and in the Madera County Regional Groundwater Management Plan (Provost & Pritchard, 2014) as generally good for agriculture. Nitrate is an important constituent of concern in the area and can be found in concentrations higher than desired. Specific conductance is a general indicator of salts and TDS and is typically a good indicator of water quality. For drinking water purposes, water quality concerns in RCWD include elevated levels of manganese, arsenic, and HPC (mostly in wells about 800 feet deep). Groundwater above a depth of 650 feet appears to be largely suitable for drinking water supply, except for manganese in some shallower wells. A review of the groundwater quality concludes that, with a few exceptions, groundwater is adequate for agricultural use.

The most current and complete discussion on recent groundwater quality is referenced in the RCWD Groundwater Management Plan (Provost & Pritchard, 2012) and a report prepared by Kenneth D. Schmidt & Associates and Provost & Pritchard (2003), which documents samplings from 15 deep and shallow wells throughout the District. This information represents a more complete horizontal and vertical water quality data set, thus allowing for a more detailed understanding of water quality, especially in the deeper groundwater. Results from this study along with others are presented in more detail in Section 3.2.6.

3.1.10 Surface Water Features

§354.14(d)(5) Physical characteristics of the basin shall be represented on one or more maps that depict surface water bodies that are significant to the management of the basin.

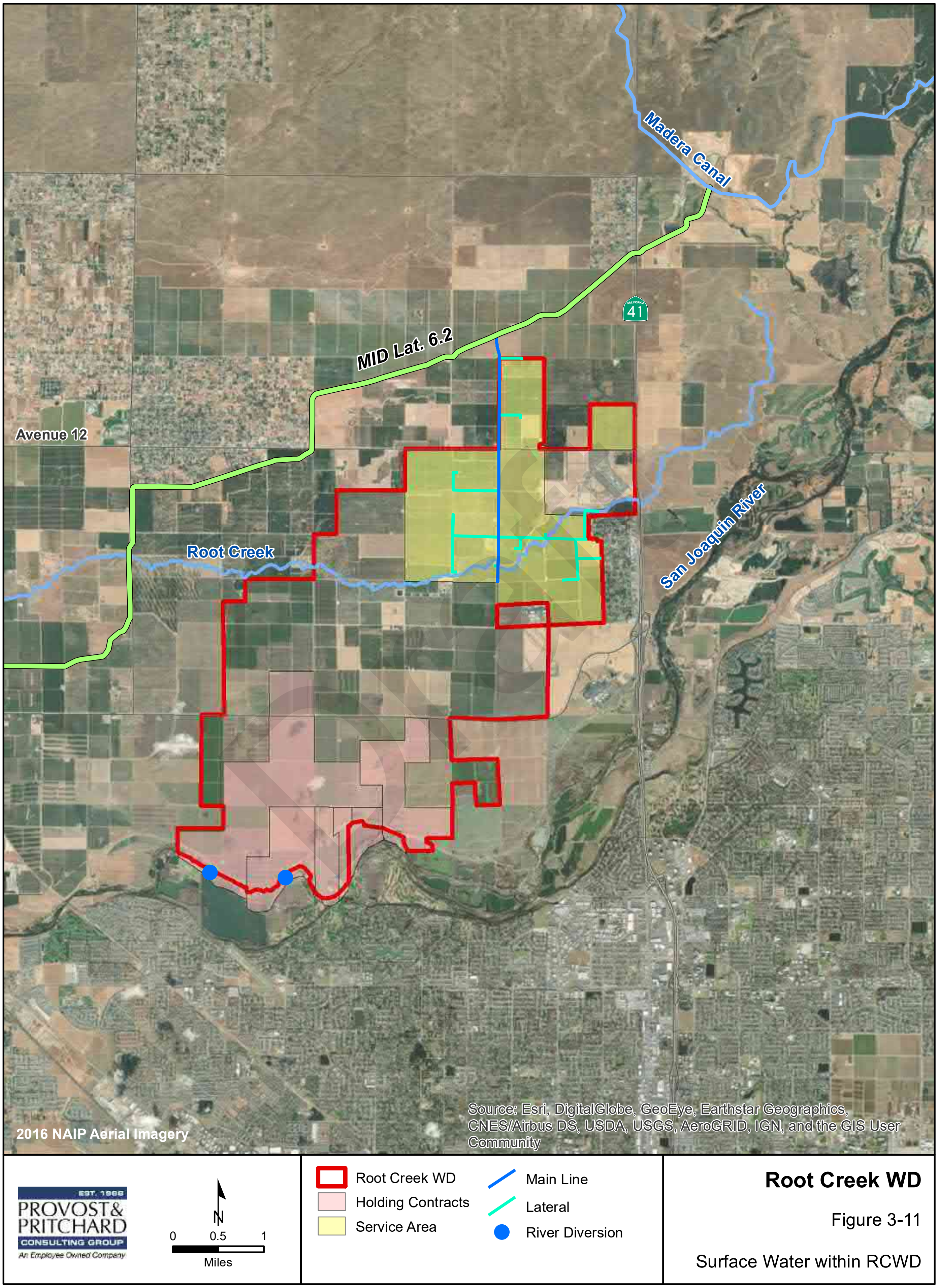
Surface water features are minimal across the GSA. The San Joaquin River runs along the District's southern boundary and is the most significant water feature in the GSA (seen in **Figure 3-11**). Riparian diversions along the San Joaquin River provide irrigation water to private users with holding contracts in lieu of using groundwater. Root Creek is a largely undefined intermittent creek that has minor flow during wetter winter seasons and is not currently used for irrigation.

3.1.11 Source & Point of Delivery of Imported Water

Regulation Requirements:

§354.14(d)(6) Physical characteristics of the basin shall be represented on one or more maps that depict the source and point of delivery for imported water supplies.

The source of the San Joaquin River is the Sierra Nevada Mountains, where it is dammed in the foothills by the Friant Dam, creating Millerton Lake approximately 16 miles upstream of RCWD. RCWD has contracted for surface water supplies with MID and Westside Mutual to use in-lieu of groundwater pumping, which they may receive via the San Joaquin River. RCWD also has an agreement with USBR to redirect Section 215 flows when available. In 2014, RCWD constructed a turnout from MID Lateral 6.2 (which branches off of the Madera Canal), as well as a pipeline conveyance and distribution system. Surface water imports through the system began in 2017. The only other sources of imported surface water supplies are through two known turnouts on the San Joaquin River that supply water to individual landowners with holding contracts. All sources of surface water and points of diversion are shown on **Figure 3-11**.



Root Creek WD

Figure 3-11

Surface Water within RCWD

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3.1.12 Recharge and Discharge Areas

Regulation Requirements:

§354.14(d)(4) Physical characteristics of the basin shall be represented on one or more maps that depict delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.

This section discusses existing and potential groundwater recharge areas and areas of groundwater discharge. The information is presented on a regional scale and provides a general assessment of the GSA's recharge potential. This information would need to be supplemented with local information for developing site specific groundwater recharge projects.

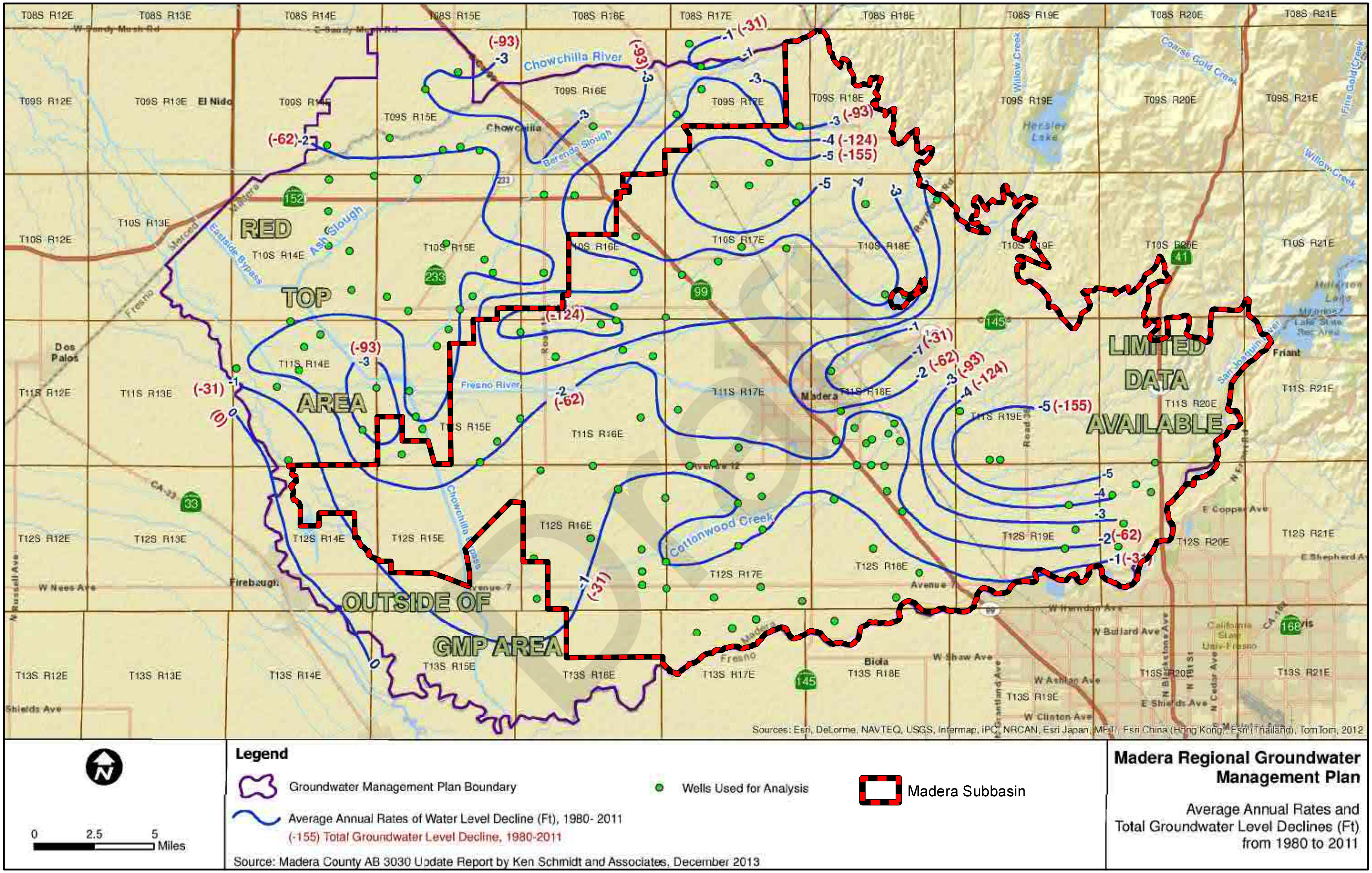
Figure 3-12 depicts the average annual rate and total decline of water level in the basin. Of note, on this figure are the locations of the San Joaquin River and other significant creeks and rivers. In general, areas where the rate of groundwater level decline is low indicates recharge is occurring. For example, the contour for an average annual decline of one foot per year is near the San Joaquin River, indicating that the river acts as a source of recharge. The southeast portion of the basin is different where the contours indicate a depression located in the general area of the Madera Ranchos, indicating that this area is a source of discharge or groundwater pumping.

<u>Existing Recharge Areas</u>
RCWD recognizes that replenishment of groundwater is an important technique in management of groundwater supply to mitigate overdraft. Natural recharge occurs along the San Joaquin River where water seeps into the bed of the river and enters the groundwater system. The San Joaquin River provides a significant source of recharge in the basin, accounting for an estimated 900 af per mile. This recharge helps maintain groundwater levels near the river while providing surface water for holding contract owners. Root Creek also offers a minor source of recharge in wet years when there is a lot of rain. Lastly, with the development of the Riverstone community, there is a location of wastewater effluent recharge. Areas of recharge and discharge can be seen in **Figure 3-13**. However, there are no existing intentional infiltration basins in the GSA. Studies, infiltration testing, and subsurface exploration will be performed in the future to evaluate potential recharge areas.

<u>Potential Recharge Areas</u>
Potential recharge areas can be identified using the soil and geologic maps described herein. These maps provide a regional assessment of recharge potential and can be useful for initial screening. It should also be recognized that land availability is generally a limiting factor in the selection of recharge areas.

<u>Soils</u>
A soils map based on Natural Resource Conservation Service soil textural classes in relation to Saturated Hydraulic Conductivity is presented as **Figure 3-8**. This map generally represents soils in the upper 5 to 7 feet of the soil profile. The most permeable soils appear to be mapped in the northern upland areas of the older alluvial fan and near the San Joaquin River. The majority of the area is shown to have a duripan or restrictive layer within 6 feet of the surface; however, this resistive layer is penetrated in local channel erosion areas.

Figure 3-12



X:\2016\16-119 Madera Co. - Chowchilla & Madera Subbasins SGMA Support\GIS\Maps\FinalMapsForTM\Madera Subbasin\Figure 3-12 Madera Subbasin Groundwater Level Change from 1980 to 2011.mxd

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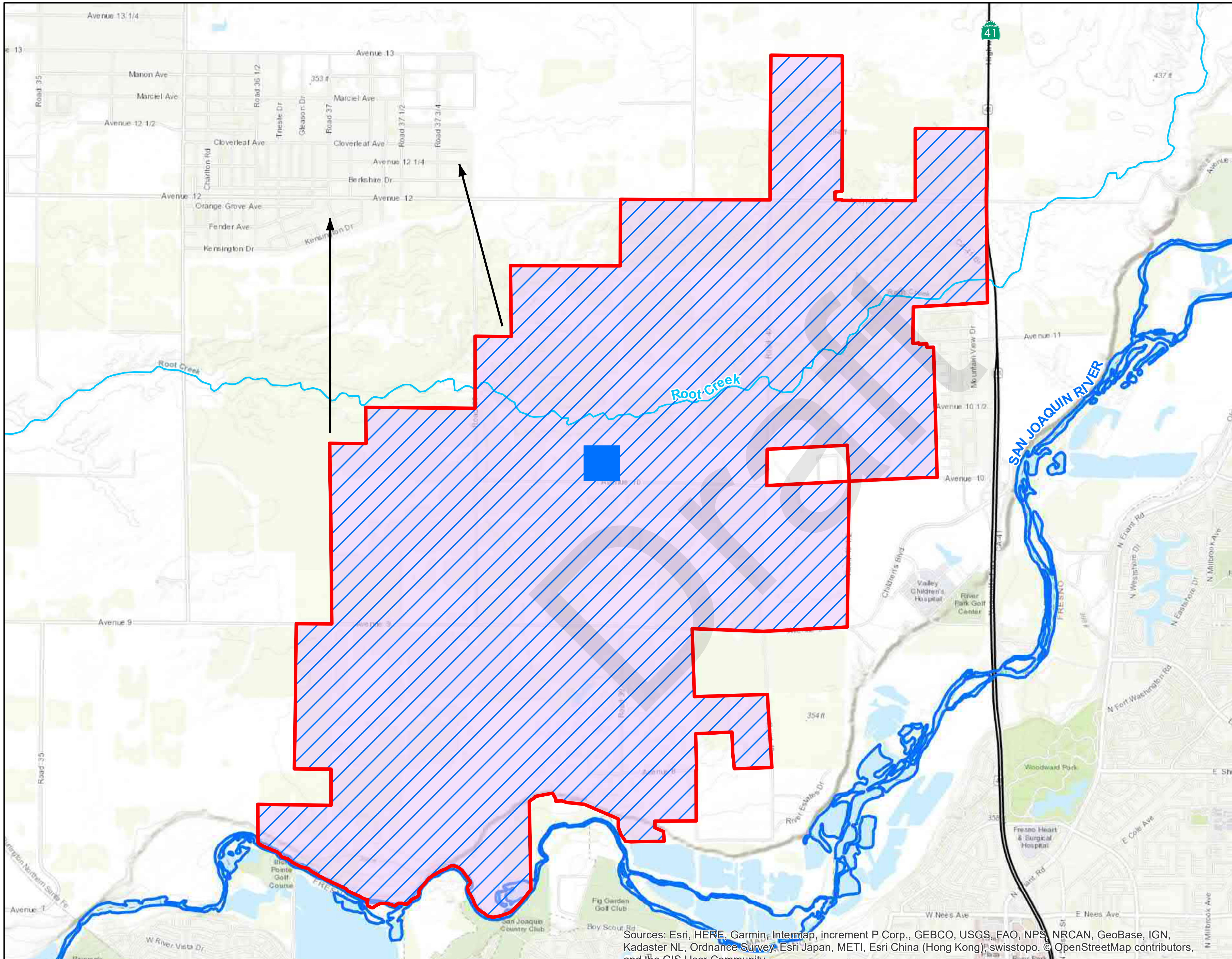
FIGURE 3-13
Groundwater Level Change from 1980 to 2011 (from 2014 Madera Regional GMP)

Madera County: Madera Subbasin
SGMA Data Collection and Analysis

Root Creek WD

Figure 3-13

Areas of Recharge and Discharge



- Root Creek WD
- Area of Groundwater Extraction
- Effective Recharge
- Recharge Ponds
- San Joaquin River
- Stream Recharge
- Groundwater Discharge Direction

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0 0.25 0.5 Miles

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Soil Agricultural Groundwater Banking Index

The Soil Agricultural Groundwater Banking Index (SAGBI) is a composite evaluation of the feasibility of groundwater recharge on agricultural land (also called Irrigation Field Flooding). Irrigation Field Flooding could have significant potential for groundwater recharge due to irrigated agriculture in the GSA. The Index was developed by University of California, Davis and the University of California Division of Agriculture and Natural Resources. The Index incorporates the following five parameters:

1. Deep percolation is dependent upon the saturated hydraulic conductivity of the limiting layer.
2. Root zone residence time estimates drainage within the root zone shortly after water application.
3. Topography is scored according to slope classes based on ranges of slope percent.
4. Chemical limitations are quantified using the electrical conductivity (EC) of the soil.
5. Soil surface condition is identified by the soil erosion factor and the sodium adsorption ratio.

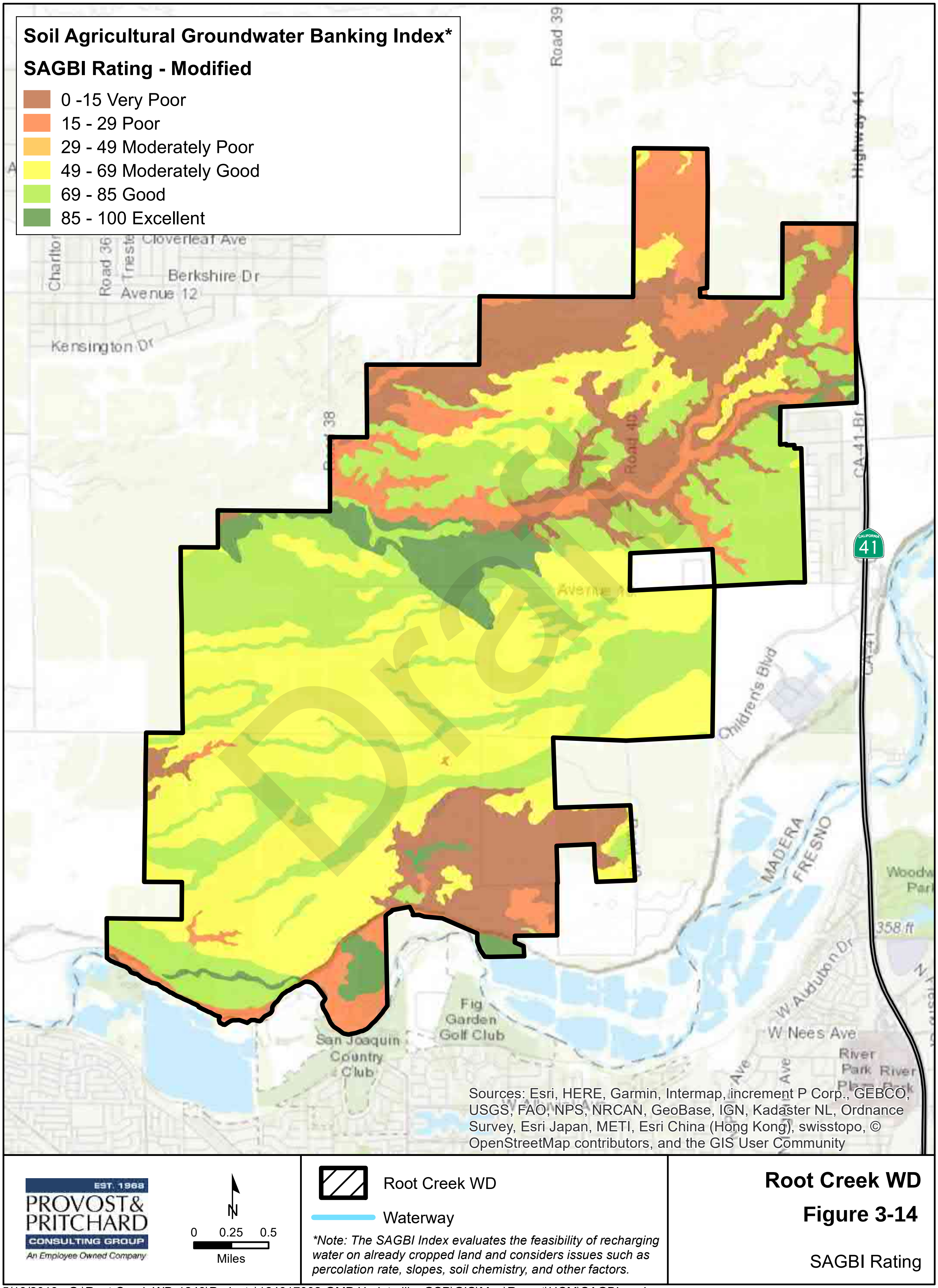
Proximity to a water conveyance system is not a factor considered in the SAGBI composite evaluation. Each factor was scored on a range, rather than discretely, and weighted according to significance. Adjustments were then made to reflect soil modification by deep tillage (i.e., shallow hard pan is assumed to have been removed by historic farming activities).
Figure-3-14 illustrates the SAGBI Index for the RCWD. Ultimately, SAGBI seeks to categorize recharge potential according to risk of crop damage at the recharge site. Usefulness of the index is diminished when evaluating locations for dedicated recharge basins. In these cases, a soil profile illustrating deep percolation potential may prove to be more useful. As is the case with any model, SAGBI is best applied in conjunction with other available data and on-site evaluation.

Discharge Areas

There are currently no known natural groundwater discharges (springs, seeps, etc.) in the area. Springs and artesian wells were common decades ago; however, groundwater levels have declined such that these features are no longer found in the area. Groundwater level maps (see **Section 3.2.1**) show that average groundwater depths are well below the surface.

Wetland Areas

Wetland areas from the U.S. Forest Service's National Wetland Inventory are shown on **Figure 3-15**. Very few small areas are mapped as wetlands in the GSA.



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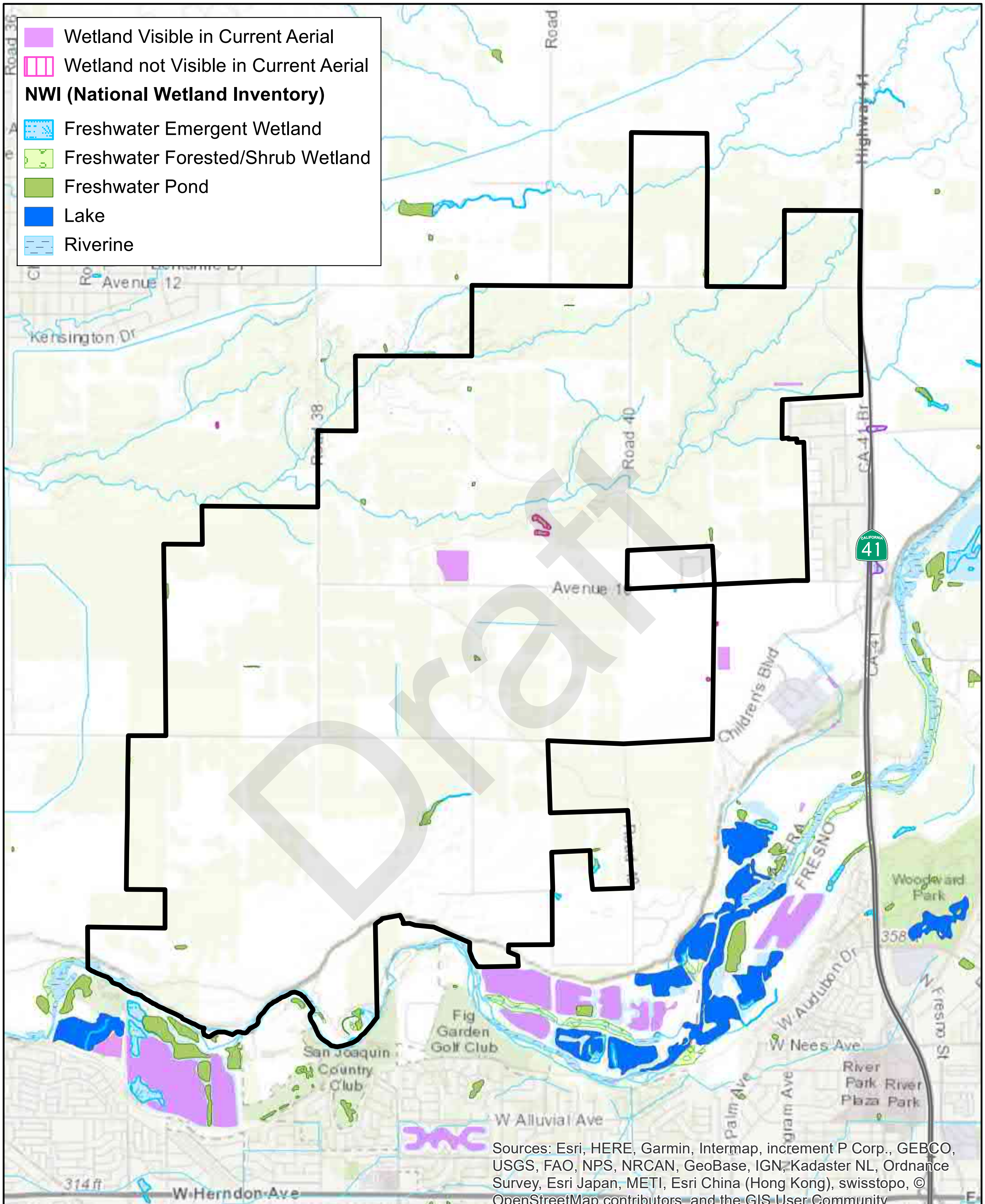

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0 0.25 0.5
Miles

Root Creek Water District

Root Creek WD

Figure 3-15

Wetlands

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3.1.13 Identification of Data Gaps in HCM

§354.14 (b)(5) The hydrogeologic conceptual model shall be summarized in a written description that includes identification of data gaps and uncertainty within the hydrogeologic conceptual model.

The HCM has been described in the preceding paragraphs. Additionally, the RCWDGSA has been working collaboratively with the Davids/Luhdorf and Scalmanini consultant team, and at this time within the RCWDGSA, there is uncertainty regarding the interconnection of surface water and groundwater where the San Joaquin River abuts the GSA. The USBR continues to work with and have contact with these landowners and maintains flow in the river to meet their needs. Even though it is not clear technically of the specifics of this interaction the parties to these agreements have contracts that pertain to the use of surface and groundwater supplies. Even though there is not technical evidence as to the connectivity the existing agreements are considered the binding requirements of the area, so this is not considered a data gap.

Due to the holding contracts and use of surface water in the southern portion of the district there are limited wells south of Avenue 8. Groundwater levels in wells south of Avenue 8 would helpful in determining change in groundwater level over time and depth of groundwater below the riverbed.

3.2 Groundwater Conditions

3.2.1 Current and Historical Groundwater Conditions

Regulation Requirements:

§354.16 Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes the following:

This section includes a description of the current and historical groundwater conditions within RCWDGSA, including groundwater levels, groundwater storage change, groundwater quality, land subsidence, and interconnected surface and groundwater. The data used in this chapter includes the most recent available information, as well as historical well levels, to describe groundwater trends in the District.

3.2.2 Groundwater Level Data

Regulation Requirements:

§354.16(a) Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:

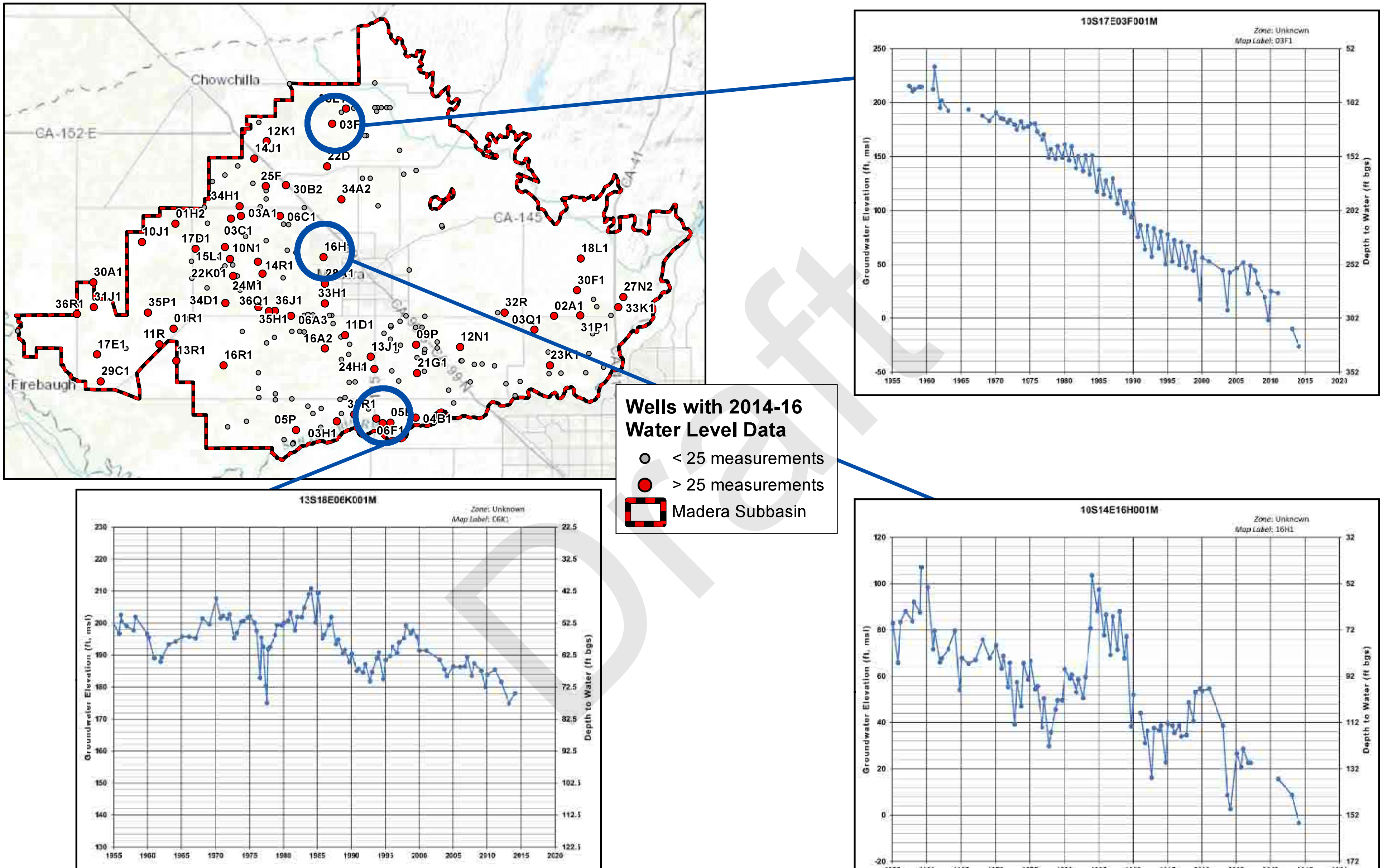
1. Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.
2. Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.

The purpose of this section is to present information on current and historical groundwater levels throughout the Madera Subbasin, and more specifically RCWD. Maps from the early 1900s indicate that groundwater in the subbasin flows from northeast to southwest, prior to significant development of groundwater. The western portion of the subbasin was considered part of an “artesian zone” running through the center of the San Joaquin Valley. Groundwater elevation contour maps developed by DWR are available for selected years between 1958 and 1989. Groundwater elevation data and GIS files of groundwater contours are also available from DWR for 2012 to 2016. Although the DWR maps are developed with water level measurements that include wells with unknown construction details, DWR has categorized these groundwater contour maps as being representative of unconfined and semi-confined groundwater levels across the Madera Subbasin.

Groundwater hydrographs with a relatively long period of record and recent data (at least through 2014) were reviewed to evaluate long-term trends (Davids Engineering and Luhdorff & Scalmanini, 2018). Selected hydrographs in different areas of the subbasin are displayed in **Figure 3-16**. Well 3F1 in the northeastern portion of the subbasin shows a sustained long-term decline in groundwater elevations from about 215 feet above mean sea level (msl) in the late 1950s to -25 feet msl in 2014. Well 16H1 in the middle of the subbasin shows year-to-year climatic fluctuations combined with an overall decline from about 80 feet msl to 0 feet msl from 1955 to 2014. Well 6K1 in the southern portion of the subbasin along the San Joaquin River shows fairly stable groundwater elevations from 1955 to 2014 with an overall net decline from about 200 feet msl to 180 feet msl.

Overall, long-term declines and very steep recent declines (between 2012 and 2016) were prevalent in the northwestern and northeastern portions of the subbasin. More stable areas of the subbasin generally lie along the San Joaquin River in the southern portion of the subbasin and extends northwest from the San Joaquin River in the western portion of the subbasin. More recent groundwater elevation contours for most of the subbasin are shown on **Figure 3-17** for Fall 2016.

Figure 3-16



X:\2016\16-119 Madera Co. - Chowchilla & Madera Subbasins SGMA Support\GIS\Maps\FinalMapsForTM\Madera Subbasin\Figure 3-10 Madera Subbasin Selected Groundwater Hydrographs.mxd

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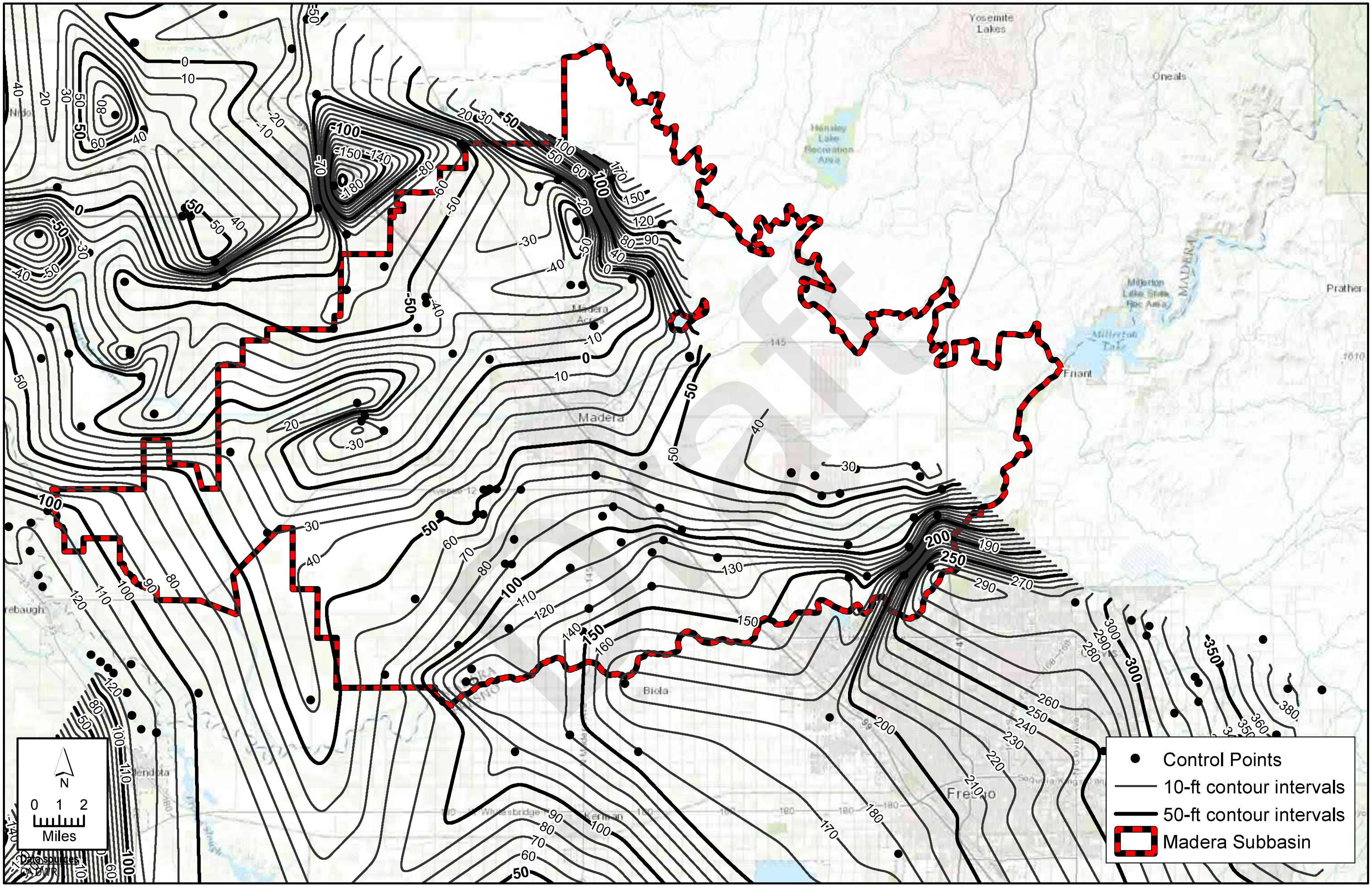
Selected Groundwater Hydrographs

Madera County: Madera Subbasin
SGMA Data Collection and Analysis

Figure 3-17



X:\2016\16-119 Madera Co. - Chowchilla & Madera Subbasins SGMA Support\GIS\Maps\FinalMapsForTM\Madera Subbasin\Appendix B Madera Subbasin GWE Contours Fall 2016.mxd

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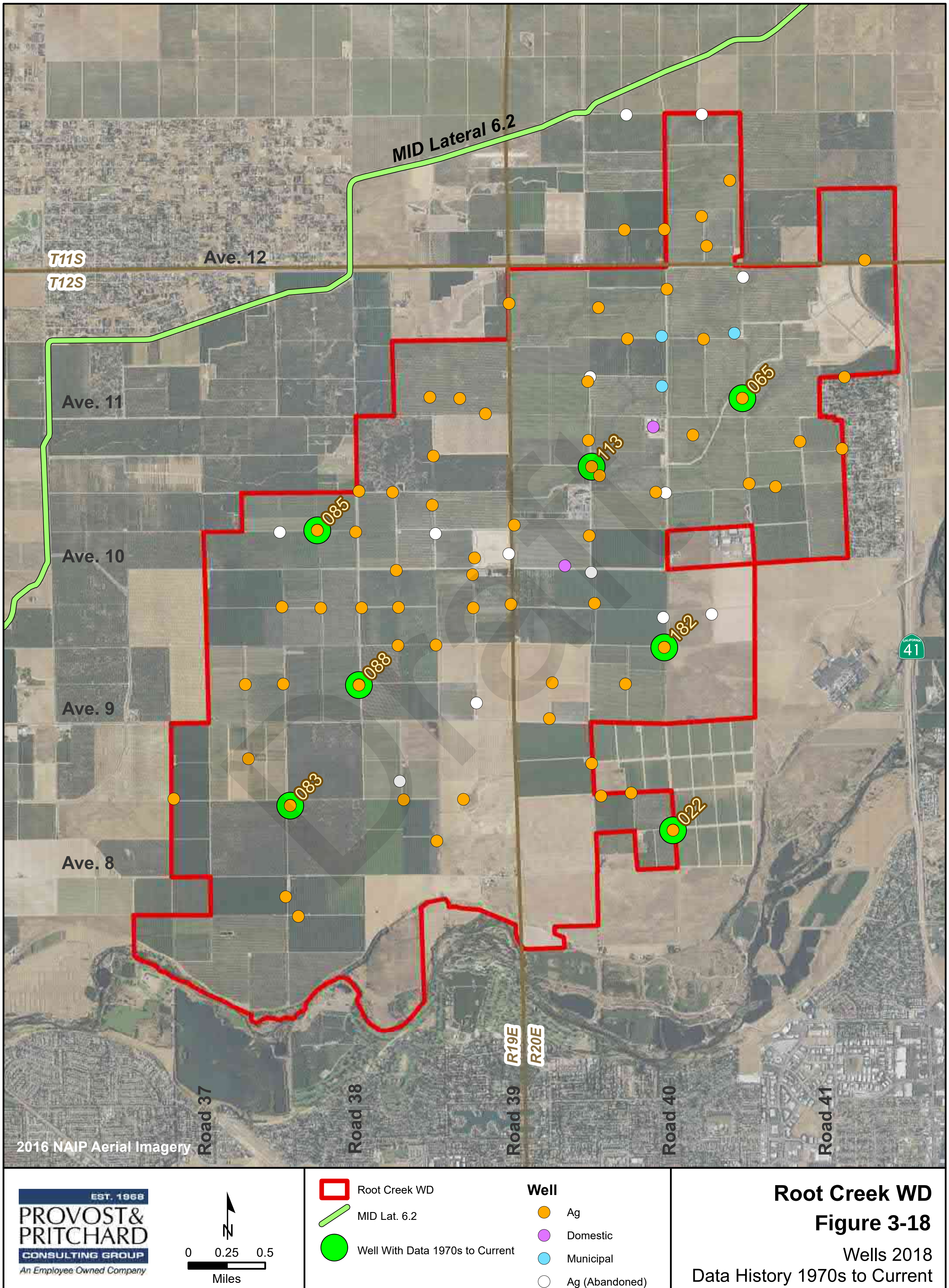
APPENDIX C
Contours of Equal Groundwater Elevation
Fall 2016

Madera County: Madera Subbasin
SGMA Data Collection and Analysis

The rest of this section will display and discuss current and historical groundwater level conditions more specific to RCWD. Included in the discussion are groundwater contour elevation maps and hydrographs for wells with adequate historical data within the GSA. Well construction information is unknown for each individual well; however, 58 Well Completion Reports have been reviewed for general information regarding well depth, which varies considerably throughout the GSA. In the northern two-thirds of the District, the total well depths range from 470 feet to just over 800 feet deep with most well having a depth of less than 600 feet. In the southern third of the District, the total well depths were generally in the range of 400 to 500 feet deep.

Groundwater contour mapping was initiated in the RCWD area in 1998. Prior to 1998, measurements of depth to water were acquired in some wells. So, while regional data is not available, there is some record as to change in groundwater conditions from the late 1970s forward. **Figure 3-18** shows the location of the wells with hydrographs that reach back to 1975, while
Figure 3-19 shows the hydrographs for the wells. By looking at the Figures, it can be seen that the further north a well is located in the District, the lower the water levels and the more drastic the decline becomes. This may be attributed to seepage from the San Joaquin River along with surface water use by landowners with holding contracts, which decreases groundwater pumping closer to the river. These hydrographs represent long-term trends that show how groundwater pumping has changed over time and location.

A second set of hydrographs are plotted for five selected wells (see **Figure 3-20**) across RCWD to represent a 20-year record (from 1998 to 2018) as shown on **Figure 3-21**. Data from these hydrographs provide a more recent indication of historical groundwater level trends seen in the basin. Seen more clearly in these hydrographs is the seasonal fluctuation due to agricultural pumping and in response to wet or dry periods; however, all wells show a long-term trend of decline. The decline is gradual in the central part of the District (wells 088 and 145) but progressively increases in rate of decline to the northeast (wells 113 and 153). Across the District, the average rate of decline from 1998 to 2018 is about -2.5 feet/year. Note, the fall readings for 2017 show relatively constant water levels from the spring readings, even a slight increase in some wells. This may be due to the use of the new conveyance system in the northern portion of the District, which brought in a large volume of surface water in 2017 during the irrigation season.



Root Creek WD

Figure 3-18

Wells 2018

Data History 1970s to Current

5/13/2019: G:\Root Creek WD-1249\Projects\124917002-GMP Update like GSP\GIS\Map\Report\Gen\Wells_data1970s_v2.mxd

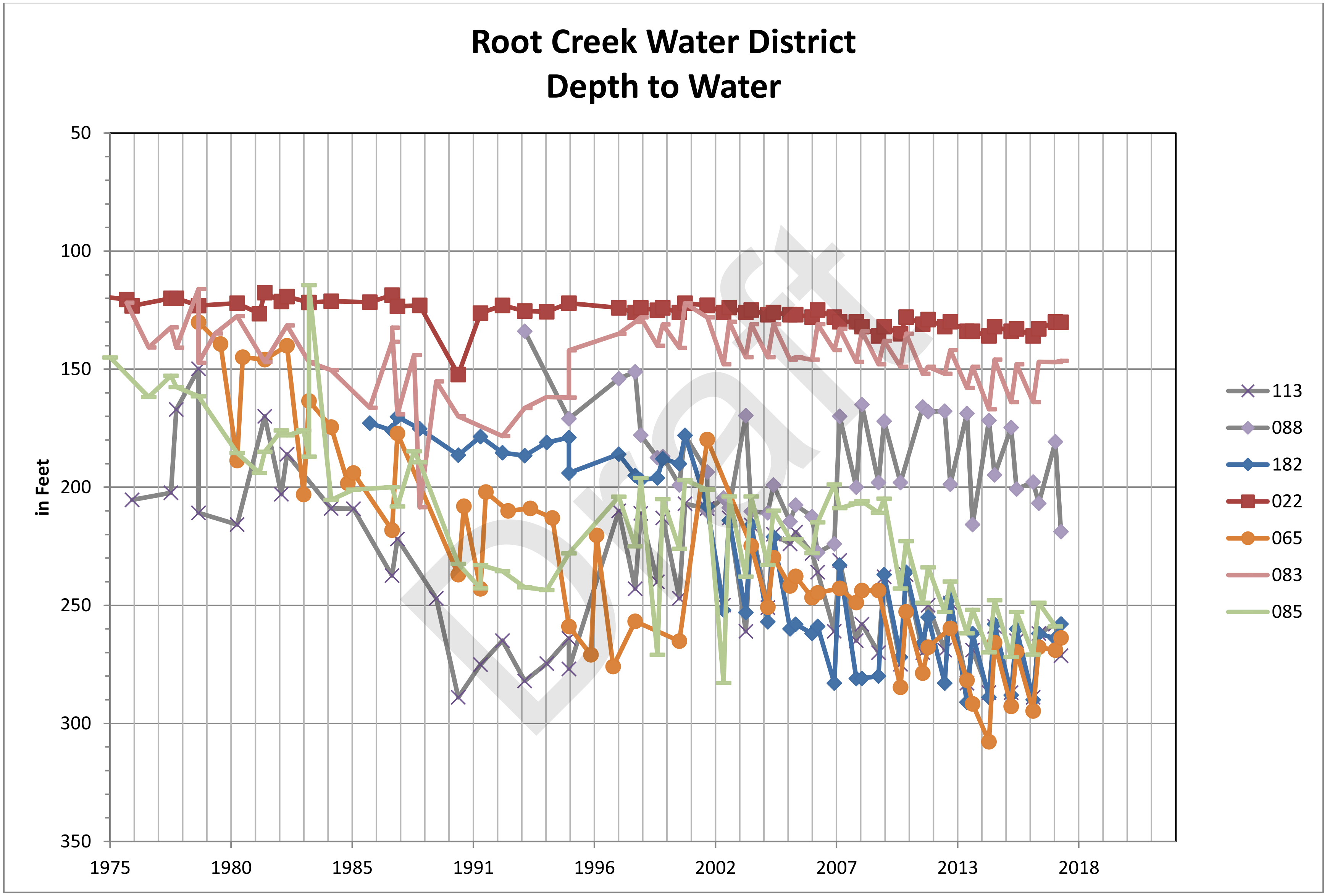
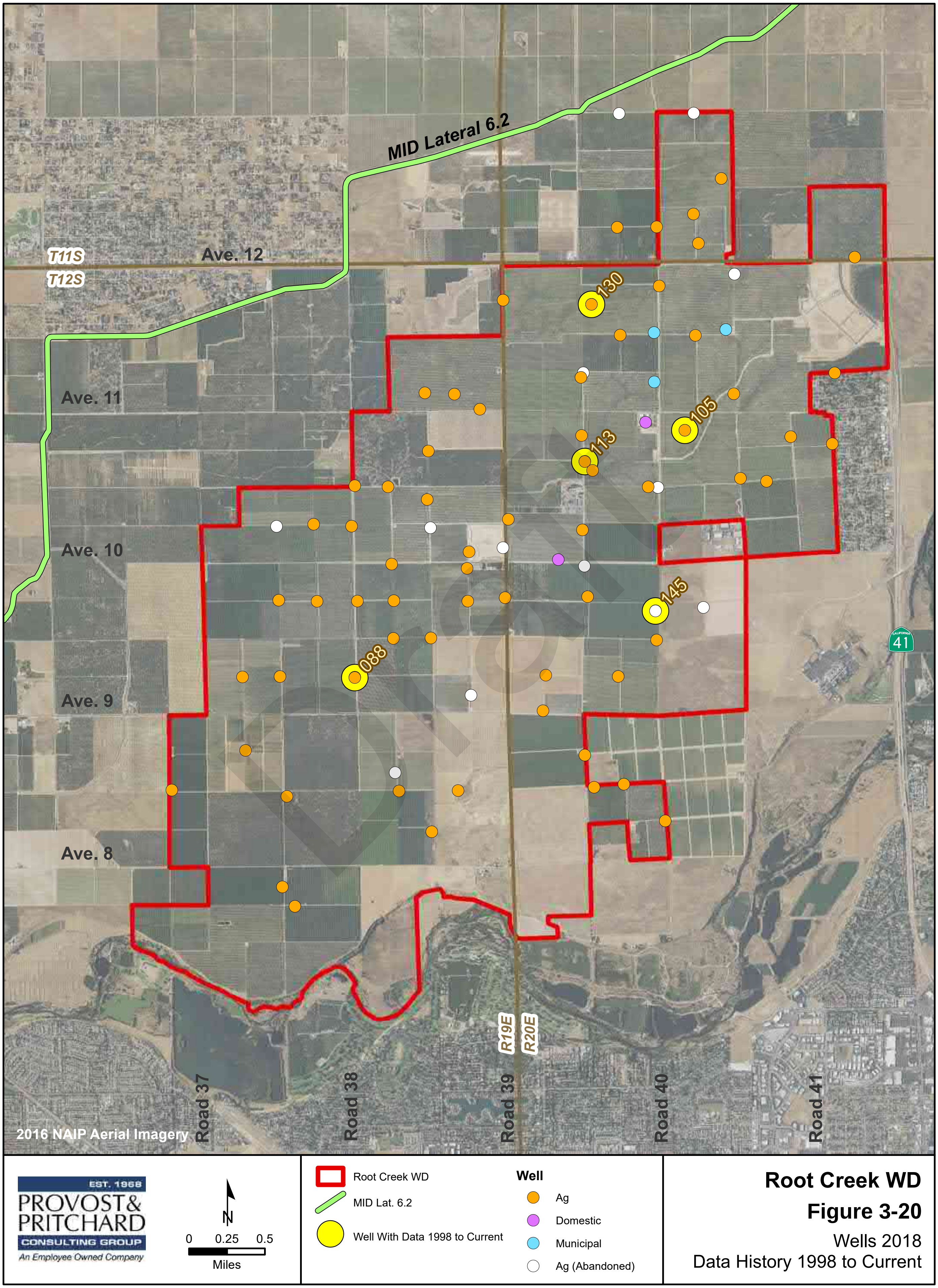


Figure 3-19. RCWD Select Well Hydrographs 1975-2018



Root Creek WD

Figure 3-20

Wells 2018

Data History 1998 to Current

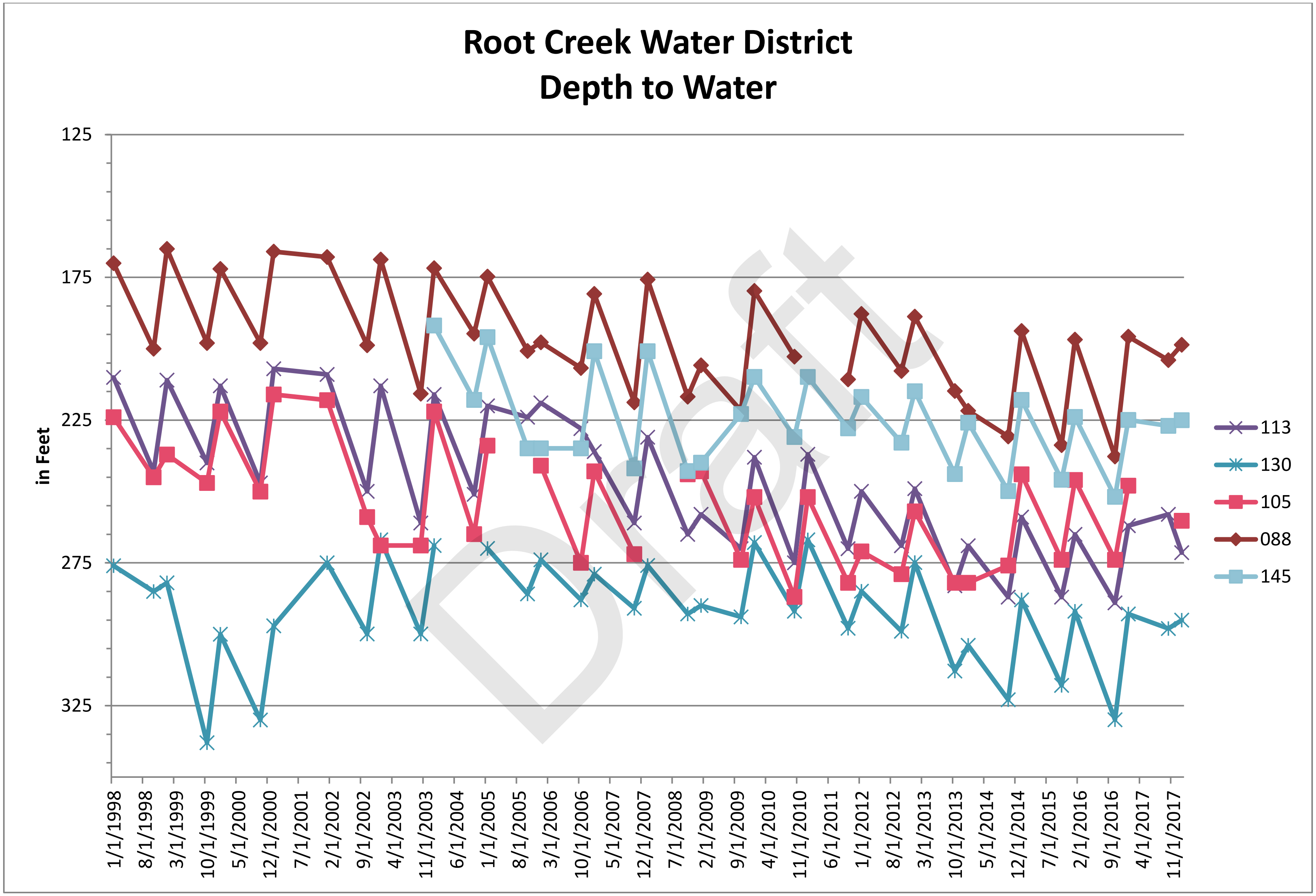
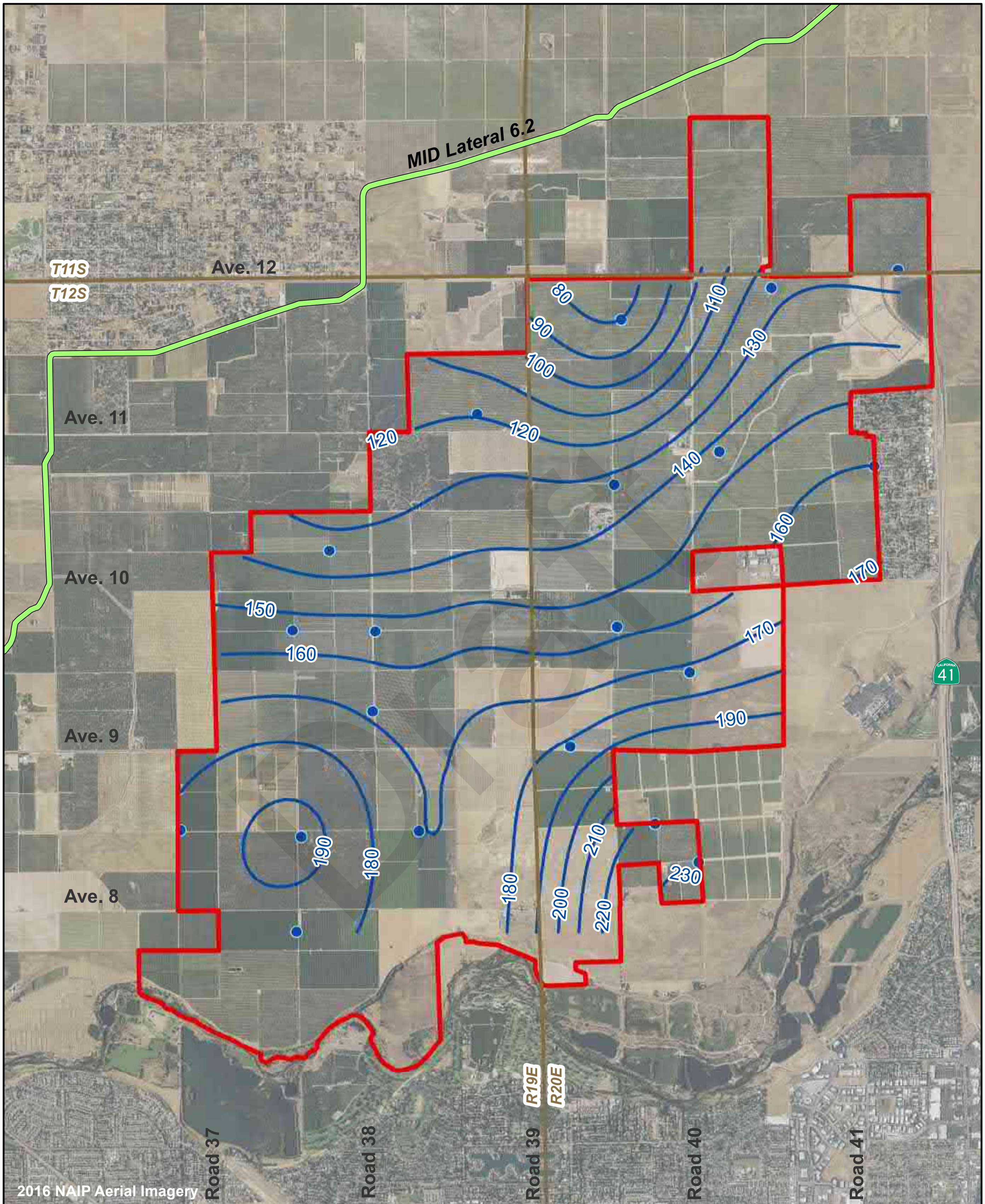


Figure 3-21. RCWD Select Well Hydrographs 1998-2018

The RCWD GMP (2012) indicates that prior to development of groundwater resources in the current GSA area, groundwater was typically about 100 feet below the ground surface and the direction of flow was to the southwest. In the fall of 1936, the first period for which a groundwater map was available, well water-levels ranged in elevation from about 270 feet above msl in the northeast corner of the District to 240 feet in the southwest. By the spring of 1960, groundwater elevations ranged from around 230 to 255 feet above msl and the direction of flow was more westerly with a slight southerly component. By 1993, a large pumping depression had formed north/northwest of the District, and water elevations had lowered to 150 feet msl while levels remained about 210 feet msl near the San Joaquin River in the south. This large offsite pumping depression effectively changed the direction of flow across the District from westerly to northerly.

Water elevations have continued to decline into 2017, and more recent groundwater elevation maps indicate that the direction of flow across the District is typically northerly. Prior to 1998, sufficient data is lacking, consequently the period evaluated in this section is 1998 through 2017. However, there is a lack of sufficient data close to the San Joaquin River to create elevation contours. **Figure 3-22** displays groundwater elevation contours for the year 1998, compared to **Figure 3-23**, which shows 2017 levels. The total change in groundwater elevations between the two years is shown in **Figure 3-24**. Change in groundwater elevation gives insight into where the most change in groundwater storage is occurring since groundwater levels are directly related to storage change using the specific yield.

Groundwater elevations in the northern part of the District in 2017 were up to 70 feet lower than in 1998, with the most decline in the northwestern corner. Although the data is sparse near the San Joaquin River, it appears that constant river recharge tends to stabilize water elevations in this area. From 1936 to 2011, groundwater levels have declined about 140 feet in the north part of the District and have dropped only 10 to 20 feet near the San Joaquin River.



EST. 1968 PROVOST& PRITCHARD CONSULTING GROUP An Employee Owned Company

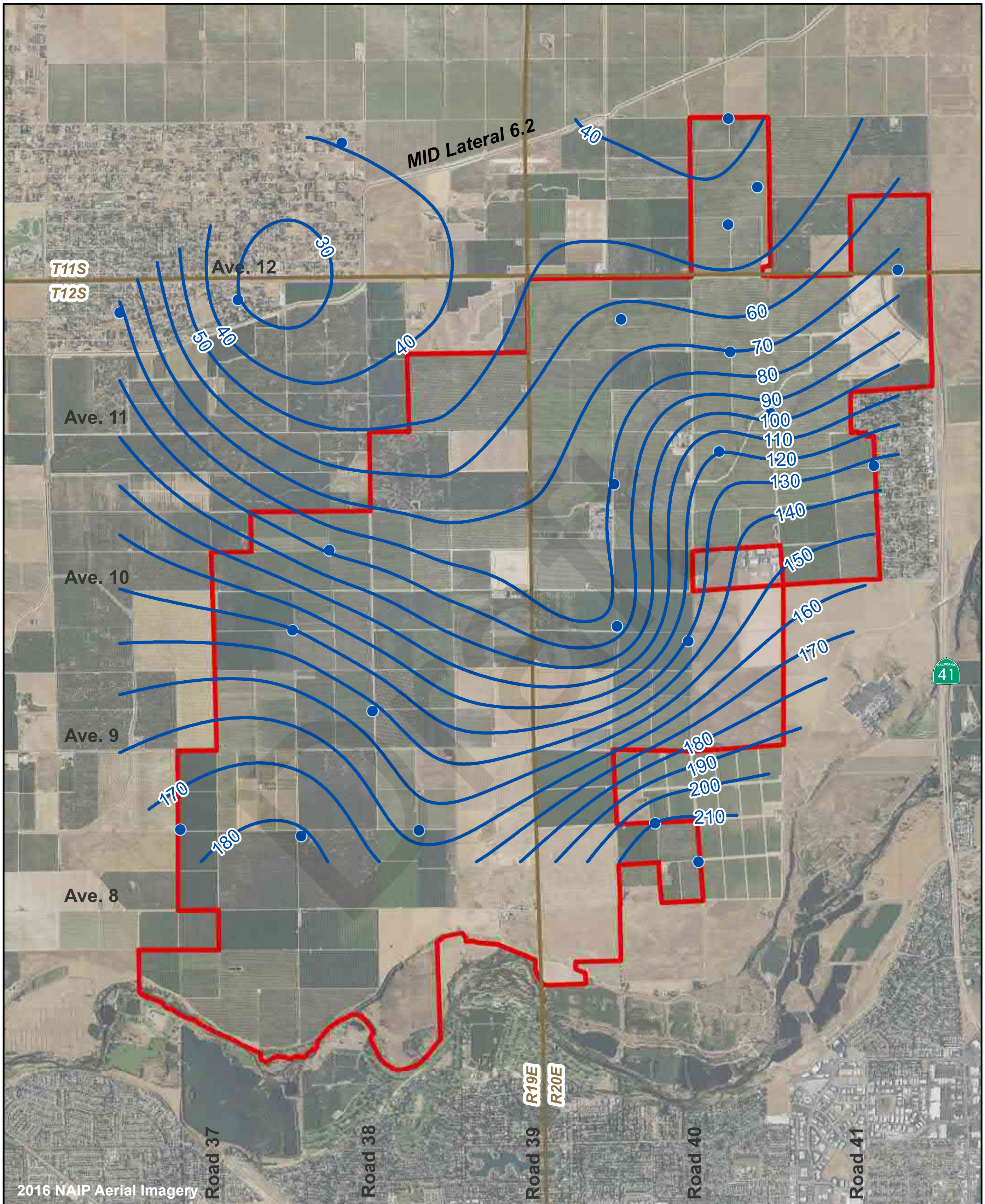
N

0 0.25 0.5 Miles

- Root Creek WD
- MID Lat. 6.2
- Line of Equal Elevation (10 ft interval)
- Well Used In Analysis

Root Creek WD
Figure 3-22
Water Surface Elevation
Spring 1998

5/13/2019: G:\Root Creek WD-1249\Projects\124917002-GMP Update like GSP\GIS\Map\Report\Gen\Spring1998_WSE.mxd



EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
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N

0 0.25 0.5
Miles

Root Creek WD

Well Used In Analysis

Elevation of Water in Wells (feet above sea level)

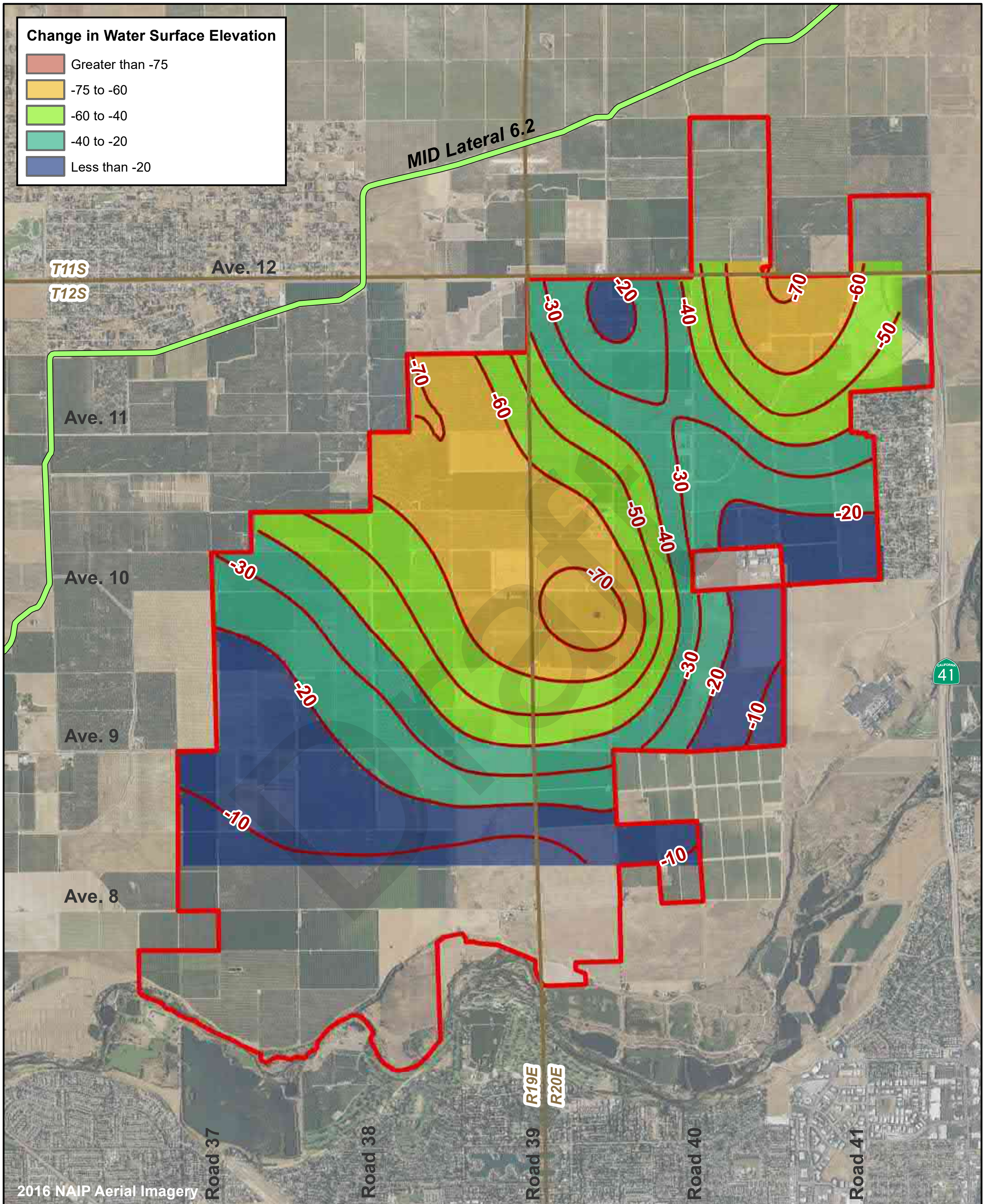
Line of Equal Elevation (10 ft interval)

Root Creek WD

Figure 3-23

Elevation of Water in Wells
Spring 2017

5/13/2019: G:\Root Creek WD-1249\Projects\124917002-GMP Update like GSP\GIS\Map\Report\GC\WSE_Spring17.mxd



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Root Creek WD

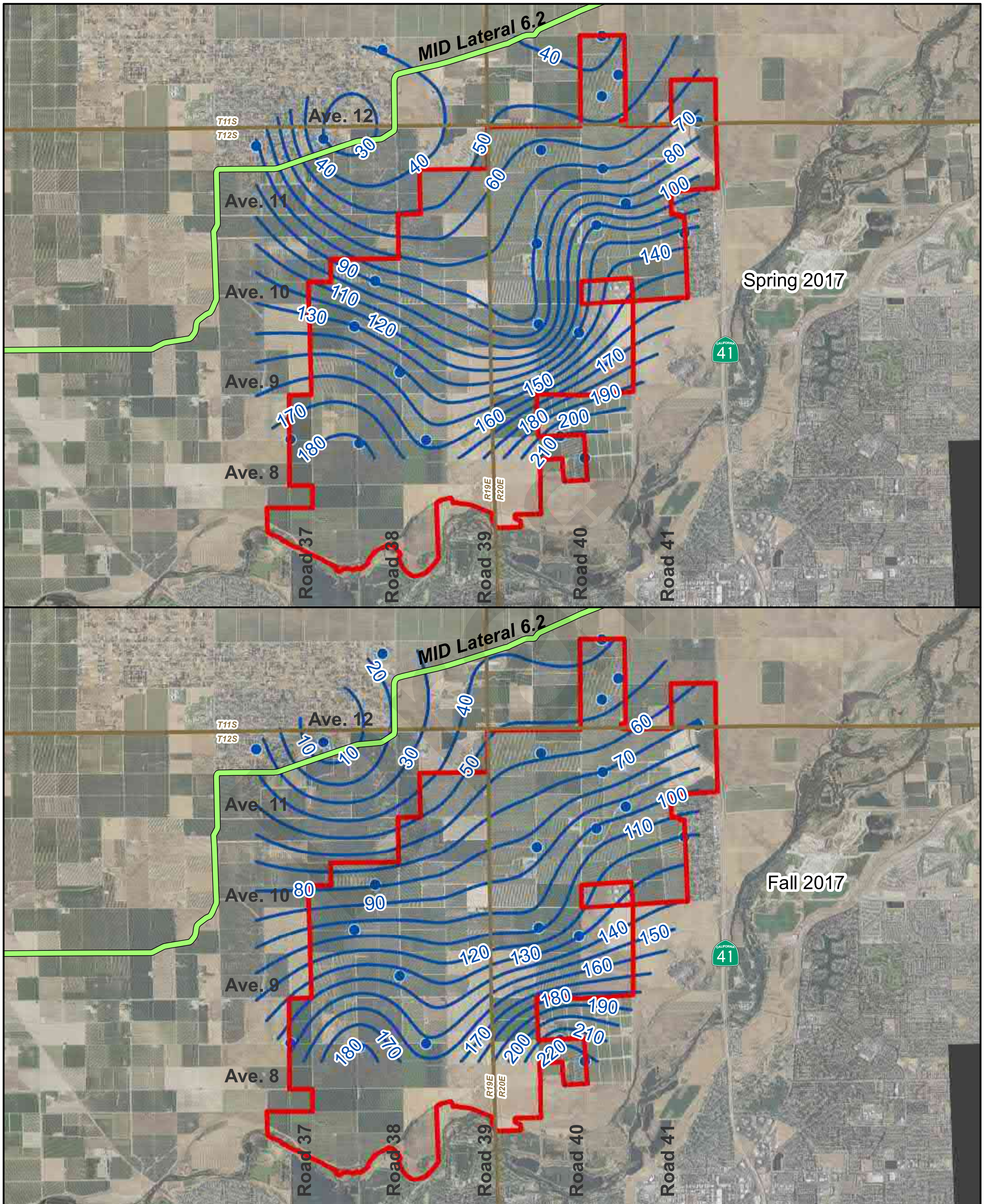
Figure 3-24

Water Surface Elevation, Spring 1998

5/13/2019: G:\Root Creek WD-1249\Projects\124917002-GMP Update like GSP\GIS\Map\Report\Gen\WSE_Change_1998_2017.mxd

3.2.3 Groundwater Movement

Figure 3-25 shows the Spring 2017 and Fall 2017 groundwater elevation contour maps for RCWD to display changes from seasonal pumping. Both maps depict the north to northwesterly flow gradient and display the drawdown impact of the summer's pumping in the Fall 2017 contours. With continued implementation of the In-Lieu project, the northeastern portion of the district should experience significantly less drawdown over time.



Root Creek WD

MID Lat. 6.2

PROVOST& PRITCHARD CONSULTING GROUP

EST. 1968

An Employee Owned Company

N

0 0.75 1.5

Miles

Root Creek WD

Water Surface Elevation
Spring & Fall 2017

5/13/2019: G:\Root Creek WD-1249\Projects\124917002-GMP Update like GSP\GIS\Map\Report\Gen\2017_WSE.mxd

3.2.4 Estimate of Groundwater Storage

Regulation Requirements:

§354.16(b) A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type.

The method used in this GSP estimates the change in groundwater storage in the unconfined aquifer for RCWD. Specific yield is known as the drainable porosity of an aquifer and is defined as the ratio of the volume of water a rock or soil will yield by gravity drainage to the volume of rock or soil (Meinzer, 1932). The value is used in groundwater storage calculation and was obtained from a limited number of available publications. Specific yield data derived from subsurface material textures are generally considered to be the most accurate values that can be obtained. To calculate storage change, specific yield for unconfined groundwater is multiplied by the change in groundwater depth for an area for a specific time period. For instance, if over a 1,000-acre area there is a 10-foot per year decline in the groundwater level, and an estimated specific yield of 8%, then the change in groundwater storage volume would be equivalent to 1,000 acres x 10 feet x 8% = 800 acre-feet per year. Specific yield values within RCWD have been identified for varying depths: 0-50ft, 50-100ft, 100-200ft, and 200-300 feet below the ground surface by Davis et al. (1959) and Williamson et al. (1989). **Table 3-4** summarizes the specific yield values recommended for the District.

Table 3-4 Summary of Recommended Specific Yield Estimates

Publication Information	Data Coverage	Depth of Coverage	Recommended Specific Yield in Area of RCWD
USGS WSP 1469, (Davis and others, 1959)	San Joaquin Valley and locations against the foothills	10-50 feet 50-100 feet 100-200 feet	10-50 feet - 14.6 50-100 feet - 13.4 100-200 feet - 12.8
USGS PP 1401-D, (Williamson, and others, 1989)	San Joaquin Valley, except locations against the foothills	Variable from 150 to >600	200-600 feet – 11.5

The storage changes from spring to spring for 1998 to 2017 are shown on **Figure 3-26**. The average depth to groundwater over a time period was based on an average of available groundwater level readings. A three-dimensional surface representing the groundwater table is prepared to estimate average groundwater levels and the change in storage. This depth change for a time period of spring to spring is multiplied by the specific yield value for 100 to 200 feet deep and the value for 200 to 300 feet deep, then multiplied by the area of the District.

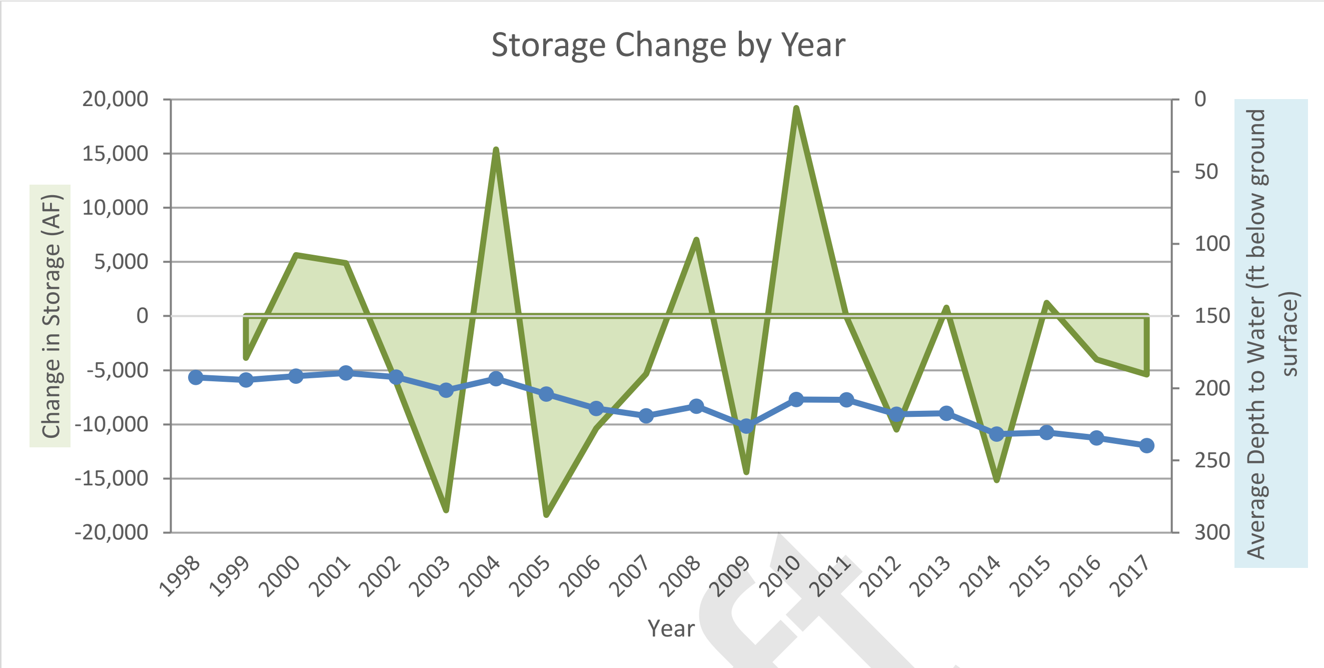


Figure 3-26 Change in Groundwater Storage from 1998 to 2017

3.2.5 Seawater Intrusion

Regulation Requirements:

§354.16(c) Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.

The Madera Subbasin is not impacted by seawater intrusion, which occurs when saline water from the ocean infiltrates the groundwater system and is pulled towards freshwater sources by gradients in groundwater levels caused by overdraft, in many cases. However, there may be naturally occurring saline or brackish water in the groundwater system, which would usually occur at greater depths. Page (1973) mapped the base of fresh groundwater in the San Joaquin Valley, which he defined as water having less than 3,000 micromhos electrical conductivity. RCWD is not located within an area having saline water according to Page. Mitten et al. (1970) states that highly saline connate water is present west of the District. Connate water is ancient water, often of marine origin, trapped in the interstices of a sedimentary rock when the rock was deposited. It is often identified at great depths and not used as a regular water supply. KDSA and P&P (2001, October) indicate that connate water is not an important water supply for RCWD because of the District's easterly location and that high chloride water below depths of 600 feet is located approximately 2 miles west of RCWD. They indicate that this may reflect some connate water influence due to upward movement of deeper groundwater. Additionally, KDSA and P&P (2003) report that an 800-foot deep well in the central portion of the District had chloride concentrations of 172 mg/L and TDS 500 mg/L. This could indicate that groundwater from deeper wells in that area might be affected by deeper connate groundwater. KDSA and P&P (2003) sampled 15 wells throughout the District and found that the highest TDS values were from wells perforated more than 700 feet deep. However, a majority of the wells in the District are constructed shallower (due to the proximity of the San Joaquin River) and do not have problems with saline water.

3.2.6 Groundwater Quality Issues

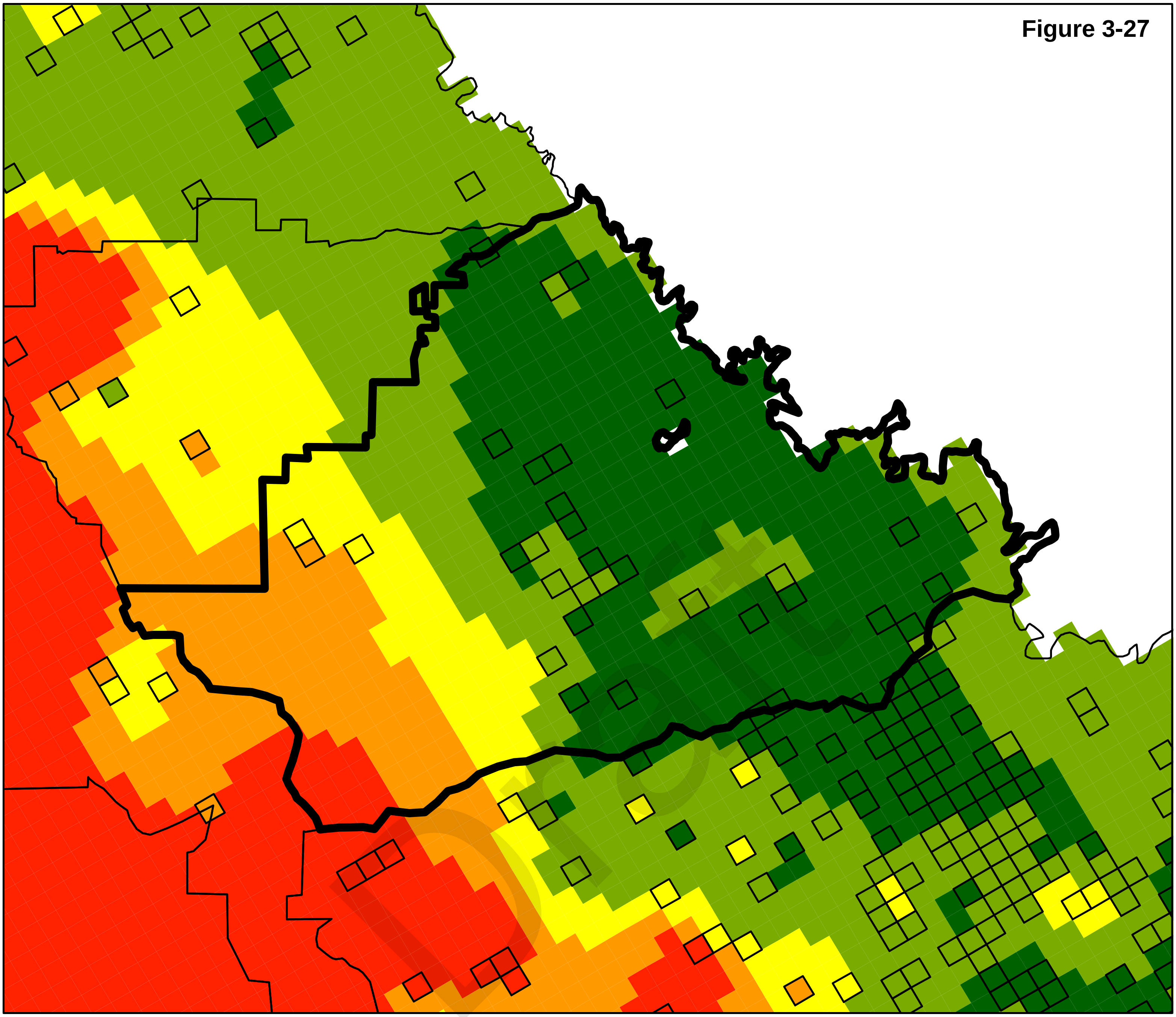
Regulation Requirements:

§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.

Davids Engineering (2017) provides information on groundwater quality in their Technical Memorandum for Data Collection and Analysis on Madera Subbasin. The report collects information from various sources, such as the CV-SALTS program, the Regional Groundwater Management Plan, GAMA, and Luhdorff and Scalmanini (LSCE). A figure done by LSCE and Larry Walker Associates for DWR Bulletin 118 shows TDS concentrations for the upper aquifer (**Figure 3-27**). Concentrations of TDS generally increase from east to west in the Madera Subbasin, starting out at about 250 mg/L increasing to concentrations greater than 1,000 mg/L.

A map done by Wood Rodgers for Madera County displays specific conductance values, which correlate to concentration of TDS. Testing was done in wells of unknown depth due to lack of Well Completion Reports; therefore, it is unknown whether the water is from the upper aquifer, lower aquifer, or composite. **Figure 3-28** shows the majority of wells tested having water quality adequate for drinking as far as dissolved solids are concerned. Out of the wells tested around the RCWD area, all wells display results of specific conductance less than the recommended levels. Another main constituent of concern is concentration of nitrates. Wood Rogers has completed a map showing concentration levels of nitrate in wells which shows great variability throughout the subbasin, as seen in **Figure 3-29**. Again, the well depth is unknown; however, based on the few well measurements that do include well depth information, nitrate concentrations are typically higher in shallower wells and decrease with depth. Arsenic concentrations for wells less than 400 feet deep and from 400 to 600 feet deep were below the maximum contaminant level (MCL) of 10 ug/L. Available data from Provost & Pritchard et al. (2014) for deep wells indicates the majority are at less than the MCL for arsenic, but there were two wells exceeding 10 ug/L in the southeastern portion of the subbasin.

Figure 3-27



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

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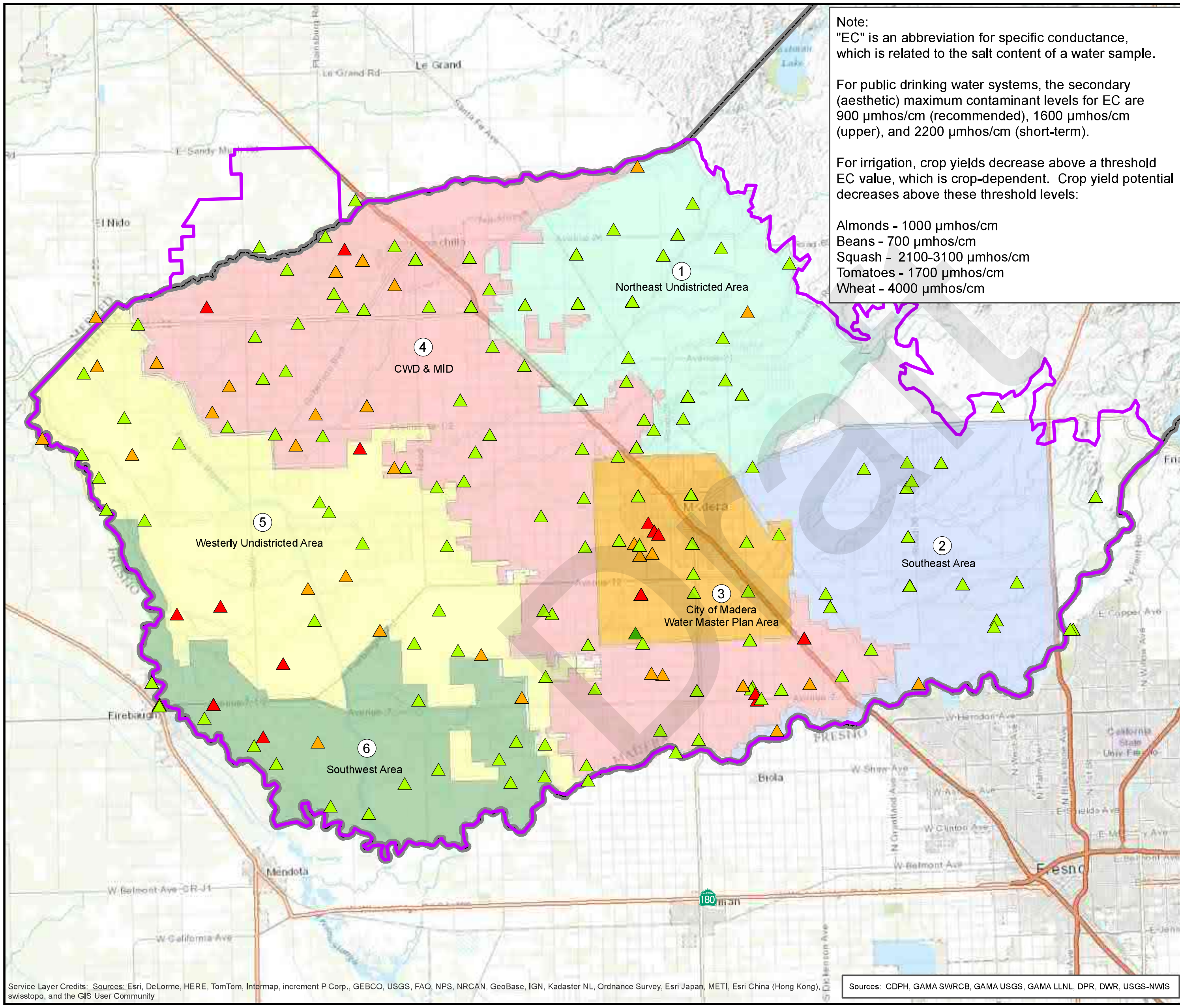
LARRY WALKER ASSOCIATES

Figure 3-28



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

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

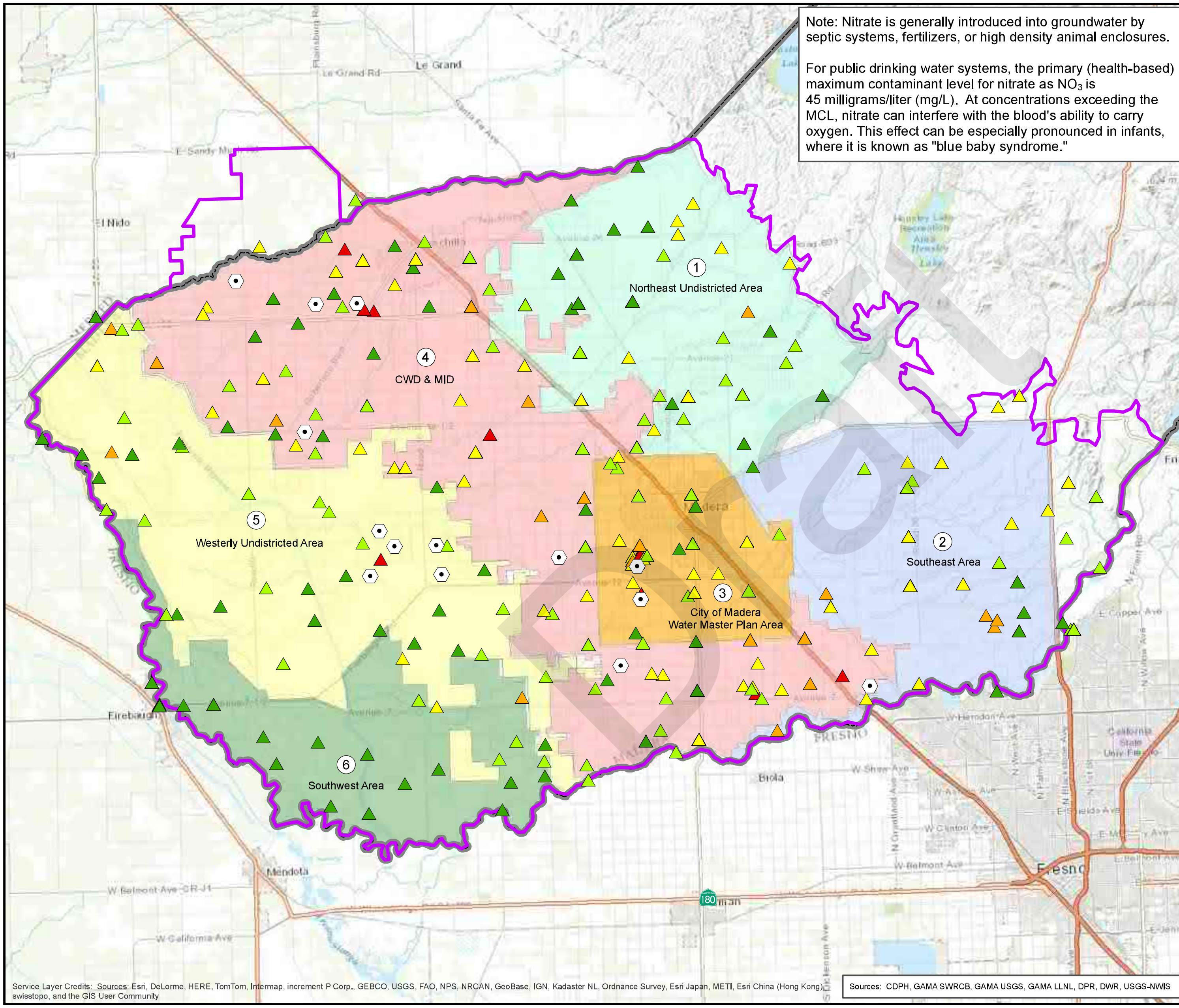
- < 600
- 600 - 900
- 900 - 1600
- > 1600
- Groundwater Management Plan Boundary
- Madera County Boundary

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.

WOOD RODGERS
DEVELOPING INNOVATIVE DESIGN SOLUTIONS
3301 C Street, Bldg. 100-B Tel: 916.341.7760
Sacramento, CA 95816 Fax: 916.341.7767

Document Path: J:\Jobs\8489_Madera_County\8489.005_Madera_County_GMP\GIS\Tasks\Water_Quality_Maps\20140407_Updated_Figures\Madera_EC_Map_4_OTHER_WELLS_20140407.mxd

Figure 3-29



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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Sacramento, CA 95816 Fax: 916.341.7767

Document Path: J:\Jobs\8489_Madera_County\8489.005_Madera_County_GMP\GIS\Tasks\Water_Quality_Maps\20140407_Updated_Figures\Madera_Nitrate_Map_4_OTHER_WELLS_20140407.mxd

Historically, RCWD has generally had adequate groundwater quality for both agricultural use and drinking water. One of the better sources of general information on historical water quality is provided by Mitten et al. (1970). A review of the maps indicates that wells at that time were typically less than 300 feet deep, although the information on well depths was sparse. The groundwater typically had low salinity and sodium hazards and variable nitrate concentrations from 1 to greater than 20 mg/L. Chloride was less than 20 mg/L in groundwater with a small pocket of higher chloride water from 20-40 mg/L in the central part of the District. Soft groundwater (0-60 mg/L as $CaCo_3$) was found in the northeast part of the District, and a transitional zone of hardness (60-120 mg/L as CaCo3) extended northwest to southeast across the central part of the District with a zone of harder water (121-180 mg/L as CaCo3) evident near the San Joaquin River. Total Dissolved Solids ranged from 96 to 424 mg/L.

The most current and complete discussion on recent groundwater quality in the District is presented by KDSA and P&P (2003), who document sampling from 15 deep and shallow wells throughout the District. This information presents horizontal and vertical water quality data, thus allowing for a more detailed understanding of water quality, especially the deeper groundwater. Constituents selected for analysis included nitrate, fluoride, iron, manganese, arsenic, heterotrophic plate counts (HPC), and Dibromochloropropane (DBCP). The latter constituents are important in terms of potential water quality problems for future public supply. HPC serves as an indicator of slime producing organisms, which have previously been found in some wells in and near the District. Results from the study of these 15 wells are summarized in **Table 3-5**. In general, groundwater above 500 feet was of calcium-sodium bicarbonate type while deep groundwater was of sodium bicarbonate or sodium chloride type. TDS concentrations are higher in wells more than 700 feet deep.

Table 3-5 Water Quality Data from 15 Wells in RCWD

Chemical	MCL (mg/L)	RCWD range (mg/L)	Notes
Arsenic	0.01	<0.002 - 0.109	Five wells exceeded MCL ranging from 0.013 - 0.109 mg/L
Nitrate	10	1 - 26	Five wells exceeded MCL
TDS	500 - 1000	120 - 500	All tested wells below contaminant level
Iron	0.3	<0.05	One well had concentration of 0.1 mg/L
Manganese	0.05	<0.01 - 0.63	Four wells exceed ranging from 0.16 - 0.63 mg/L
DBCP	0.2	<0.01	All tested wells below contaminant level
HPC*	N/A	Mostly 2 - 12	Two wells with elevated concentrations ranging 160 - 900 CFU/ml
*Unit in CFU/ml			

DBCP and EDB were not detected in the sampled wells and gross alpha activities were reported at 6 picocuries or less. For drinking water purposes, water quality concerns in RCWD include elevated levels of manganese, arsenic, and HPC (mostly in wells about 800 feet deep). Groundwater above a depth of 650 feet appears to be largely suitable for drinking water supply, except for manganese in some shallower wells. A review of the groundwater quality concludes that, with a few exceptions, groundwater is adequate for agricultural use. The most notable exceptions include elevated chloride in water from two wells and especially one deep well near Avenue 10 and Road 39 (severe at 172 mg/L) along with several wells with water that have moderate micro-irrigation system plugging hazards due to alkalinity, pH, and manganese. Sodium is also indicated to be a problem for agricultural use but only in two wells sampled for the study. Groundwater quality in the District is generally better in the upper 600 feet of the aquifer.

3.2.7 Land Subsidence Conditions

Regulation Requirements:

§354.16(e) The extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department, as specified in Section 353.2, or best available information.

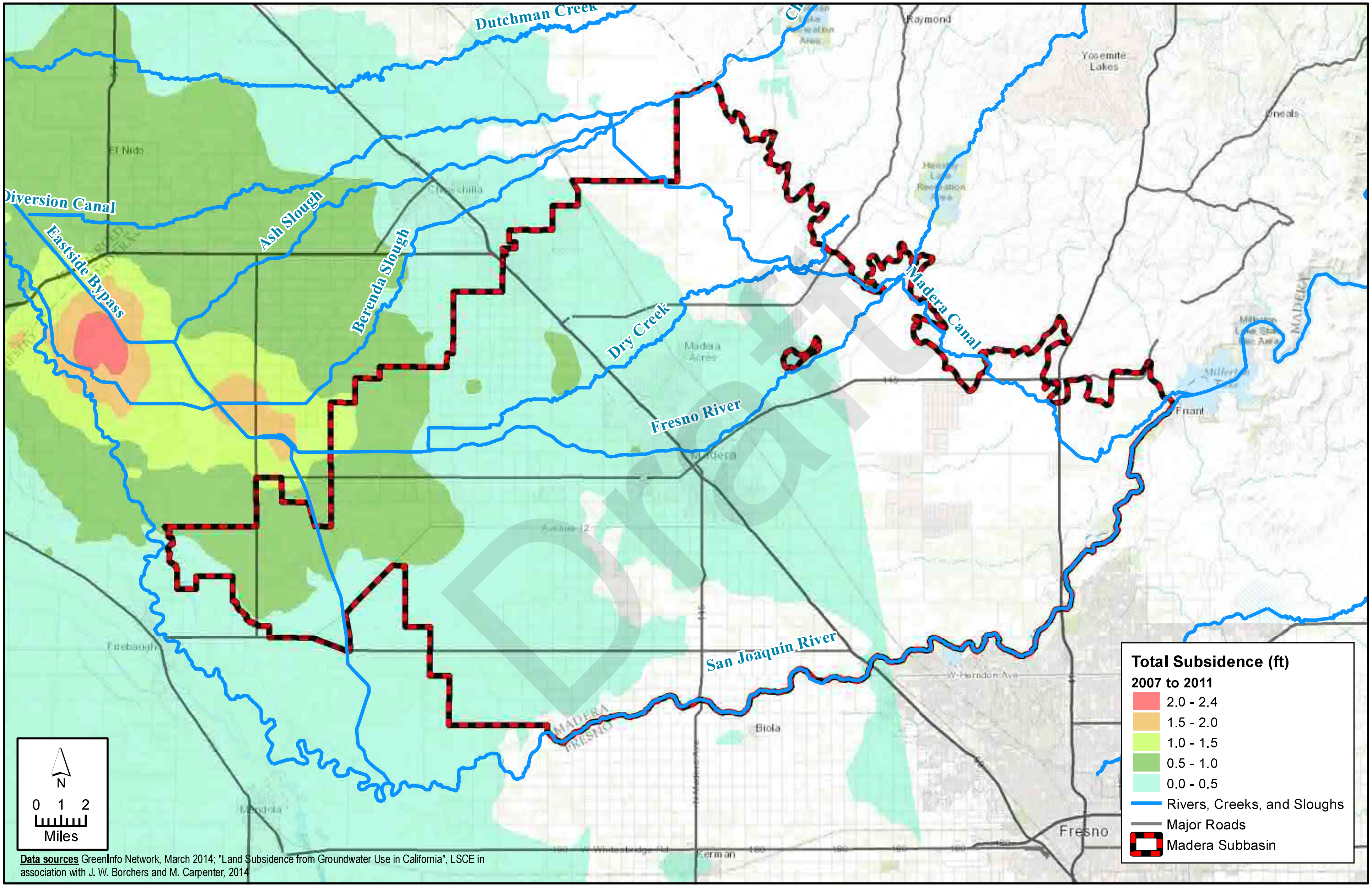
Pumping large volumes of groundwater from below a confining layer may contribute to land subsidence across a broad area, resulting in aquifer compaction, loss of storage capacity, and adverse effects to surface features such as canals, flood control systems, and water supply pipelines which rely on gravity flow. Land subsidence was first monitored from the 1920s to 1970s when there was less access to surface water and greater pumping withdrawals. During this timeframe, subsidence rates varied but were as high as 1 foot per year in some areas. The U.S. Geological Survey Professional Paper 437-I (Ireland, Poland, & Riley, 1984) shows most subsidence occurring on the west side of the San Joaquin Valley (along the California Aqueduct) with cumulative subsidence of greater than 24 feet between 1926 and 1970. The majority of land subsidence during this time frame occurred within the boundary of the Corcoran Clay. Subsidence in most of Madera Subbasin between 1926 and 1970 was less than 1 foot. Subsidence monitoring decreased after the 1970s when there was more access to surface water due to the canals and water storage projects built in California, and less reliance on groundwater to meet demands.

Monitoring land subsidence increased again in the 2000s due to drought conditions, environmental regulations that resulted in lower surface water allocations, and increased local demand on groundwater. Furthermore, collapsed wells and subsidence impacts to canals were becoming more prevalent throughout the central and western San Joaquin Valley. More recently, land subsidence has become a concern in the northwestern portion of Madera County, north of the Chowchilla Bypass. Between the years 2007 and 2011, there was up to a foot of subsidence in the northwest corner of Madera Subbasin, shown in **Figure 3-30** (Davids Engineering and Luhdorff & Scalmanini Consulting Engineers, 2017). Mapping by USBR between July 2012 and December 2016 shows total subsidence ranging up to two feet.

RCWD, which is located in the southeast portion of the subbasin, historically has not had issues with land subsidence. The areas prone to subsidence were underlain by deposits where the clayey deposits were dominated by the clay mineral montmorillonite (Meade, written communication, 1967). Meade, in written communication with R. J. Janda, reports that kaolinite and halloysite are the predominant clay mineral constituents of the soils and alluvium of the upper San Joaquin basin in the Sierra. This indicates that, while there may be confined groundwater and fine-grained deposits over much of the eastern valley region, the clay mineral assemblage in the fine-grained deposits for the most part do not appear to contain enough of montmorillonite to be as susceptible to subsidence as those areas west of RCWDGSA.

Data sources on land subsidence include the USBR SJRRP, from 2012 to 2018, and NASA Interferometric Synthetic Aperture Radar (InSAR) from 2015 to 2017. SJRRP data indicates an average annual subsidence rate between 0 and 0.15 feet per year in the RCWD area. NASA InSAR data provided by DWR shows a similar trend, as seen in **Figure 3-31**, with the highest rate of subsidence as 5 inches over two years, or 0.2 feet per year. The ground surface elevation is monitored by satellites which will have some variation due to accuracy.

Figure 3-30



Data sources GreenInfo Network, March 2014; "Land Subsidence from Groundwater Use in California", LSCE in association with J. W. Borchers and M. Carpenter, 2014

X:\2016\16-119 Madera Co. - Chowchilla & Madera Subbasins SGMA Support\GIS\Maps\FinalMapsForTM\Madera Subbasin\Figure 3-14 Madera Subbasin Map of Land Subsidence.mxd

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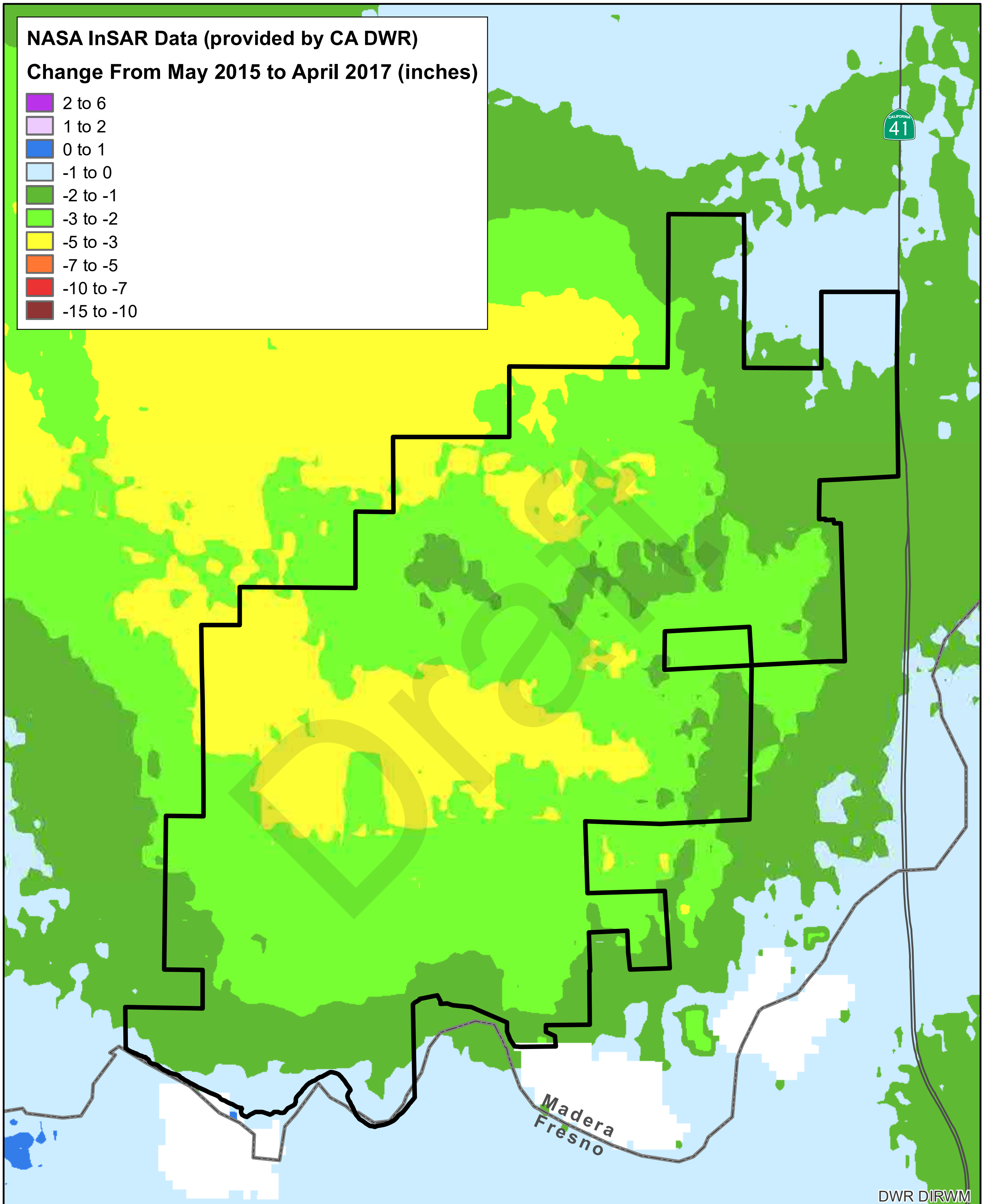
FIGURE 3-14
Map of Land Subsidence: 2007-2011



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N
0 0.25 0.5
Miles

Root Creek Water District

The legend shows the change in ground surface elevation from May 2015 to April 2017. The positive values indicate rebound while the negative values indicate land subsidence.

Root Creek WD

Figure 3-31

Land Subsidence - NASA, 2015-2017
(via CA Dept.Water Resources)

5/16/2019 : G:\Root Creek WD-1249\Projects\124917002-GMP Update like GSP\GIS\Map\Report\Gen\subsidence_nasa.mxd

3.2.8 Surface Water and Groundwater Interconnections

Regulation Requirements:

§354.16(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 best available information.

Interconnected surface water systems are defined as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted (California Department of Water Resources (DWR), 2016). This section discusses the volume or rate of surface water depletion in basins where surface water and groundwater are interconnected. The purpose is to identify areas within a basin where groundwater pumping has a direct connection to surface water depletion.

Minimal literature is available on the topic, thus the term "disconnected" can be misunderstood for several reasons (Brunner, Cook, & Simmons, 2011). The definition of a disconnected system is not where there is no exchange between the surface and the subsurface. Even in a disconnected system, a river loses water to the groundwater. In fact, the infiltration rates of a disconnected system are higher than those under a connected flow regime. The surface water body and the groundwater are disconnected only in the sense that changes in groundwater do not affect the infiltration rate (Brownbill, et al., 2011). **Figure 3-32** displays what connected versus disconnected surface and groundwater systems may look like.

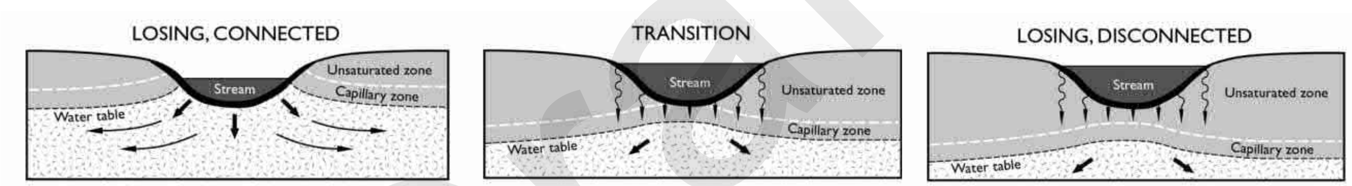


Figure 3-32 Connected and Disconnected Surface and Groundwater Systems

In RCWD, the only area of potential interconnected systems exists along the San Joaquin River. Information to evaluate the presence of interconnected surface water systems in the RCWDGSA is minimal and inferred in a few locations along the San Joaquin River through the SJRRP, a US Geological Survey groundwater flow model documentation report (Traum, Phillips, Bennett, Zamora, & Metzger, 2014), and Friant Water Users Authority and Natural Resources Defense Council (URS Corporation, 2002). Additional information, of a regional nature, is available from the USGS's Central Valley Hydrologic Model (Faunt, 2009) and USGS Open File Report 85-401 as part of the Regional Aquifer System Analysis (Mullen & Nady, 1985). In general, although the model reports and regional studies imply a lack of continuous connection between surface water and groundwater in RCWD, the location specific data from the SJRRP indicate that there may be a connection at some locations (discussed below).

Historical Conditions Overview

Groundwater pumping in the Madera Subbasin in the last century removed large volumes of groundwater. Significant declines in groundwater levels have resulted, which in turn has converted most reaches of the San Joaquin River from gaining conditions to losing conditions with respect to surface water. Prior to rural development, groundwater flowed from the high elevations of the valley margins towards the San Joaquin Valley trough. Water originating from mountain rain and snowmelt entered the valley aquifer system and recharged the shallow unconfined aquifer along the valley margins. During periods of low surface flow, the shallow unconfined groundwater of the valley trough would contribute significant baseflows to the San Joaquin River. These conditions were applicable to Reaches 3, 4, and 5, and portions of Reach 2 (URS Corporation, 2002). The south border of the RCWD is located entirely within Reach 1 (see **Figure 3-33** and

Figure 3-34). The documents do indicate that the groundwater elevations in relatively close proximity to the river responded to wet or dry years by raising or lowering, implying there may be interconnection.

Present Day Conditions

A limited number of studies have evaluated groundwater and surface water interaction, which include the area encompassing RCWD. Present day regional groundwater elevations are significantly lower than the San Joaquin River channel and tributary channel elevations in SJRRP Reach 1 (URS Corporation, 2002). The head differential between stream water elevations and the underlying groundwater elevations induces seepage losses from the stream (losing stream). Historically (pre-Friant Dam, late 1940s), most reaches of the San Joaquin River were gaining reaches as described above. The significant decrease in groundwater elevations has now led to most reaches of the San Joaquin River being losing reaches (URS Corporation, 2002). As anticipated, the depth to groundwater in the losing stream area decreases rapidly with distance away from the river. However, no direct discussions were found in available literature that stated that the groundwater was disconnected from the San Joaquin River, where water was perennial in this area of Madera County.

Regional Reports

As mentioned above, the USGS regional reports (Faunt, 2009) and (Mullen & Nady, 1985) can be interpreted to imply that groundwater and surface water are not interconnected along the San Joaquin River. However, these reports do not explicitly discuss interconnectedness of the surface water system with groundwater. Instead these reports provide maps that show areas of gaining or losing streams. Along the San Joaquin River, the regional maps provided show that the San Joaquin River is a losing stream (i.e., surface water seeps into groundwater). Furthermore, the USGS 1985 report (Mullen & Nady) indicates that the San Joaquin River was a losing stream in the RCWD area based on average conditions from 1961 to 1977. However, a losing stream does not necessarily mean the system is disconnected.

San Joaquin River Studies

FWUA and the NRDC (2002) compared the 1998 elevation of the base of the San Joaquin River (developed from topographic data gathered by the Corps of Engineers Comprehensive Study) to the 1996 groundwater elevations. Reaches where the shallow groundwater elevations were lower than the riverbed elevation of the stream were considered to be potentially losing reaches. Within the RCWD area, the reach upstream of river mile (RM) 243 (Herndon) was identified as a potentially losing reach.

USGS Scientific Investigations Report 2014-5148 (Traum, Phillips, Bennett, Zamora, & Metzger, 2014) describes a groundwater flow model for the SJRRP prepared in cooperation with the USBR. This model is an integrated hydrologic model that simulates the surface-water hydrologic system, the groundwater aquifer system, and land surface processes within 5 miles of the San Joaquin River and adjacent bypasses from Friant Dam to the confluence with the Merced River. Overall, this report indicates that when the river has high flows, groundwater levels near it rise and when the river has low flows, groundwater levels fall.

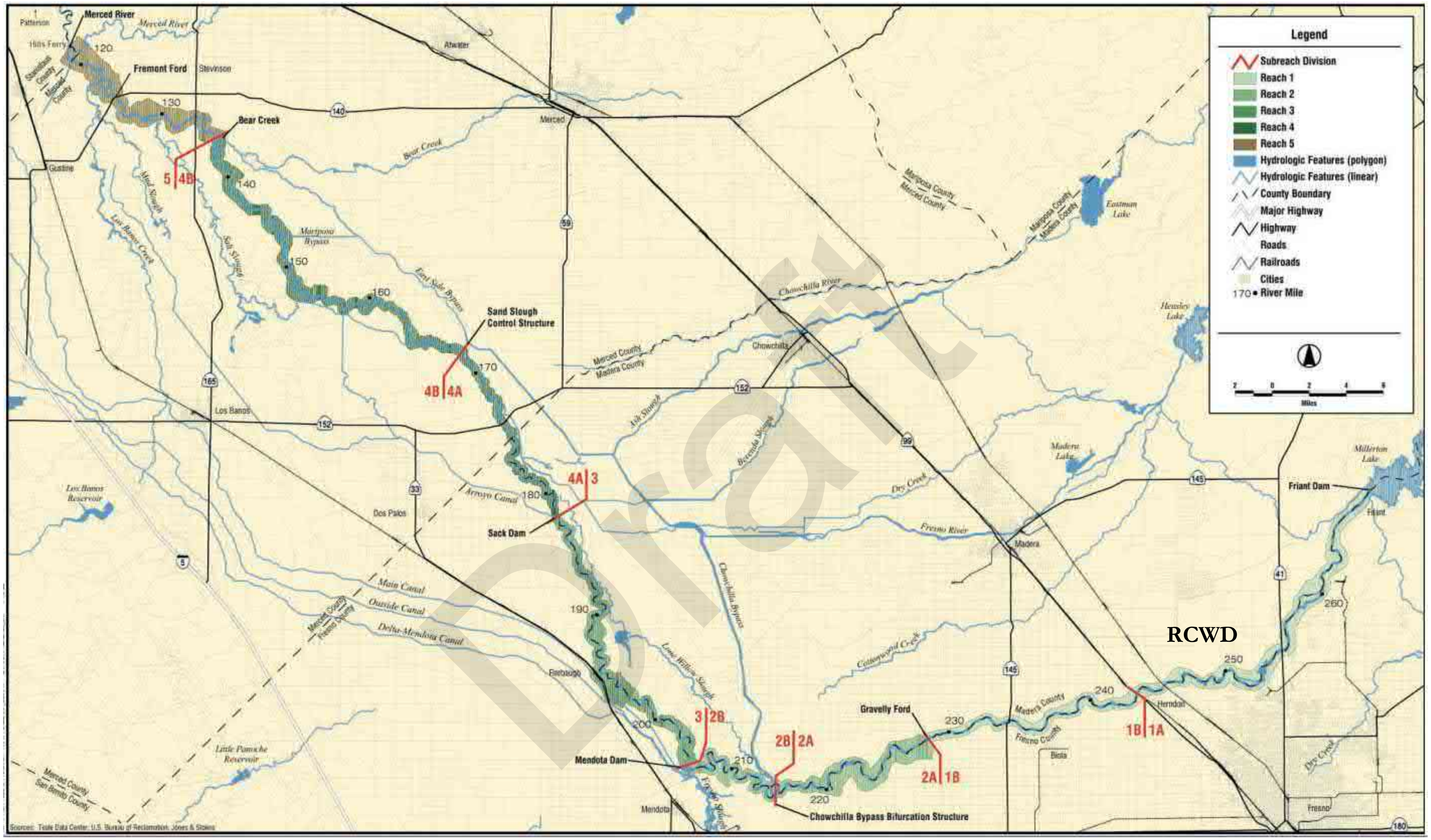


Figure 3-33. San Joaquin River Restoration Plan, Showing the Reach and sub-reach boundaries (from FWUA and NRDC, 2002)

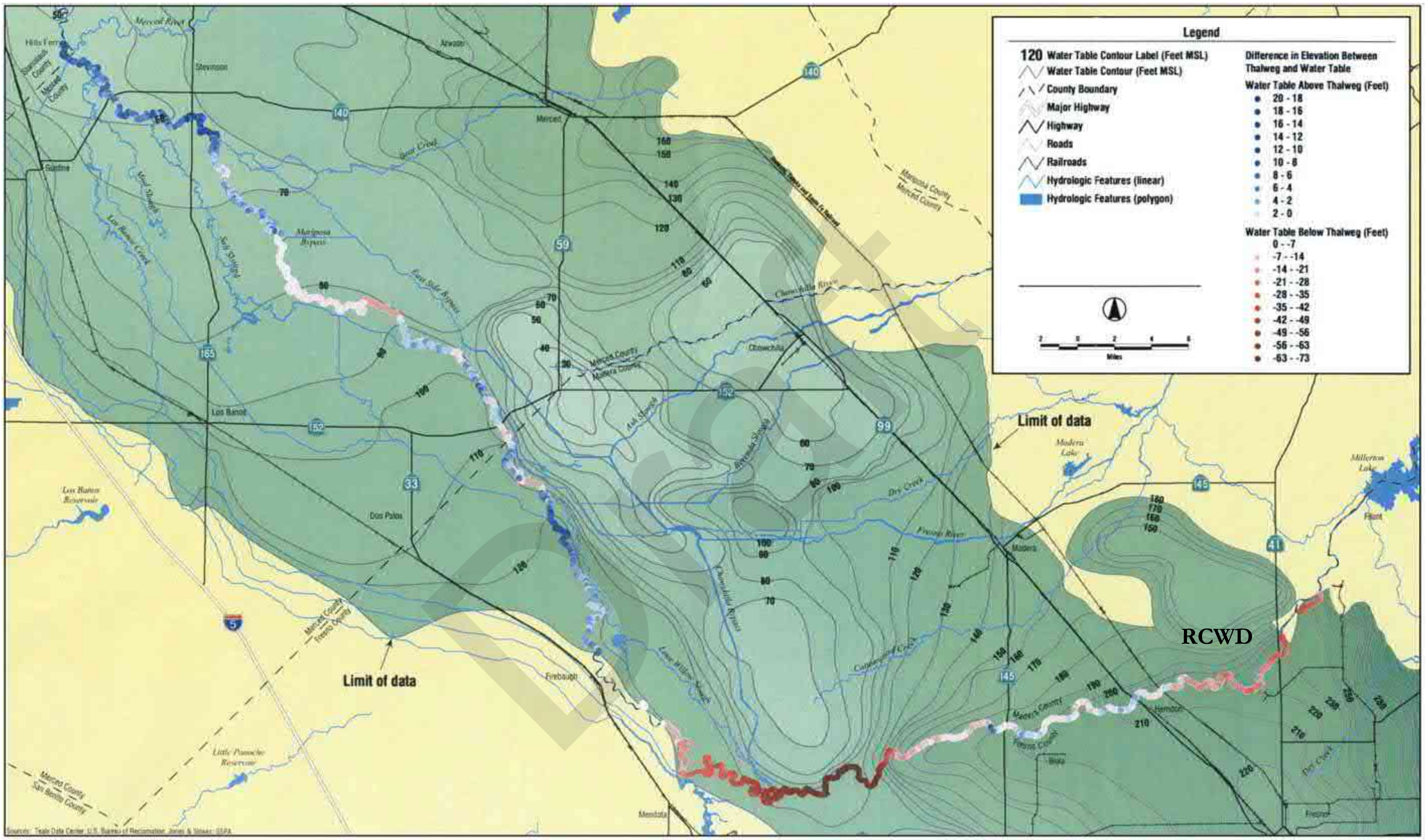


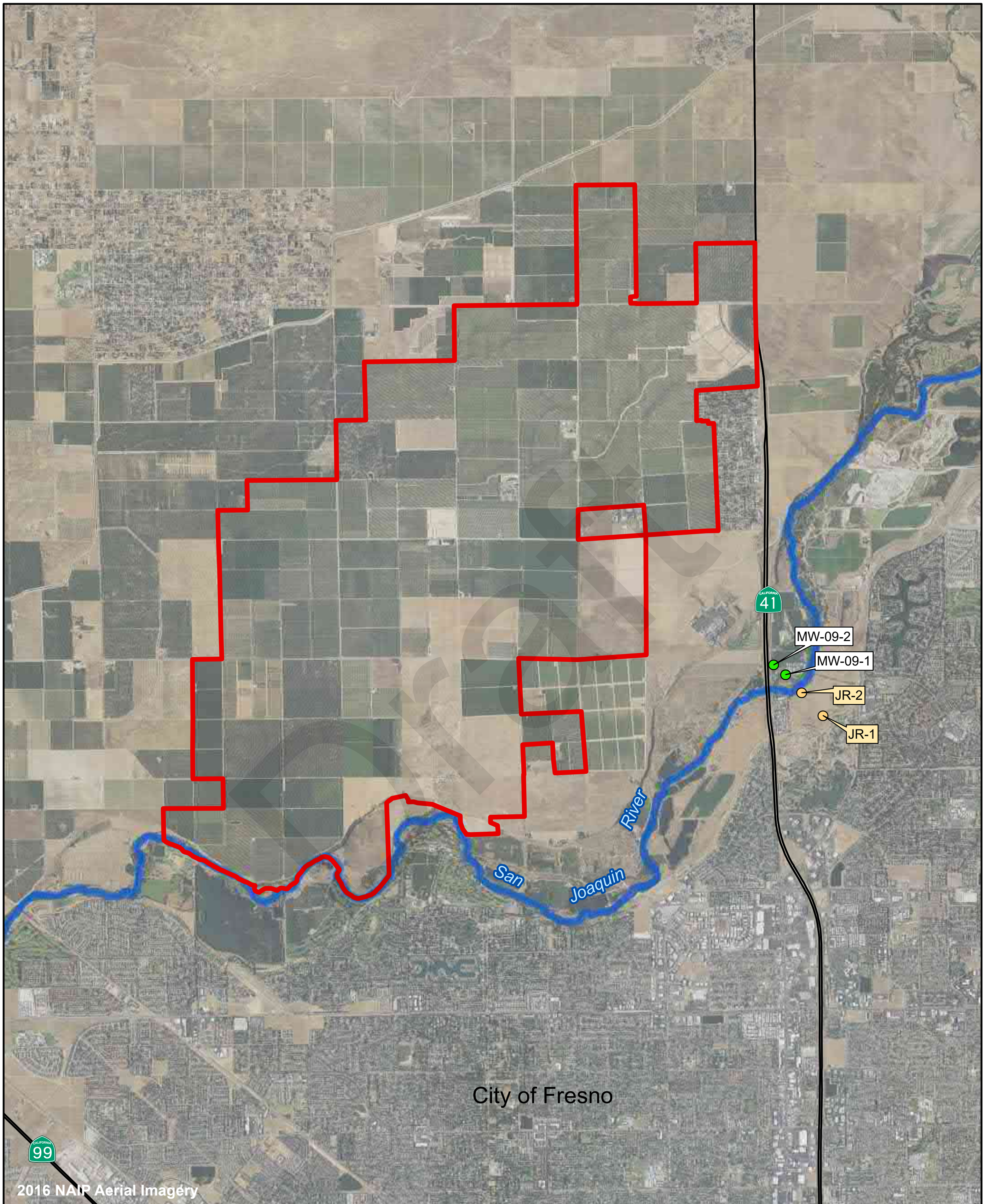
Figure 3-34. Potentially gaining and losing reaches based on Spring 1996 water table conditions and 1998 channel thalweg conditions (from FWUA and NRDC, 2002)

San Joaquin River Restoration Program, Location Specific Data
Groundwater elevation data from piezometers installed to monitor shallow groundwater near the river as part of the SJRRP provide data to evaluate interconnected surface water systems. Unfortunately for this evaluation, the majority of SJRRP groundwater elevation monitoring is being conducted considerably downstream of RCWD (west of US Highway 99). However, information from two piezometers is available, along with channel bed elevations just east of RCWD from the draft San Joaquin River and Bypass System HEC-RAS Model Documentation (Tetra Tech, 2017). The monitoring well cluster (MW-09-1 and MW-09-2) is located just east of HWY 41. Groundwater elevation data are available from the monitor wells from Fall of 2009 to July 2017 (see **Appendix 3-A**). A map of the monitor well locations along with supporting documentation used to estimate the channel bed elevations at the monitor well locations is included in **Figure 3-35**.

SJR at HWY 41
Groundwater elevation data are available at this location from two monitor wells; MW-09-1 (600 feet northwest of SJR) and MW-09-2 (1,000 feet north of SJR). The channel bed elevation is estimated to be approximately 259 feet. Groundwater elevations in both monitor wells increase when flows in the river increase and decrease when flows decrease. When river discharge is high, groundwater elevations in both wells are higher than the channel bed elevation indicating interconnected groundwater-surface water during these times. When the river is flowing at low flow or base flow, the groundwater elevation is below the estimated channel invert elevation, indicating a lack of interconnection.

Flow data is available from the SJRRP below Friant and at Gravelly Ford, located a few miles downstream of the southern shared border between the river and RCWD. By agreement, flows at Gravelly Ford are linked to the amount of flow being released at Friant Dam. During prolonged periods of low flow releases at Friant, flows at Gravelly Ford are periodically reported as zero. It is difficult to know exactly what would be considered base flow at the locations where SJRRP measures water levels in monitor wells available, but the flow data would indicate that significant losses occur along the reach. Additional flow loss data in Reach 1 is available from the Draft Flow Losses, Technical Memorandum (San Joaquin River Restoration Program (SJRRP), 2013). According to that study, flow losses in Reach 1 (defined as Friant to Gravelly Ford) of the San Joaquin River were variable but ranged from 100 to 200 cfs during the period of their study from 2009 to 2012.

The shallow groundwater elevation data presented here appears to indicate that the San Joaquin River in RCWD is connected to shallow groundwater. This finding is in part supported by channel bed elevation changes over relatively short distances where pools are deeper (e.g., at lower elevations) than riffle crests (the rise in the adjacent streambed elevation downstream and higher than the bottom of the upstream pond). Pools, being deeper, are more likely to have channel bed elevations that show connectivity to shallow groundwater. East of Highway 99 and east of Highway 41, the abundance of historical gravel mining pits probably enhanced connection of surface water and groundwater.



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Root Creek WD

SJRRP Reach 1A and Reach 1B Wells in NKGSA

- With Groundwater Elevation Data
- Without Groundwater Elevation Data

Root Creek WD
Figure 3-35
Locations of SJRRP Shallow Monitor Wells Along the San Joaquin River Reach 1A

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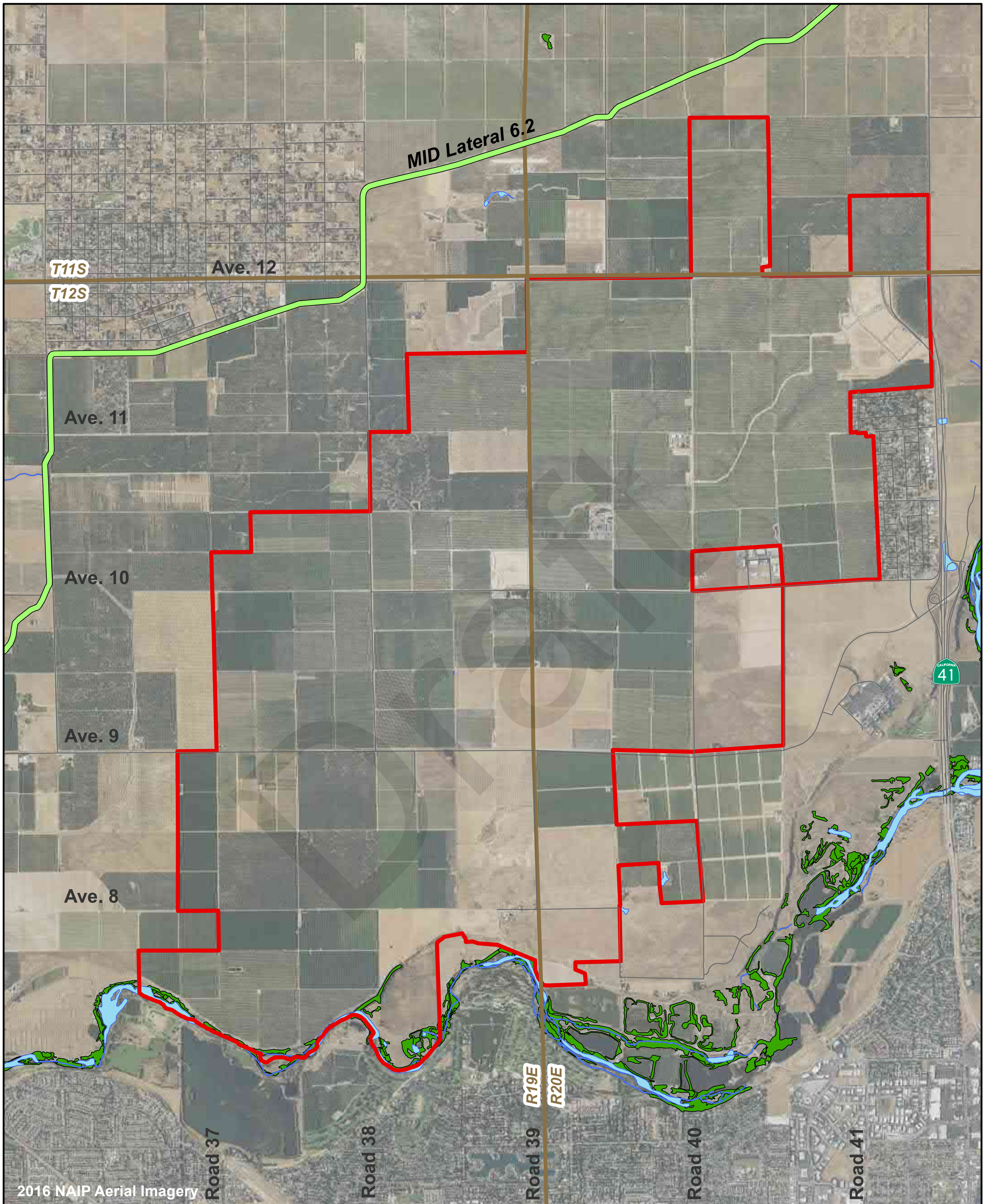
3.2.9 Groundwater Dependent Ecosystems

Regulation Requirements:

§354.16(g) Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or best available information.

GDEs are natural communities that depend on shallow groundwater levels for their existence. Groundwater levels throughout the San Joaquin Valley have significantly declined over the last 50 years, meaning areas of shallow groundwater are becoming increasingly rare. GDEs are not prevalent throughout Madera Subbasin; for those that do exist, most are along rivers, areas of recharge, or perennial streams, and the same is true of RCWD. The San Joaquin River is the primary source of surface water running along the southern edge of the District for about 4 miles. As seen in **Figure 3-36** , vegetative GDEs primarily exist along the river bed and on the edge of historical gravel mining pits, intermixed with areas indicated as wetlands by potential GDE mapping done by DWR and the Nature Conservancy.

There is one small area identified as a potential wetland in the south east corner of the District. By looking at satellite imagery, it can be seen that the land where it is located is empty except for a couple trees. There is a small area on the parcel that has a bit of lower elevation, which could potentially collect and pool water in wetter seasons.



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NC Wetlands
NC Vegetation

Root Creek WD
Figure 3-36
Nature Conservancy iGDE
Wetlands & Vegetation

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3.3 Water Budget Information

Regulation Requirements:

> **§354.18**
> **(a)** 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.

A water budget is defined as a complete accounting of all water flowing into and out of a defined area (e.g., a subbasin or GSA) over a specified period of time. A water budget is crucial to sustainable groundwater management by quantifying the historic and current overdraft, in turn having a goal to set demand mitigation and supply augmentation objectives. The water budget for Root Creek WD was developed using knowledge gathered from the hydrogeologic conceptual model, precipitation data, measurements of inflows and outflows, and other various data sets described throughout this section in more detail.

GSP regulations stipulate the need to use the best available information and the *best available science* to quantify the water budget for the basin. Best available information is common terminology that is not defined under SGMA or the GSP Regulations. Best available science, as defined in the GSP Regulations, refers to the use of sufficient and credible information and data, specific to the decision being made and the time frame available for making that decision, which is consistent with scientific and engineering professional standards of practice. It is understood that initial steps to compile and quantify water budget components may be constrained by GSP timelines and limited funding and may consequently need to rely on the best available information that is obtainable at the time the GSP is developed. The best data available for the water budget was often incomplete, had to be estimated or was based on assumptions. The confidence intervals for each parameter vary from 5% to as high as 50%. As a result, the water budget presented herein is merely an approximation of the hydrologic system in the GSA.

3.3.1 Description of Groundwater Model

Regulation Requirements:

> **§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. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions.
> **(f)** The Department shall provide the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the Integrated Water Flow Model (IWFM) for use by Agencies in developing the water budget. Each Agency may choose to use a different groundwater and surface water model, pursuant to Section 352.4.

GSP Regulations do not require the use of a model to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater. However, if a model is not used, the GSA is required to describe in the GSP an equally effective method, tool, or analytical model to evaluate projected water budget conditions. As stated earlier, the district is approximately 10,000 acres in size and is small related to the larger Madera Subbasin. It is also recognized by reviewing Figure 1-1 that the southeastern portion of the Madera Subbasin is sadly lacking in surface water supplies with the exception of the Root Creek Water District. Thus, most of the area in which the RCWDGSA resides is almost entirely reliant upon groundwater pumping. Measurement of water level in wells will identify the direction of movement and change in level for this region better than a regional model. Additionally, the current, historical, and projected water budgets for the RCWDGSA have been developed directly from measured and estimated data.

Having said all that the RCWDGSA has also participated in the development of the model being developed for the Subbasin by LSCE. To this end we have not seen recent modeling results but have received the model output for the five prospective representative monitoring sites that are being proposed by the RCWDGSA. More information on these results can be found in Section 4.2.

This use of an analytical water budget also has the advantage of clearly showing the origin of data used for the water budget, as opposed to extracting data from a water budget which does not explicitly identify the data source or computation method. Ongoing use of an analytical water budget will performed for annual updates and be reviewed during the first five years of GSP implementation and a decision will be made on the capability, data adequacy, and usefulness of utilizing the regional groundwater model in concert with the other GSA's for future GSP activities.

RCWD has also been part of a cooperative effort in the Madera Subbasin and much of the documentation for the water budget can be found in *Madera Subbasin Sustainable Groundwater Management Act Basin Boundary Water Budget* by Davids Engineering and Luhdorff & Scalmanini (2018). The purpose of the investigation was to develop a preliminary water budget for the subbasin as a whole according to DWR's GSP regulations. The subbasin boundary water budget is based on historical data and provides insight into the magnitude of the historical imbalance (or overdraft) of the subbasin. The following discussion is a summary of the conceptual water budget model from DE & LSCE for the subbasin as a whole.

Groundwater and surface water are critical resources that support agriculture and other economic activities in the subbasin. Groundwater is particularly important, because it is relied upon to a significant extent in all years and serves as the main supply source in periods when surface water supplies are limited. Thus, the sustainable management of groundwater is important to the long-term prosperity of Madera County's various communities. The Sustainable Groundwater Management Act of 2014 (SGMA) allows for local control of groundwater resources while requiring sustainable management.

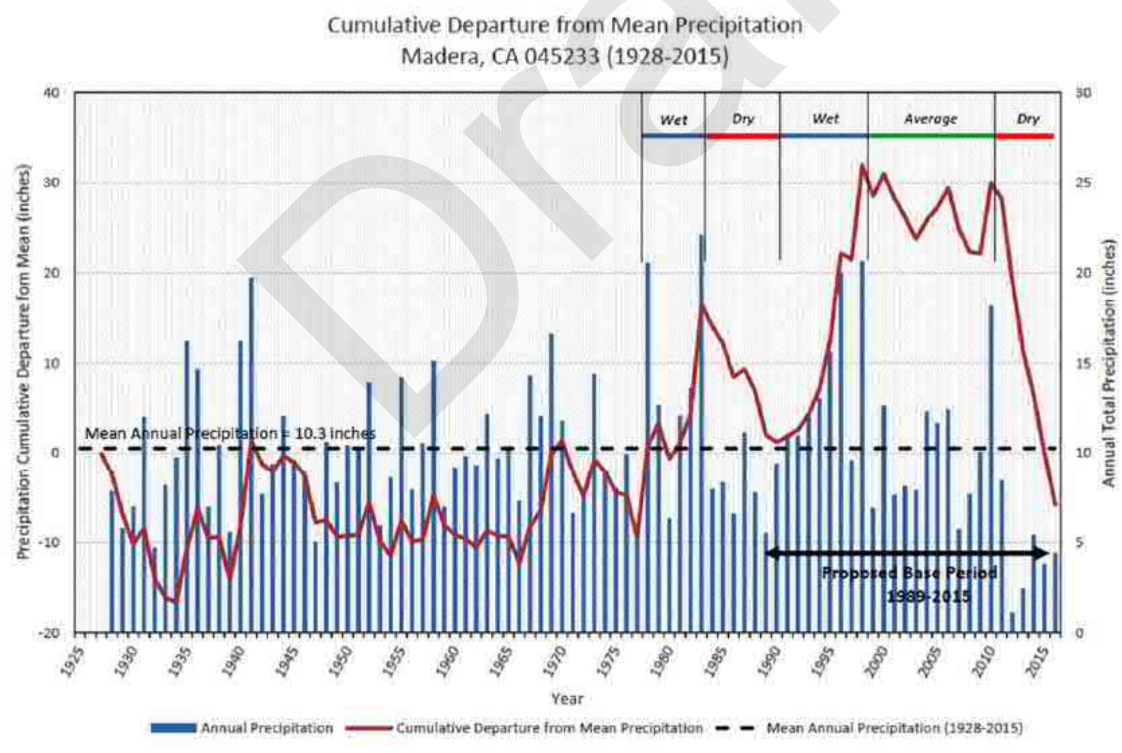
The lateral extent of the basin is defined by the subbasin boundaries provided on DWR's groundwater website (DWR, 2017) and is discussed in Chapters 2 and 3.1. The vertical boundaries of the subbasin are the land surface and the base of fresh water in the underlying aquifer (Page, 1973), as discussed in the basin wide Hydrogeologic Conceptual Model (HCM) developed during previous data collection and analysis efforts conducted by DE and LSCE (2017). The vertical extent of the basin 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.

In accordance with GSP regulations, a base period must be selected so that the analysis of sustainable yield is performed for a representative period with minimal bias that might result from the selection of an overly wet or dry period, while recognizing changes in other conditions including land use and water demands. The base period should be selected considering the following criteria: long-term mean annual water supply; inclusion of both wet and dry periods, antecedent dry conditions, adequate data availability; and inclusion of current hydrologic, cultural, and water management conditions in the basin. To develop a preliminary base period to for sustainability analyses of the Madera Subbasin during GSP development, only historical precipitation records for the area were evaluated.

Precipitation provides an indication of the long-term mean water supply and potential for natural groundwater recharge. Monthly precipitation records acquired from the Western Regional Climate Center for a station in Madera (Station 045233) were analyzed for the period 1928 through 2016. A plot with annual precipitation, mean annual precipitation, and cumulative departure from mean annual precipitation was developed for the Madera station (**Figure 3-37**). It was determined that the period of 1989 through 2015 is a relatively balanced climatic period with a similar number of wet and dry years and some prolonged periods of wet, dry, and average conditions and represents a reasonable base period for conducting sustainability analyses.

Evaluation of the precipitation data in Madera suggest that 1989 through 2015 represents an average base period of 27 years for conducting GSP analyses. Additional consideration with respect to the base period was given to the patterns of CVP supplies and to local supplies from Hensley Lake, which may or may not be strongly correlated with local precipitation. Ultimately, the GSP base period was selected based on a combination of these factors to define a period that is normal for the subbasin from a water budget perspective.

During review of groundwater level data needed to calculate change in groundwater storage from observed conditions, it became apparent that 1989 through 2014 would be a more appropriate analysis period for this effort because of the relative sparsity of groundwater level data (and therefore diminished quality of resulting groundwater level interpretations) available for 2015. Therefore, the analysis results discussed below are based on analysis of the period 1989 through 2014, although data and calculations of water budget components were also assembled for 2015, to the extent that suitable data exists. Based on the cumulative departure curve **Figure 3-37** was used to choose time periods for analysis, using 2014 as the last year still provides a balanced hydrologic time period for the analysis. Therefore, groundwater elevation contours were produced for spring of 2014, and used for change in groundwater levels and change in storage calculations.



(Precipitation data from Western Regional Climate Center, 2017)

Figure 3-37. Cumulative Departure from Mean Precipitation

3.3.2 Description of Inflows, Outflows, and Change in Storage

Regulation Requirements:

§354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:
(1) Total surface water entering and leaving a basin by water source type.
(2) Inflow to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.
(3) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.

Subbasin boundary inflows and outflows must be quantified according to Section §354.18(b) of the GSP Regulations. Quantification of inflows and outflows is necessary for estimating the overdraft on an average annual basis. Some variables were estimated based on best available information due to a lack of measured data. For the water budget, water supply and demand has been broken down by water source type and use. A summary of the Madera Subbasin water budget flows from Davids Engineering and Luhdorff & Scalmanini (2018) is provided below.

Madera Subbasin Water Budget Conceptual Model

A conceptual representation of the Madera Subbasin boundary water budget is simplified and presented in **Figure 3-38**. Boundary inflows include precipitation, surface water inflows (in various canals and streams), boundary watercourse seepage, and groundwater inflows from adjoining subbasins. Outflows include evapotranspiration (ET), surface water outflows (in various canals and streams), and groundwater outflows. Also represented in **Figure 3-38** are groundwater recharge and extraction, which are "internal" flows between the Surface Water System (SWS) and Groundwater System (GWS). Subbasin boundary inflows and outflows were quantified on a monthly time step for the period 1989 through 2015, including accounting for changes in storage within each time step, such as changes in water stored in the root zone. Surface water inflows and outflows for Madera Subbasin are shown in **Figure 3-39**.

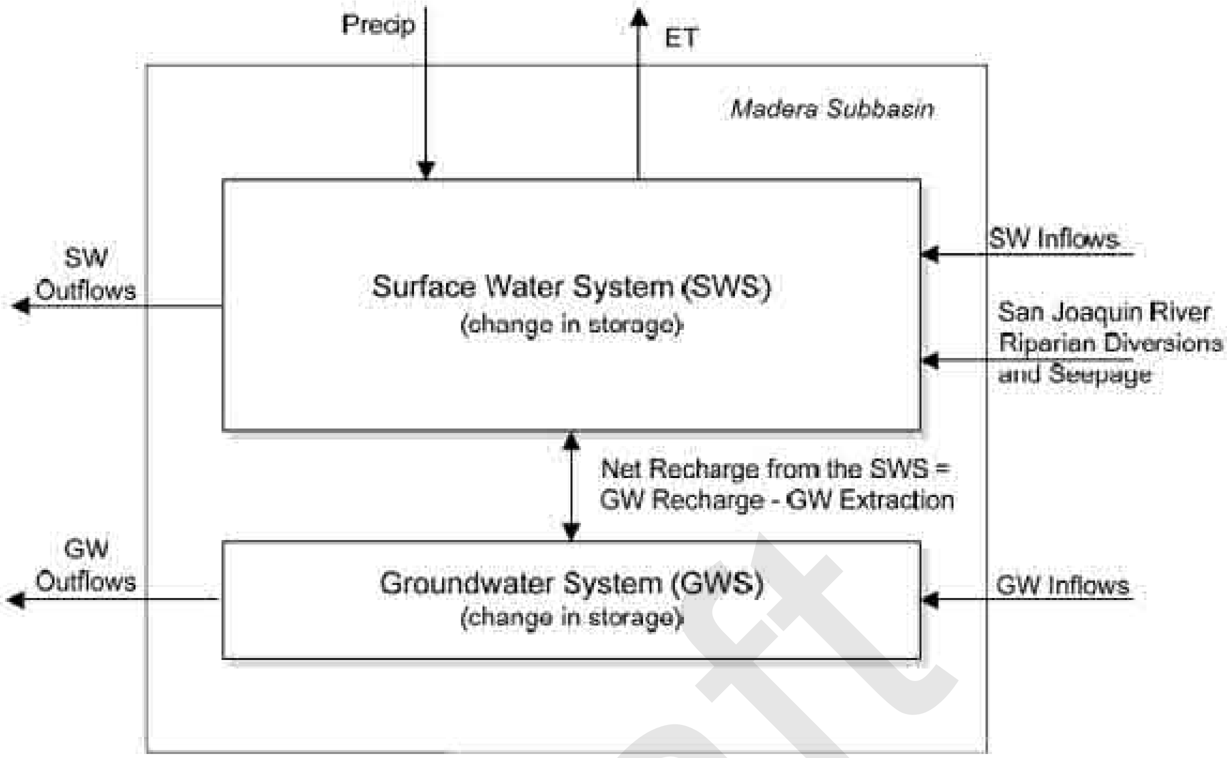


Figure 3-38. Preliminary Basin Water Budget Diagram (Davids Engineering and Luhdorff & Scalmanini, 2018)

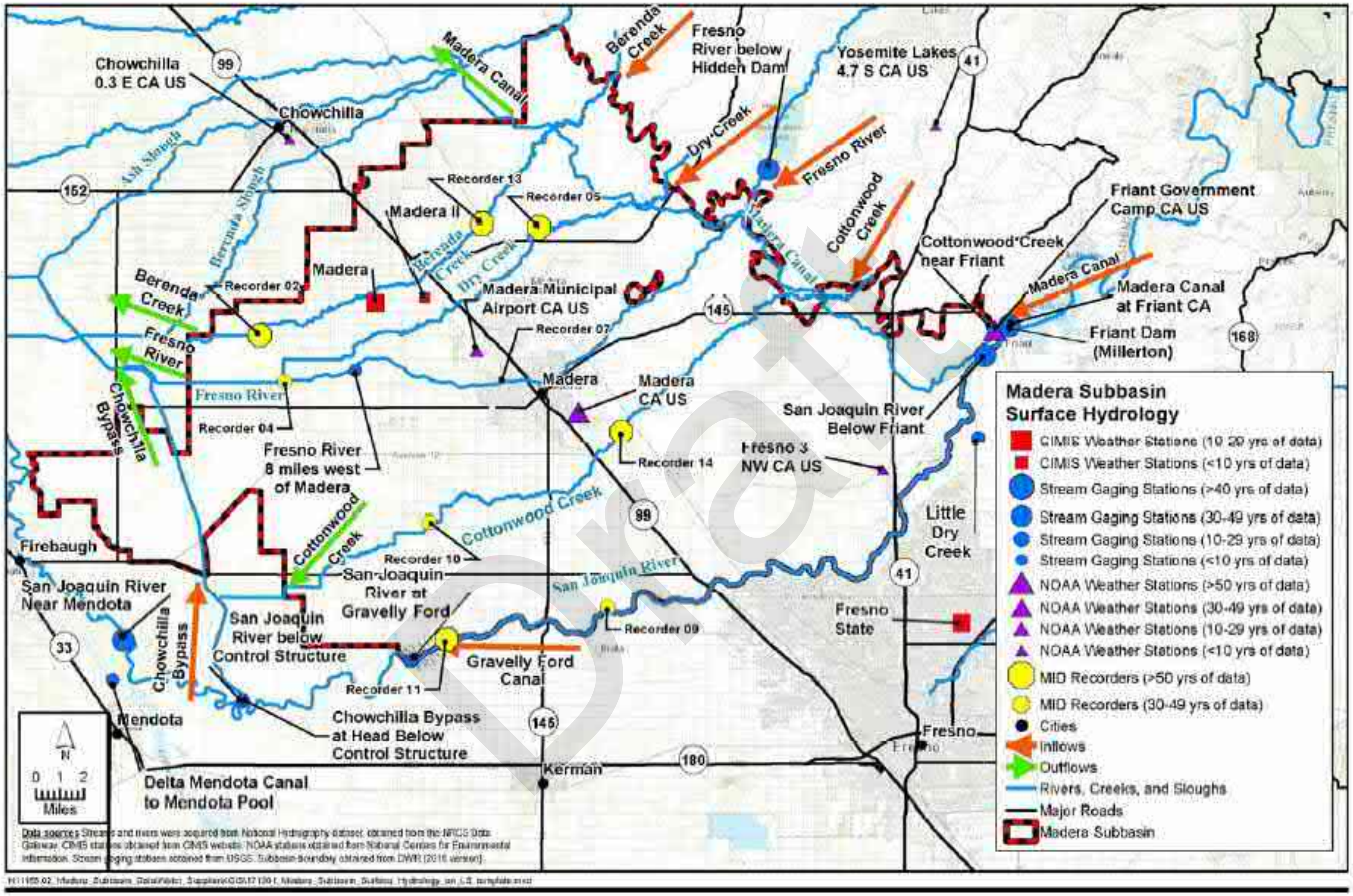


Figure 3-39. Preliminary Madera Subbasin Inflows and Outflows (Davids Engineering and Luhdorff & Scalmanini, 2018)

The SWS represents the land surface down to the bottom of plant root zone, within the lateral boundaries of the basin. The GWS extends from the bottom of the root zone to the definable bottom of the subbasin, within the lateral boundaries of the basin. The SWS basin boundary water budget was completed on a monthly time step and by calendar year. Inflows and outflows may cross the subbasin boundary or may represent exchanges of water between the SWS and the underlying GWS. **Figure 3-40**, below, shows the conceptual water budget flows including various inflows and outflows comprising recharge, extraction, and discharge from the GWS. Net recharge from the SWS to the GWS is defined as groundwater recharge minus groundwater extraction and is useful for understanding and analyzing the combined effects of land surface processes on the underlying GWS. Basin boundary inflows and outflows for Madera Subbasin were quantified on a monthly basis and also account for any changes in storage, such as changes in water stored in the root zone.

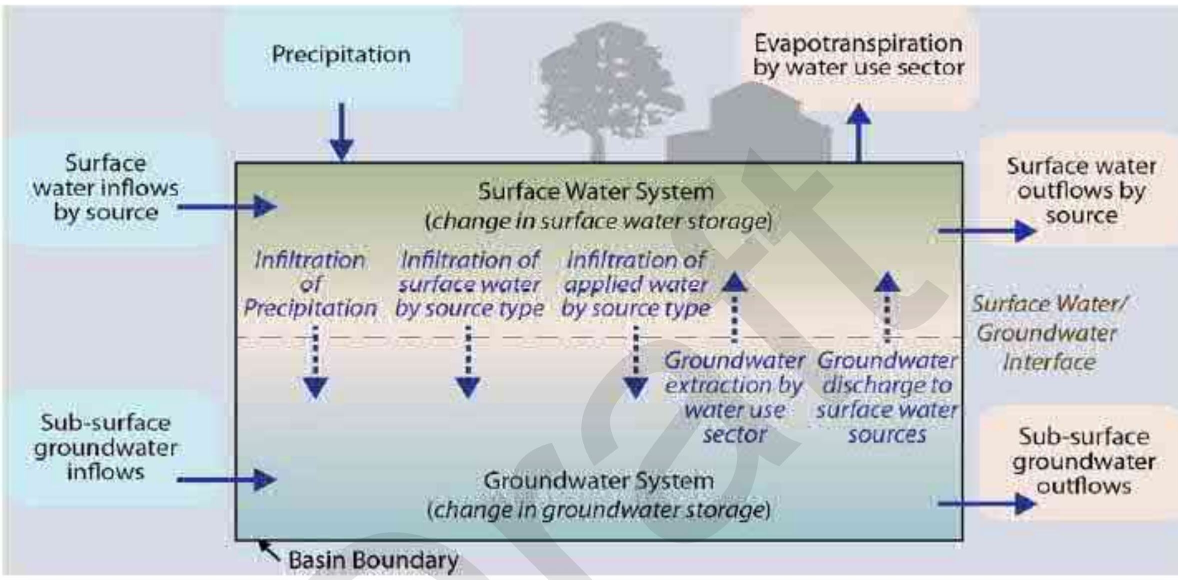


Figure 3-40. Preliminary Basin Boundary Water Budget (DWR Water Budget BMP, 2016)

The SWS is further subdivided into water use sectors identified in the GSP regulations. Water use sectors are defined in the GSP Regulations as "categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation." Water budget components were broken down both by water source type and water use sector for quantification.

Preliminary estimates of subbasin overdraft derived from Davids' and LSCE's SWS and GWS water budgets are briefly described in the following sections. Note: the report estimates an initial Preliminary Sustainable Yield across the entire Madera Subbasin and does not quantify local variability, including the variability between the different GSAs. The preliminary sustainable yield for the overall Madera Subbasin will change once a more detailed analysis is performed. This GSP quantifies local variability for RCWDGSA.

Sustainable yield is defined as the maximum quantity of water, calculated over a base period representative of long-term conditions (in this case 1989 through 2014), in the subbasin that can be withdrawn annually from a groundwater supply without causing an undesirable result (CA Water Code 10721). This includes accounting for any temporary water surpluses. According to DWR's recently released Sustainable Management Criteria BMP (2017), "Sustainable yield estimates are part of the SGMA's required basin-wide water budget" and "a single value of sustainable yield must be calculated basin-wide."

For this preliminary analysis, three calculation methods were used to estimate sustainable yield in the Madera Subbasin. The three methods use different combinations of SWS and GWS water budget results to calculate sustainable yield. These preliminary sustainable yield estimates do not include an evaluation of the spatial distribution of pumping and recharge within the subbasin in relation to sustainability indicators.

The results of all three sustainable yield calculations are similar in magnitude as indicated in **Table 3-6**. The first method is based on subtracting historical change in groundwater storage from historical pumping, indicating an average sustainable yield of slightly more than 300,000 acre-feet annually. The second method is based on summing the total inflow to the GWS, indicating a sustainable yield of slightly less than 300,000 acre-feet. Finally, the third method is based on numerical modeling of the subbasin in which water demands are reduced until extraction (pumping) from the subbasin is balanced by recharge. This method also indicates a sustainable yield of slightly more than 300,000 acre-feet. The second and third methods each depend on the water budget results and, therefore, may not be completely independent.

Table 3-6. Preliminary Sustainable Yield Calculation Results

Qualification Method	Average Volume (AF)*	Estimated Confidence Interval (CI) (percent)	CI Source	Average minus CI (AF)	Average plus CI (AF)
GW pumping and GW Change in Storage	301,500	16%	Calculation	253,900	349,100
Total Inflows to GWS	298,200	28%	Calculation	214,900	382,400
"Simulation" of Reduced Demand	303,100	20%	Professional Judgment	242,500	363,700

*1989 through 2014

Based on these preliminary results, which represent recent historical conditions and reflect the 410,000 to 420,000 acre-feet of groundwater extractions occurring on an average annual basis in the subbasin, it is estimated that groundwater recharge would need to be increased by approximately 110,000 to 120,000 acre-feet annually to achieve sustainable operation of the groundwater system. Alternatively, some combination of increased groundwater recharge and decreased groundwater pumping and water consumption totaling approximately 110,000 to 120,000 acre-feet annually would be needed to achieve sustainable operation of the groundwater system. This estimate assumes that all other water budget parameters (namely surface water supplies and GWS inflows and outflows) would remain the same in the future as they were during the period of analysis.

Root Creek Water District Water Budget Model

In place of a model, the complete water budget including historical, current, and projected, for RCWDGSA was created using information from the basin setting discussed earlier in this chapter along with actual data from sources such as California Irrigation Management Information System (CIMIS), National Oceanic and Atmospheric Administration (NOAA), DWR, Irrigation Training & Research Center (ITRC), etc. The period of record chosen to analyze historical data was 1989-2014 to be consistent with the rest of the Madera subbasin and to cover an average hydrologic period. Descriptions of inflows and outflows to the groundwater basin are described below by water use sector and water source type.

Inflows

Surface Water for Irrigation

The two main sources of natural surface water inflow for the District are the San Joaquin River and Root Creek, which is a fairly small ephemeral stream. Root Creek is an uncontrolled creek that only runs after storm events and is not subject to use for surface supply. The San Joaquin River provides a surface water supply to riparian landowners that have holding contracts with the USBR. There is no ceiling on the amount of water that may be claimed with the contracts as long as it is put to beneficial use on the land outlined in the contract, yet there are only two known turnouts on the river out of the six holding contracts. One known diversion point has submitted statements of diversion for the years 2010-2017. For the portion of this information within the historical base period, between 2010 and 2014, the average diversion was 1,130 AF/year applied to about one-third of the land within the holding contract. However, for the current water budget, the average of all years through 2017 was used and amounts to 930 AF/year. The second known turnout has been estimated at having a potential maximum flow of 9 cfs. Therefore, the volume of water diverted was calculated using the crop demand limited by the turnout capacity which is approximately 3,600 AF/year. The projected water budget assumes the new cost structure for water will incentivize landowners with holding contracts to fulfill their water demand using surface water in the future and thus reflects that volume in the budget. The potential supply is estimated at approximately 9,900 AF/year based on crop water demand of the holding contract lands. This surface inflow should not change based on the effects of climate change on surface water supply. Holding contracts allow landowners to take as much water as is beneficially used.

Historically, there have been no other sources of surface water in RCWD. However, surface water contracts were formed with MID, Wonderful, and the USBR for San Joaquin River Section 215 water. Since the delivery system was completed in 2014, RCWD has had the ability to take surface water. The agreement with MID gives RCWD the first right to purchase surplus surface water up to 10,000 AF annually, but the average annual deliveries have been 1,785 AF since construction of the distribution system. It is anticipated, based on a hydrologically average, 24-year surface water availability analysis, that about 2,200 AF on an average annual basis may be available through this contract. This volume may or may not change, due to SGMA and the need for MID to use their own surface water and will be updated with each five-year update based on hydrological data. The contract with the USBR was made in 1999 and is anticipated to only supply approximately 2,000 AF on an average annual basis based on historic river flows and the capacity of the RCWD turnout from MID Lateral 6.2. Lastly, the contract with Wonderful is a firm supply contract that allows RCWD to purchase up to 7,000 AF/year. This water comes at a high expense and will only be used in circumstances that justify the cost. Based on the surface water availability analysis, it is anticipated that approximately 900 AF/year will be used. It is assumed that all surface water available to the District will be used. A Proposition 218 measure was passed to increase assessments and impose fees on groundwater pumping as a recharge fee, which makes surface water competitive in pricing and incentivizes landowners to use surface water in lieu of groundwater.

Surface Water for M&I
The Infrastructure Master Plan for Gateway Village (now named Riverstone) suggests the need for municipal use of surface water will arise, but not until the groundwater quality causes it to be necessary. Therefore, the projected water budget accounts for this use beginning in 2035, assuming that 20 percent of municipal needs are met by surface water.

Spill Inflows
Operational spill inflows are considered negligible. The only District surface water facility is a turnout from MID Lateral 6.2, and a flow meter is used to determine the diversion volume.

Precipitation
Monthly precipitation data was collected from the NOAA Regional Climate Center's Applied Climate Information System for the last 50-year period. The closest weather station to RCWD with the available data is located at the Fresno Yosemite International Airport; therefore, this station was utilized to represent the District. The historic water budget considers the water years from 1989-2014 to calculate an average annual precipitation of 10.8 inches. For calculating the projected precipitation in 2040, the monthly precipitation averages for the last 50 years were gathered and DWR monthly averaged climate change factors were applied. By interpolating between the given 2030 and 2070 climate change factors, values for 2040 could be calculated.

According to the data provided by DWR, it is anticipated that precipitation will increase overall by about 2 percent with most of the change occurring in the winter months, for a total precipitation of approximately 11.39 inches.

Deep Percolation

Deep percolation occurs from precipitation, applied irrigation water, and outdoor municipal use. When precipitation or irrigation causes the soil to reach field capacity (become saturated), water begins to move downward through the soil due to gravity. When it passes the root zone, it is considered part of the groundwater system. Deep percolation of precipitation is calculated using **Equation 3-1** (Williamson, Prudic, & Swain, 1989):

Equation 3-1 Deep Percolation of Precipitation

$$DP = 0.64 * P - 6.2$$

Where:
DP = Deep Percolation (inches)
P = Annual Precipitation (inches)

Deep percolation of irrigation water is estimated by assuming that any water applied in excess of evapotranspiration requirements, due to irrigation efficiency, trickles through the root zone and reenters the groundwater system. As for municipal water use, it is assumed that approximately 2/3 of demand is for outdoor use and the irrigation efficiency is 70 percent for landscape irrigation. The other 30 percent of landscape irrigation is considered deep percolation.

Surface Water Seepage

A potentially large source of groundwater recharge occurs through seepage of unlined canals, streams, lakes, and reservoirs. RCWD does not currently contain any large reservoirs for water storage nor does it have much in the way of surface water distribution. The main pipeline for surface water distribution is a turnout off of MID Lateral 6.2, which was built in 2014. It is assumed that leakage from the pipe is very low and has been calculated as 2 percent of the anticipated average annual flow for the current and projected water budget.

River and Local Stream Recharge

The San Joaquin River runs along the southern edge of the district and contributes a substantial amount of seepage to the groundwater system. There is no readily available information or data on the volume of recharge the San Joaquin River provides to the aquifer; however, it may be estimated given other information. Seepage from the San Joaquin River was calculated with the total losses method using the following equation:

Equation 3-2 River Seepage Losses

$$Seepage = Total\ Losses - Riparian\ ET - Surface\ Water\ Evaporation - Diversions$$

The total volume loss between various measure points has been quantified by the USBR in the August 2013 Flow Loss Analysis Draft Technical Memorandum (United States Bureau of Reclamation, 2013). Seepage had to be calculated for the whole reach between measurement points, in this case Friant Dam to Gravelly Ford. Riparian ET and surface water evaporation can be estimated using acceptable engineering practices. The variable causing the most uncertainty in the above equation is the volume of diversions from the holding contracts, since this data is not readily available. Diversions of surface water for holding contract lands was estimated by assuming water use patterns from the one known statement of diversion applied to the rest. The calculated historic seepage is expected to remain the same into the future, as it is required that the river maintains flow for contracts further downstream. As for Root Creek, the volume of seepage on an average annual basis is assumed to be negligible due to information gathered on the characteristics of the creek including total annual runoff volume, soil characteristics, and the location of ponding (outside district boundaries).

Urban Stormwater Recharge
To help the District meet its need in reducing the overdraft, Riverstone has agreed to assist in the development of a groundwater recharge basin or small stormwater detention basins in Root Creek. Currently, Riverstone has created a few small stormwater detention basins to capture rain for recharge; however, they may be located in an area not favorable to recharge due to soil type.

Intentional Groundwater Recharge
Historically, RCWD has not used intentional groundwater recharge as a method for banking water. In 2017, however, 178 AF of surface water was recharged in wastewater treatment basins before the plant was in operation. As for the projected water budget, there is a possibility of a recharge facility being built if the timing and availability of water supplies prove it necessary.

Other Recharge
There are no other known sources of recharge for the historical base period. As the Riverstone development gets closer to build out, a larger wastewater treatment plant will be necessary, and the plan is to recharge effluent into the groundwater system. Based on actual per capita indoor water use data and build out population, an estimation for volume of wastewater produced in 2040 was calculated.

Groundwater Inflow
The largest inflow of groundwater into RCWD is through subsurface flows at approximately 17,000 AF/year. This number is calculated based on transmissivity values, groundwater level contours, and district boundaries and has the highest uncertainty associated with it. The projected budget into 2040 assumes the same subsurface flow.

Outflows
Evaporation and Runoff of Precipitation
Evaporation and runoff of precipitation is a surface outflow. It is calculated as the volume of precipitation that has not been attributed to deep percolation or effective precipitation. It does not have much of an effect on groundwater storage changes.

Groundwater Pumping for Irrigation
Groundwater pumping for irrigation of crops is usually an unknown factor due to the lack of historic regulation and monitoring of pumping. However, private groundwater pumping can be estimated with land use cropping data, ET data, and effective precipitation. Effective precipitation is the amount of rainfall that is beneficially used by the crops and is calculated for each year in the hydrologic period using the set of three equations seen below (MacGillivray, 1989).

Equations 3-3 Effective Precipitation

$$Nov - Feb = -0.54 + (0.94 * P)$$
$$Mar = -1.07 + (0.837 * P)$$
$$Oct = -0.06 + (0.635 * P)$$

Where:
P = Precipitation for the months listed (inches)

The average annual effective precipitation over the base period is subtracted from the crop ET values, obtained from the ITRC, for a typical year to get applied water demand. Land use data from DWR surveys is available for four years (1995, 2001, 2011, 2014) during the chosen hydrologic base period. The average land area for each crop (in acres) was then multiplied by its respective applied water demand (in feet). This value is known as the average annual crop water demand, or the amount of water that needs to be beneficially applied to the crop. More recently, land has been taken out of production for the beginning of the Riverstone development and will continue until build out. To capture the most recent land use, 2017 data from the Agricultural Commissioner of Madera County was used as the base for estimating private groundwater pumping for the current and projected budget. To ensure consistency and accuracy, a comparison made between the 2014 DWR land use map and 2014 Agricultural Commissioner map showed a difference of less than 5 percent. For projecting crop water demand into the future, land was taken out of production in the area where the Riverstone development will be built. To account for potential change in evapotranspiration due to climate, DWR change factors were applied by averaging the most recent 50 years of ET change data. In 2040, it is anticipated that there will be approximately a four percent increase in ET.

Not all water that reaches the field is beneficially used by the crop due to irrigation inefficiencies. Thus, irrigation efficiency was considered in estimating groundwater pumping for irrigation. Irrigation techniques were assigned to various crops based on available DWR data, which indicated the most popular irrigation system for various crops. System efficiencies were assumed and an area-weighted average irrigation efficiency was applied to the total crop water demand to calculate the volume of water that will need to be applied as irrigation. As mentioned before, the volume of water applied that exceeds crop water demand is assumed to percolate back into the groundwater system. Lastly, to get to the estimated volume of pumped groundwater, surface supplies and transportation losses must be considered. Known surface water diversions from the San Joaquin River minus losses were taken out of the applied groundwater demand.

Groundwater Pumping for Municipal and Industrial Use

Historically, municipal demand on groundwater resources in RCWD have been negligible due to the extremely low population in the area. However, Riverstone anticipates a population of approximately 20,000 people with an expected municipal water demand of 6,374 AF on an annual basis at build out. It is assumed that 80 percent of this demand will come from groundwater extractions.

Evapotranspiration

Evaporation and evapotranspiration are not direct sources of groundwater outflow as pumping is; however, they are the most significant sources of nonrecoverable losses. Some of the water pumped for irrigation purposes goes back into the system through deep percolation, while the majority permanently leaves the system through evapotranspiration, known as a consumptive use. This occurs to water used for irrigation of crops or municipal water used for irrigation of landscaping, so a portion of both water-use sectors contribute to nonrecoverable loss of groundwater.

Groundwater Outflow

Subsurface flow is also a significant source of outflow in the district, approximated at 11,000 AF per year, using the same methods as calculating groundwater inflow.

3.3.3 Quantification of Overdraft

Regulation Requirements:

§354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:
(4) The change in the annual volume of groundwater in storage between seasonal high conditions.
(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.
(7) An estimate of sustainable yield for the basin.

Madera Subbasin

For the basin, **Table 3-7** documents the change in levels, change in storage, and the preliminary sustainable yield estimate. **Figure 3-41** illustrates the total change in levels and the average yearly change in groundwater levels over the base period.

Table 3-7. Preliminary Summary of Calculated and Model-Based Results of Change in Groundwater Storage (AFY)

Source	Estimate	Sy Estimate	Analysis Period	Wet Period	Average Period	Dry Period
			1989-2014	1990-1998	1999-2010	2011-2014
Calculated	Average Annual Upper Aquifer	*C2VSim*	-160,398	-103,073	-126,875	-358,755
		CVHM	-99,212	-107,480	-43,246	-158,242
		DWR	-71,368	-53,510	-50,600	-143,466
		GMP	-89,210	-66,887	-63,262	-179,333
		Average	-105,047	-82,738	-70,996	-209,949
Model-Based	Average Annual Upper Aquifer		-87,895	-37,890	-110,164	-105,771
	Average Annual Lower Aquifer		-8,009	684	-13,044	-9,024
	Total		-95,904	-37,205	-123,208	-114,796
Overall Estimated Change in Groundwater Storage from Groundwater System Analyses Over Analysis Period[1]			**-110,000 to -120,000 AFY**			

1) The overall estimated storage change of -110,000 to -120,000 AFY is based on the average of the calculated methods of the Upper Aquifer plus the average model-derived value for the Lower Aquifer.

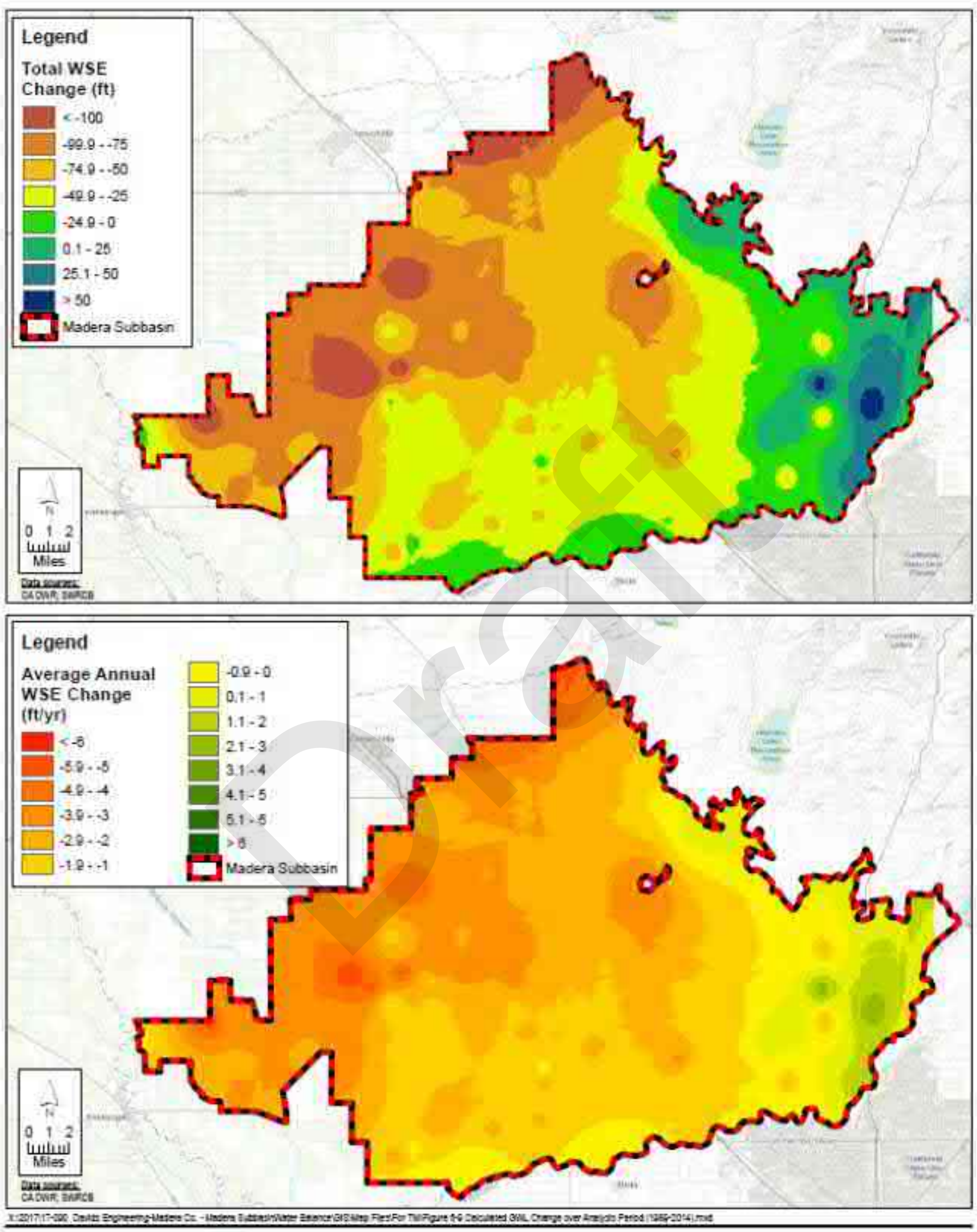


Figure 3-41. Preliminary Calculated Groundwater Level Change Over Analysis Period (1989-2014) (Davids Engineering and Luhdorff & Scalmanini, 2018)

Figure 3-42 graphically displays the change in groundwater storage in relation to a dry period, a wet period, and a typical period.

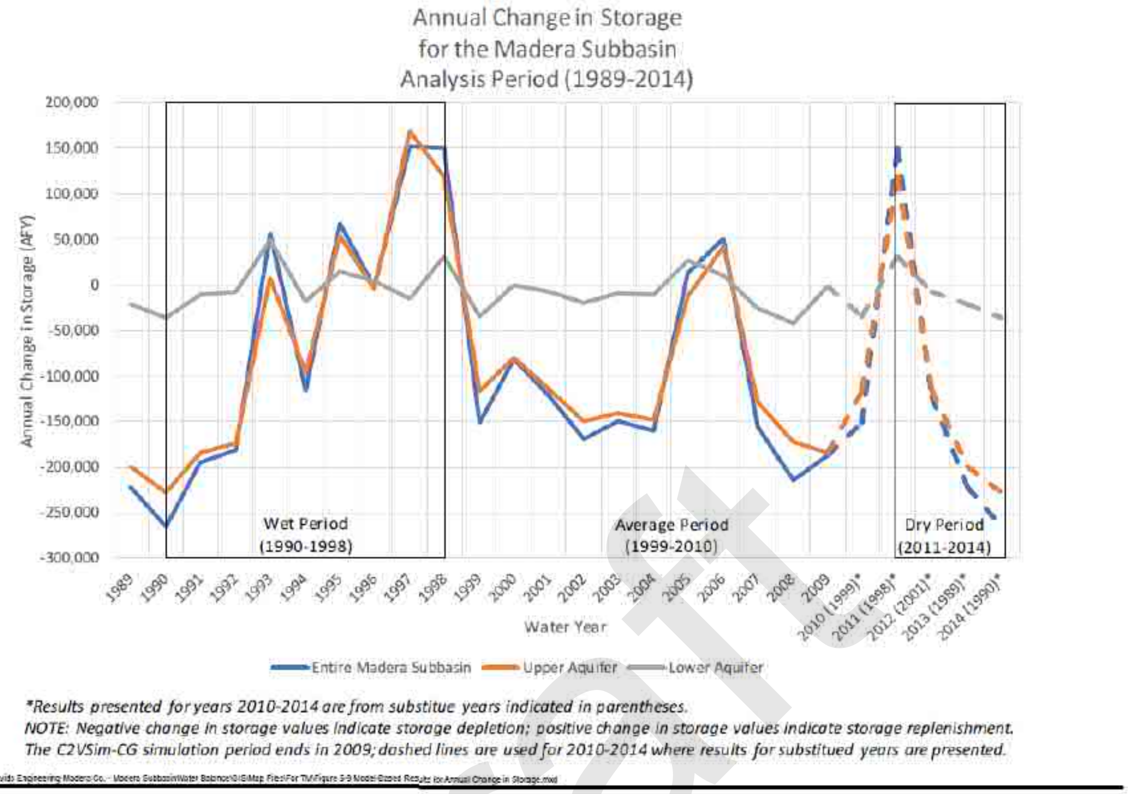


Figure 3-42. Preliminary Model-Based Results for Annual Change in Storage (Davids Engineering and Luhdorff & Scalmanini, 2018)

The third method for calculating overdraft reduced the evapotranspiration of applied water (ETaw) proportionately across all months, crops and years until the net groundwater recharge from the SWS discussed in the water budget section was increased to an average annual value of zero. The reduction in ETaw resulted in a reduction in average annual groundwater pumping that increased the net groundwater recharge from the SWS. Again, applying judgement based on experience with similar water budgets, confidence intervals (CI) were estimated for the input values, and a CI was calculated (Burt, et al., 1997) for the preliminary sustainable yield, resulting in a 95 percent CI between 242,500 and 363,700 AFY (**Table 3-8**).

Table 3-8. Preliminary Sustainable Yield Calculated from Simulation for Net Recharge from the SWS Equal to Zero (Davides Engineering and Luhdorff & Scalmanini, 2018)

Inflow/Outflow	Quantification Method	Average Volume (AF)*	Estimated CI (percent)	CI Source	Average Minus CI (AF)	Average plus CI (AF)
Sustainable Yield**	Calculation	303,100	20%	Professional Judgement	242,500	363,700

*1989 through 2014
**Estimated average annual groundwater pumping with net recharge from the SWS equal to zero

Root Creek Water District GSA

Quantification of groundwater overdraft was calculated using the following simple equation:

$$\Delta\, Storage = Inflows - Outflows$$

Where:
Inflows = Subsurface inflow, deep percolation of irrigation water and precipitation, seepage from pipelines and the San Joaquin River, and intentional and stormwater recharge (AF/year)
Outflows = Subsurface outflow and groundwater pumping for municipal and irrigation demand (AF/year)

The above parameters are quantified and summarized in tables in the following section. The change in storage based on the above equation was compared to the calculated annual change in groundwater storage based on average annual water level decline and specific yield. The approximate specific yield for current RCWD groundwater levels is 0.13 and long-term average annual water level decline across the district is about -2.5 feet per year. This method for calculating annual change in groundwater uses the following equation:

$$\Delta\, Storage = SY * \, \Delta WL * A$$

Where:
SY = Specific Yield (%)
ΔWL = Change in Water Level (feet/year)
A = Area of GSA (acres)

Using the equation above and estimated values for change in water level, the calculated storage change is approximately -3,100 AF on an average annual basis.

3.3.4 Current, Historical, and Projected Water Budget

Regulation Requirements:

§354.18

(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.

(2) Historical water budget information shall be used to evaluate availability or reliability of past surface water supply deliveries and aquifer response to water supply and demand trends relative to water year type. The historical water budget shall include the following:

(A) A quantitative evaluation of the availability or reliability of historical surface water supply deliveries as a function of the historical planned versus actual annual surface water deliveries, by surface water source and water year type, and based on the most recent ten years of surface water supply information.

(B) A quantitative assessment of the historical water budget, starting with the most recently available information and extending back a minimum of 10 years, or as is sufficient to calibrate and reduce the uncertainty of the tools and methods used to estimate and project future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon.

(C) A description of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability of the Agency to operate the basin within sustainable yield. Basin hydrology may be characterized and evaluated using water year type.

(3) 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:

(A) Projected hydrology shall utilize 50 years of historical precipitation, evapotranspiration, and streamflow information as the baseline condition for estimating future hydrology. The projected hydrology information shall also be applied as the baseline condition used to evaluate future scenarios of hydrologic uncertainty associated with projections of climate change and sea level rise.

(B) Projected water demand shall utilize the most recent land use, evapotranspiration, and crop coefficient information as the baseline condition for estimating future water demand. The projected water demand information shall also be applied as the baseline condition used to evaluate future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate.

(C) Projected surface water supply shall utilize the most recent water supply information as the baseline condition for estimating future surface water supply. The projected surface water supply shall also be applied as the baseline condition used to evaluate future scenarios of surface water supply availability and reliability as a function of the historical surface water supply identified in Section 354.18(c)(2)(A), and the projected changes in local land use planning, population growth, and climate.

(d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:

(1) Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.

(2) Current water budget information for temperature, water year type, evapotranspiration, and land use.

(3) Projected water budget information for population, population growth, climate change, and sea level rise.

Basin:

Please refer to Davids Engineering and Luhdorff & Scalmanini (2018) for specifics on the complete historical and projected water budgets.

Root Creek Water District:

As previously mentioned, the historic water budget was prepared using data from 1989-2014, which represents a typical hydrologic period. This period mostly came into play when calculating various aspects of precipitation data, such as effective precipitation and deep percolation. Surface water inflow in terms of diversions off the San Joaquin River were assumed to be constant at an average annual value. **Table 3-9** summarizes the historic, current, and projected water budget parameters and estimates RCWD's historic overdraft. It should be noted that the historic overdraft has already decreased with the current budget and is anticipated disappear in the future. The initial decrease in overdraft is mostly due to the distribution pipeline that was completed in 2014 and has brought in more surface water supplies, thus directly reducing the volume of pumping. Furthermore, some crops were taken out of production in preparation for the Riverstone development.

Table 3-9. RCWD Historical, Current, and Projected Water Budgets

Description		Volume (AF) Historic	Current	Projected (2040)
Supply				
1)	Surface Water for Irrigation	4,800	5,600	13,700
2)	Surface Water for M&I	0	0	1,300
3)	Groundwater Pumping for Irrigation (Private Wells)	19,900	18,400	8,200
4)	Groundwater Pumping for M&I (Agency Wells)	0	300	5,100
5)	Precipitation	8,400	9,100	9,100
6)	Other Supply:	0	0	0
	Total Supply	**33,200**	**33,400**	**36,100**
Demand				
Consumptive Use				
7)	Evapotranspiration Crop Requirement	20,500	19,800	17,100
8)	Evapotranspiration met by Effective Precipitation	4,400	5,200	3,900
9)	Evapotranspiration of M&I	0	200	2,900
	Consumptive Subtotal	**24,900**	**25,200**	**23,000**
Groundwater Recharge				
10)	Groundwater Inflow	17,200	17,200	17,200
11)	Deep Percolation of Irrigation Water	4,300	4,200	3,500
12)	Deep Percolation of Precipitation	1,100	1,200	1,200
13)	Deep Percolation of M&I Water	0	200	1,200
14)	Seepage of Channels & Pipelines	0	0	0
15)	Urban Stormwater - Recharge	0	0	0
16)	Local Streams/Rivers - Recharge	3,700	3,700	3,700
17)	Groundwater - Intentional Recharge	0	0	0
18)	Other Recharge:	0	0	2,000
	GW Recharge Subtotal	**26,300**	**26,500**	**26,800**
Nonrecoverable Losses				
19)	Groundwater - Outflow	11,000	11,000	11,000
20)	Evaporation - Recharge Basins	0	0	0
21)	Precipitation - Evaporation and Runoff	2,900	2,700	4,000
22)	Other Losses:	0	0	0
	Nonrecoverable Subtotal	**13,900**	**13,700**	**15,000**
Method 1				
	Estimated Annual Change in Groundwater Storage	**(4,600)**	**(3,200)**	**2,500**
	GW Recharge - #10 thru #18	26,300	26,500	26,800
	GW Pumping - #3 and #4	(19,900)	(18,700)	(13,300)
	GW Outflow - #19	(11,000)	(11,000)	(11,000)

Surface Water Supply Available for Recharge

RCWD will consider using surface water for direct recharge if water becomes available in off-season months for irrigation. Studies including soil boring have shown unfavorable conditions for recharge in locations that have been tested; however, there are still more options.

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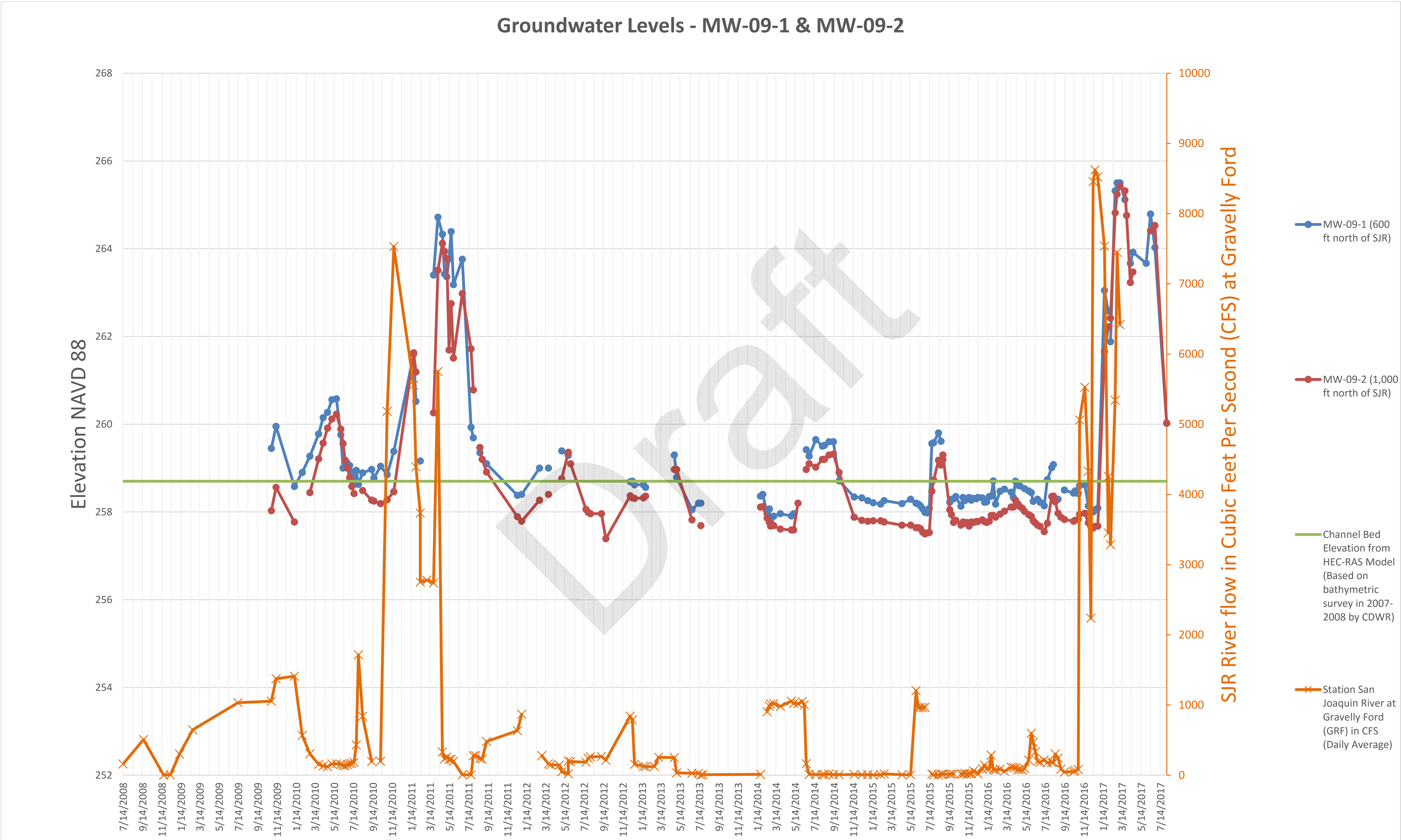
Appendix 3-A Monitor Wells Groundwater Elevation Data


Groundwater Levels - MW-09-1 & MW-09-2
Elevation NAVD 88
SJR River flow in Cubic Feet Per Second (CFS) at Gravelly Ford
268
266
264
262
260
258
256
254
252
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
MW-09-1 (600 ft north of SJR)
MW-09-2 (1,000 ft north of SJR)
Channel Bed Elevation from HEC-RAS Model (Based on bathymetric survey in 2007-2008 by CDWR)
Station San Joaquin River at Gravelly Ford (GRF) in CFS (Daily Average)
Draft

4 Sustainable Management Criteria

Regulation Requirements:

§354.22 This Subarticle describes criteria by which an Agency defines conditions in its Plan that constitute sustainable groundwater management for the basin, including the process by which the Agency shall characterize undesirable results, and establish minimum thresholds and measurable objectives for each applicable sustainability indicator.

SGMA defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results. The avoidance of undesirable results is important to the success of the GSP. Several requirements from GSP regulations have been grouped together under the heading of Sustainable Management Criteria, including Sustainability Goal, Undesirable Results, Minimum Thresholds, and Measurable Objectives. Development of these Sustainable Management Criteria is dependent on basin information developed and presented in the hydrogeologic conceptual model, groundwater conditions, and water budget sections of this Plan (DWR,2017).

The Sustainable Management Criteria described herein were prepared following the requirements set forth in the California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5, Subarticle 3 (§354.22 through §354.30). Indicators for the sustainable management of groundwater were determined by SGMA based on properties that are important to the health and general well-being of the public. There are six indicators that must be monitored throughout the planning and implementation period of the GSP. The following discussion will be broken down based upon each of the sustainability indicators including:

1. Lowering groundwater levels
2. Reduction of groundwater storage
3. Degraded water quality
4. Land subsidence
5. Depletion of interconnected surface water
6. Seawater Intrusion

4.1 Sustainability Goal

Regulation Requirements:

§354.24 Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.

> "GSAs must develop a sustainability goal that is applicable to the entire basin. If multiple GSPs are developed for a single basin, the sustainability goal must be presented in the basin-wide coordination agreement. The sustainability goal should succinctly state the GSA's objectives and desired conditions of the groundwater basin, how the basin will get to that desired condition, and why the measures planned will lead to success. Unlike the other sustainable management criteria, the sustainability goal is not quantitative. Rather, it is supported by the locally defined minimum thresholds and undesirable results. Demonstration of the absence of undesirable results supports determination that the basin is operating within its sustainable yield and, thus, that the sustainability goal has been achieved (DWR, 2017)."

<u>Goal Description</u>

The goal for the GSA is that the participants in the Madera Groundwater Subbasin will collectively work together to sustainably manage the groundwater resources of the basin while maintaining openness to the public and stakeholders such that the local citizenry has a voice in the outcome. Sustainable management of resources means the ability to maintain groundwater levels at a point that meets measurable objectives and avoids undesirable results. The overdraft quantified in Section 3.3 was used to determine a sustainable yield, which along with projects and management actions will help to stabilize water levels over time.

Discussion of Measures

In order to achieve the goals outlined in the GSP, a combination of projects and management actions will be implemented over the course of the next 20 years. Surface water supply and infrastructure projects will be crucial for supplementing the use of groundwater. Management actions may be implemented, if necessary, to help mitigate overdraft on the demand side. Projects and management actions are discussed in further detail in Chapter 6. When combined with consistent monitoring practices for each of the sustainability indicators, RCWDGSA will ensure that the District operates within its sustainable yield on an average annual basis.

Explanation of how the goal will be achieved in 20 years

The water budget, described in Section 3.3, accounts for historical water supplies and water demands by water-use sector and quantifies the average annual overdraft. This value gives the basin and the GSA a goal by which to either improve supply or mitigate demand. RCWD proposes to expand the ability of the District to accept surface water supply for meeting demands on an average annual basis. Using surface water for recharge will be considered, if necessary. To ensure that the goal will be achieved in the 20-year timeframe, interim goals for every 5 years have been established for the sustainability indicators. Understanding that projects and programs take time and money to implement, the interim goals have considered exponential mitigation rates. Funding for projects, management actions, and monitoring will come from the local area.

Designated monitoring networks have been chosen for keeping track of groundwater levels, change in storage volume, land subsidence, and water quality. The monitoring networks, described in detail in Chapter 5, will allow the GSA to evaluate the success of the plan and make changes accordingly throughout the implementation process. The GSP monitoring protocols are consistent with Section 352.2 and 352.4.

4.2 Groundwater Levels

Groundwater levels across the GSA vary from close to the surface in the southern part, near the San Joaquin River, to almost 350 feet in depth in the north. In the last 20 years alone, groundwater levels in the northwestern portion of the District have dropped around 70 feet. However, rates of decline are much lower near the river. In order to avoid undesirable results, measurable objectives and minimum thresholds must be defined.

4.2.1 Undesirable Results

The state as early as 1980 in Bulletin 118 identified this subbasin as being in a critical state of overdraft. By definition, the continued and long-term decline of water levels was identified by the crafters of the legislation as being an undesirable effect. Significant and unreasonable lowering of water levels could cause issues with wells going dry or structural integrity issues to existing wells. The terms “significant and unreasonable” are not defined by regulations, rather the conditions leading to this classification are determined by the GSA, beneficial users, and the basin of which they are a part. The process used to develop criteria for determining undesirable results began with the review of DWR well construction records for choosing monitoring wells and through discussions with stakeholders and landowners. Public meetings and discussions with stakeholders and neighbors determined that no undesirable effects had occurred as of 2015.

The historic change in groundwater levels had not resulted in a drop in levels that caused wells to go dry. Many wells were constructed in the early part of the last century and are recognized as being past their useful life. As the gradual groundwater conditions have dropped, newer wells that have replaced these older wells have been drilled—generally, deeper and gravel packed. Thus, the useful life of most wells has been maintained and the gradual decline has not resulted in an undesirable result. The change in groundwater levels associated with well 85 are most concerning. This well is in close proximity to the Madera Ranchos. From 2008 through 2016 groundwater levels have dropped significantly. More than 70 feet in 8 years. This rate is significantly greater than in any area of the District and is thought to be due to the land practices on lands adjacent to the district. Should this trend continue for more than 10 years, it is expected that this would be an undesirable result. Since this well is close to a district boundary and potentially impacted more significantly by practices in close proximity, it is advised that conversations occur with the neighboring GSA as to monitoring, projects and management actions along this boundary.

4.2.1.1 Criteria to Define Undesirable Results

Regulation Requirements:

> **§354.26** (a) Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.

In the RCWD area, there are numerous agricultural wells, a few rural residential wells, and three municipal wells, which have been constructed to deeper depths due to native water quality issues. The criteria chosen to determine what is considered significant and unreasonable lowering of groundwater levels is when the rate of decline is 3.5 feet/year or greater for 10 consecutive years which approximates the long term average groundwater decline.

4.2.1.2 Causes of Groundwater Conditions That Could Lead to Undesirable Results

Regulation Requirements:

> **§354.26** (b) The description of undesirable results shall include the following:
> (1) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.
> (2) The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.
> (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.

At present there are no conditions that result in undesirable results. Going forward there are potential changes that could occur that could have undesirable results.

These consist of the following:

1. **Climate Change**
    a. Some information developed by the State of California Department of Water Resources suggests that warmer conditions could lead to more rain and/or earlier runoff.
    b. These same studies indicate that increased temperatures could result in higher evapotranspiration rates which could increase demand.
2. **Changing Crop Patterns**. Within RCWD, there are significant permanent crops. The agricultural demand is high for agricultural cropping. No increase is forecasted.
3. **Increased Urbanization**. Increases in land use for cities/communities will result in a reduction in demand.
4. **Environmental Regulatory Requirements**. Much of the recent expansion of groundwater supply has been a direct result of State sponsored and required progress of dedicating additional surface water resources to environmental purposes. The San Joaquin Valley experienced subsidence in the 1930s through the 1950s. This is well documented through both U.S. Bureau of Reclamation and

State of California studies. The State Water Project (SWP) and the Federal Central Valley Project (CVP) were constructed with the purpose of importing surface water to the San Joaquin Valley. Farmers invested in the land and the projects. Now, approximately 50 years later, environmental regulations have taken significant surface supplies away from the area. Though not a CVP contractor, RCWDGSA is adjacent to CVP contracting agencies. Groundwater pumping in these adjacent areas could have an undesirable effect (result) on the RCWDGSA.

Change in water levels is the most important indicator in this basin. The monitoring network will be used to gather the data to evaluate the groundwater levels. Minimum thresholds will be set at different levels throughout the District at various wells and not all measurement points will have an objective and minimum threshold. Rather, management objectives and minimum thresholds will be set at certain monitor sites, representative for an area of the region. Additional sites may be added where there is a specific concern, where levels have changed significantly and historically and/or where there is a concern expressed by a local entity.

4.2.1.3 Evaluation of Multiple Minimum Thresholds

Regulation Requirements:

§354.26 (c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.

The monitoring network, both within and adjacent to the GSA, will be used to gather data to evaluate groundwater levels. Minimum thresholds will be set at different levels throughout the District, based on the well and historical data trends. Not all monitoring points will have an objective and minimum threshold; rather, minimum thresholds will be set for areas of specific concern and where levels have historically changed significantly. Five wells were chosen for setting minimum thresholds and measurable objectives. When evaluating undesirable results, monitoring well levels will be compared to groundwater elevation contour maps to determine if minimum thresholds are being exceeded.

4.2.2 Minimum Thresholds

Regulation Requirements:

§354.28 (a) Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section

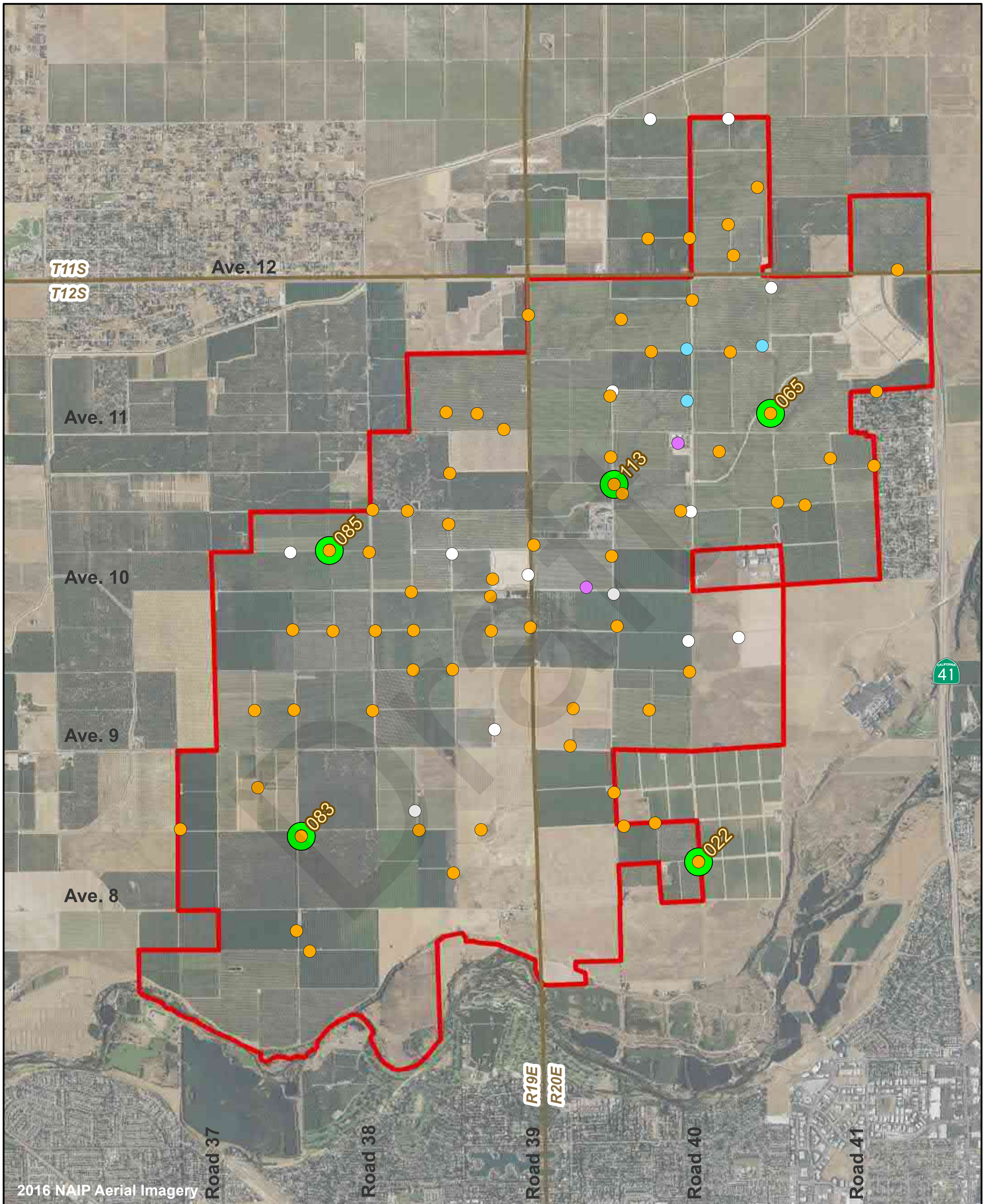
4.2.2.1 Description of Minimum Thresholds

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.
(2) The relationship between the minimum thresholds for each sustainability indictor, including and explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.
(3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.
(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.
(5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.
(6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.
(c) Minimum thresholds for each sustainability indicator shall be defined as follows:
(1) Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:
(A) The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.
(B) Potential effects on other sustainability indicators.

In developing sustainability goals for RCWDGSA, groundwater depth data from three northern and two southern wells were analyzed for trends (**Figure 4-1**). The two southern wells (No. 83 in the southwest and No. 22 in the southeast) were selected due to their relative proximity to the San Joaquin River. It is evident from their hydrographs that these two wells are less susceptible to annual drawdown changes, due to recharge flow from the river, than wells further away from the river. In contrast, the three northern wells are more affected by the reduced recharge and seasonal agricultural pumping. In addition, the northwestern well (No. 85) is believed to also be affected by the significant offsite regional drawdown created by the pumping from adjacent lands. The northwestern offsite pumping is agricultural as well as municipal pumping for the residential subdivisions to the northwest. Therefore, the northern portions of RCWD will have different measurable objectives and minimum thresholds for groundwater elevation than the region closer to the San Joaquin River.

Setting minimum thresholds for each well was completed by using approximately the last 20 years of historical data. Minimum thresholds have been set with consideration to historical trends in the rate of groundwater decline, water year type, and projected water use in the basin. The historical trend has been considered by projecting the same rate of historical decline into the period from 2020 to 2030. This has been done with the understanding that it takes time and money to implement either demand reduction actions or projects that bring in more surface water. With this understanding, it is likely that recent historical pumping trends will continue. Consideration has been given to water year type by adding a buffer to the minimum threshold line. The historical rate of decline was used but offset to intersect with the lowest water table data point for the historical period. This low point was likely due to a dry period or season, which caused an increase in the volume of groundwater pumped. Thus, by creating a buffer, there is some room between the objective and the minimum threshold for a dry season to cause unexpected drops in water levels without reaching an undesirable result. The projected water use is taken into consideration with the decrease in the rate of decline. By 2030 it is expected that projects and management actions will begin to take effect and the rate of declining groundwater levels will slow down. For calculation of minimum thresholds, it was assumed the rate would be cut in half until 2040, at which point the overdraft will stop and the basin will be operating at a sustainable level. **Figure 4-2** through **Figure 4-6** graphically display the historical trend and minimum thresholds for each of the five wells chosen.



EST. 1968 PROVOST & PRITCHARD CONSULTING GROUP An Employee Owned Company

N

0 0.25 0.5
Miles

Root Creek WD
Well With Data 1970s to Current

Well
- Ag
- Domestic
- Municipal
- Ag (Abandoned)

Root Creek WD

Figure 4-1

Wells With SMCs

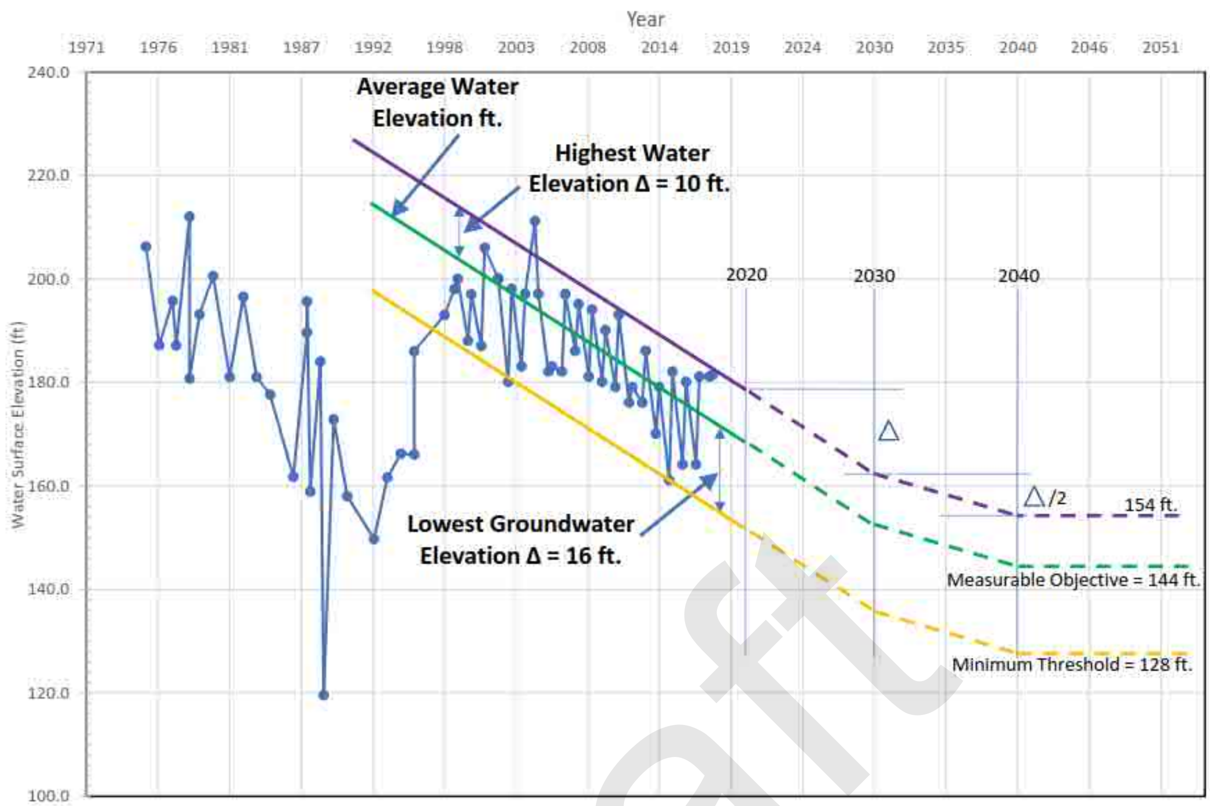


Figure 4-2 Groundwater Elevation Hydrograph for Well 83 (1975-2017)

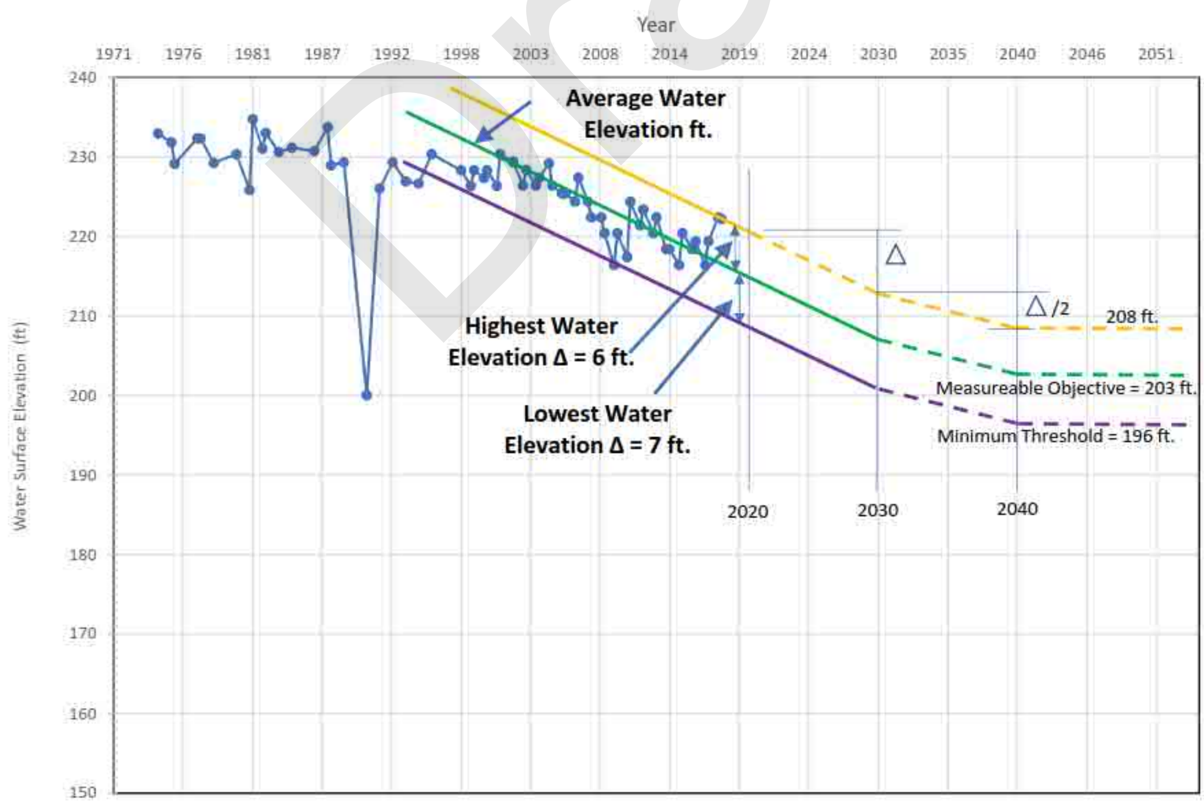


Figure 4-3 Groundwater Elevation Hydrograph for Well 22 (1974-2017)

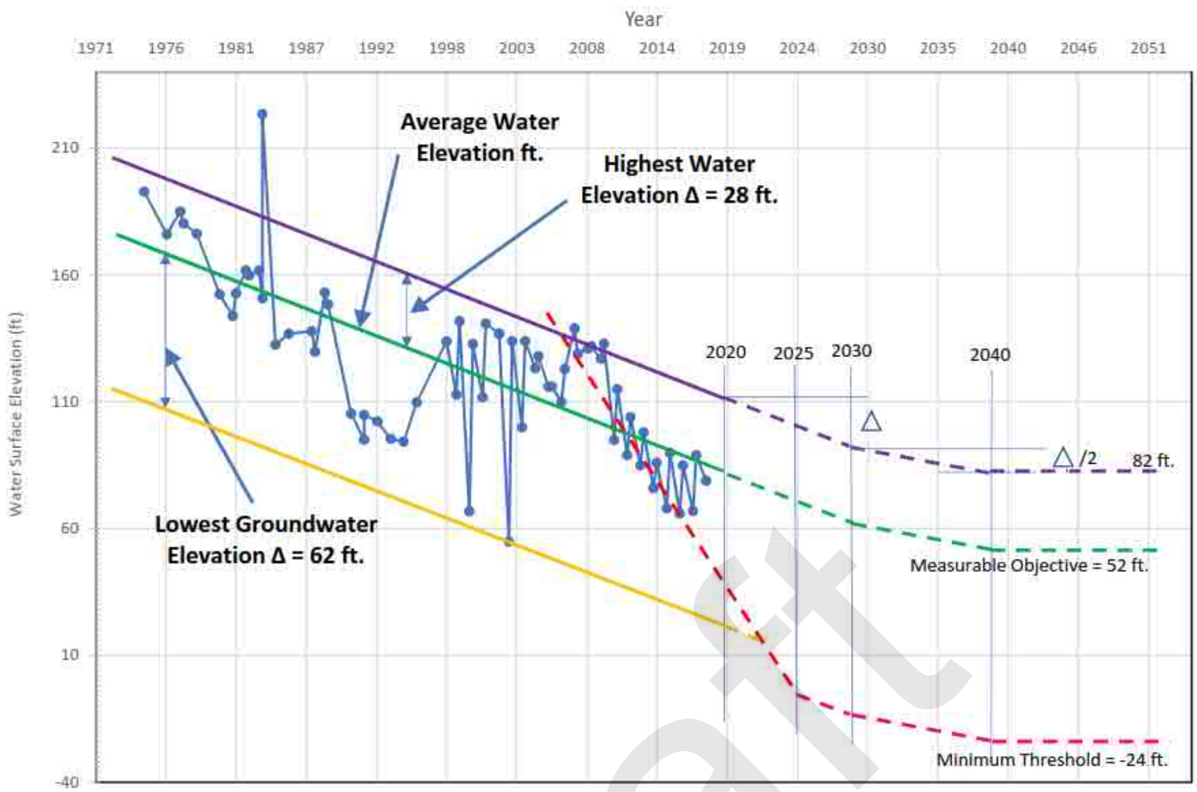


Figure 4-4 Groundwater Elevation Hydrograph for Well 85 (1975-2017)

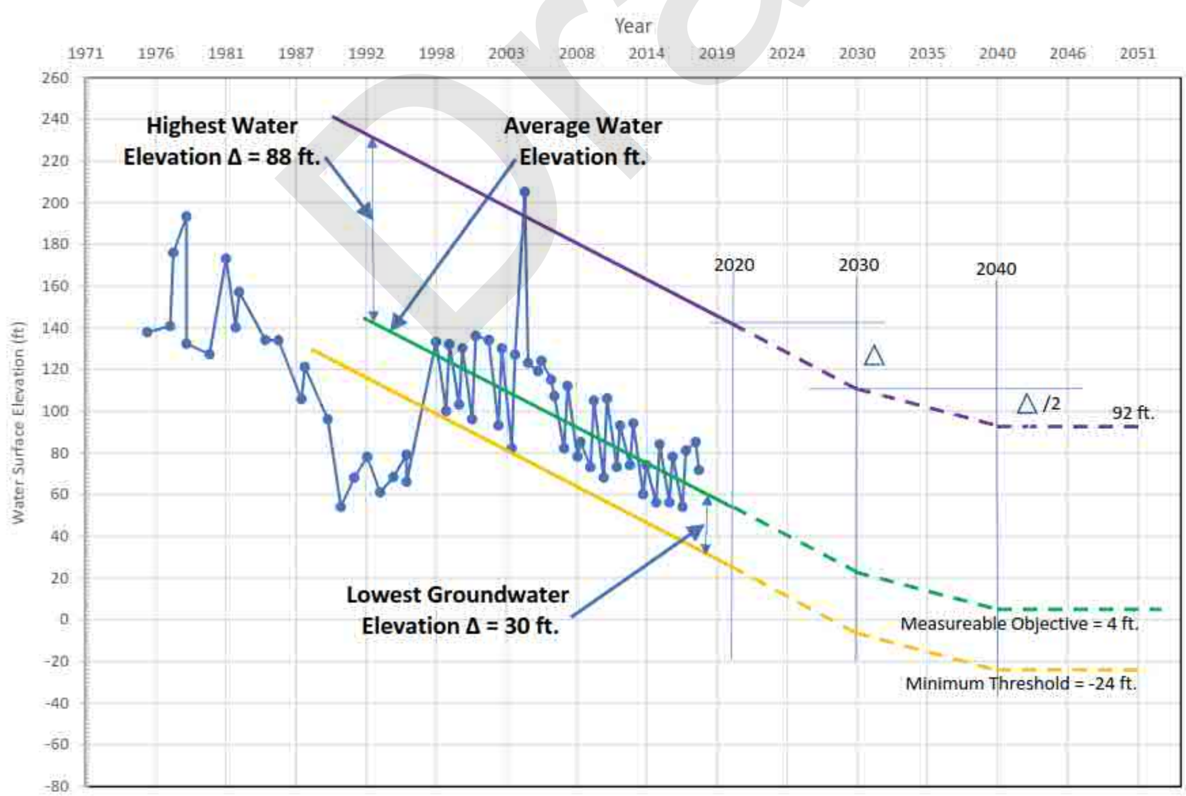


Figure 4-5 Groundwater Elevation Hydrograph for Well 113 (1975-2017)

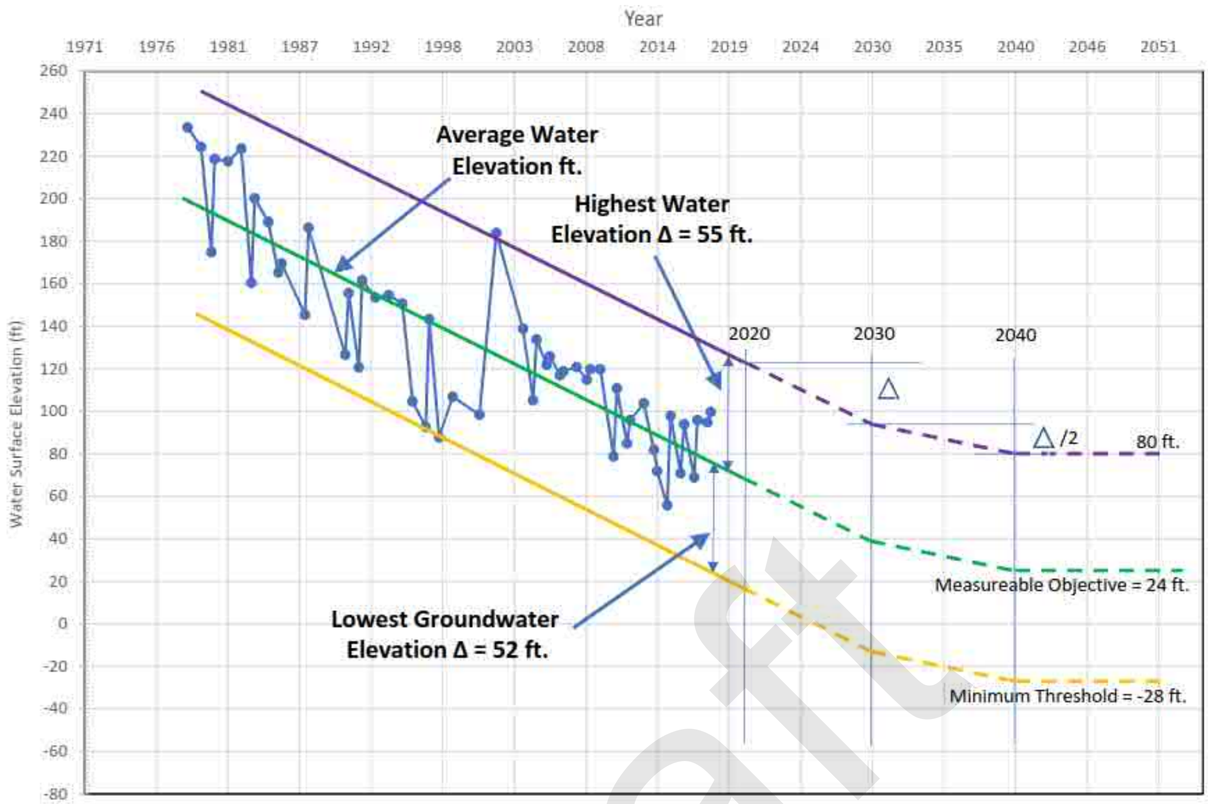


Figure 4-6 Groundwater Elevation Hydrograph for Well 65 (1979-2017)

These five wells are believed to typify the trends of the groundwater surface depths in their areas. The three northern wells (wells 85, 113, and 65) reflect conditions at distance from the San Joaquin River, and the two southern wells (wells 83 and 22) reflect the influence from the river.

The RCWDGSA has also been actively engaged with the regional efforts being performed by the other GSA's in the basin and with their consultant. It is understood that those efforts have been utilizing a model to develop simulated response to groundwater from the various inputs to the model. Include as **Figure 4-7** through **Figure 4-11** are results for the 5 above mentioned sites and the results from the modeling as of May 2019. It appears that there may be a datum issue regarding the data and modeling results. It is also not clear as of this writing how the County of Madera GSA intends to set minimum threshold or management objectives but comparing the initial model runs with the proposed methodology above suggests that the minimum thresholds and management objectives should be similar for both approaches.

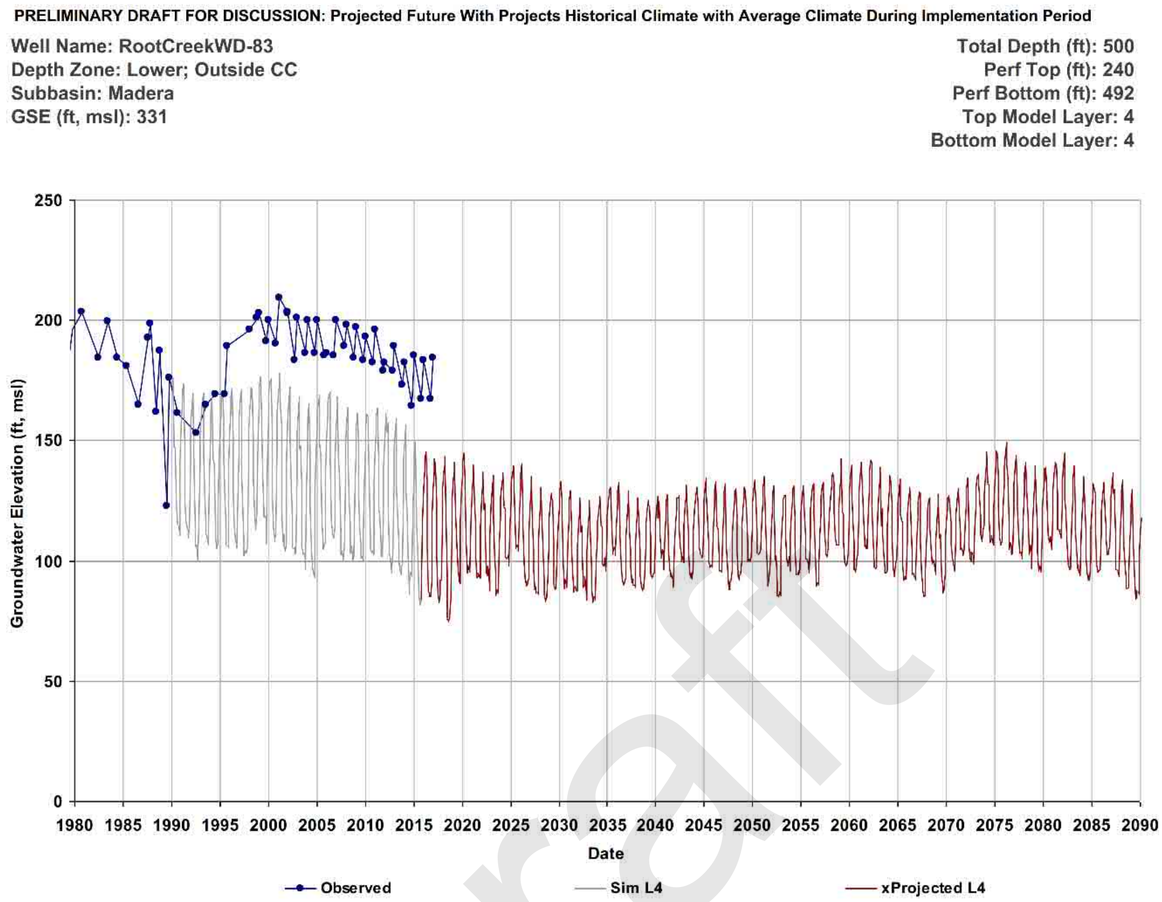


Figure 4-7 - Well 83 Groundwater Elevation Regional Model Projections

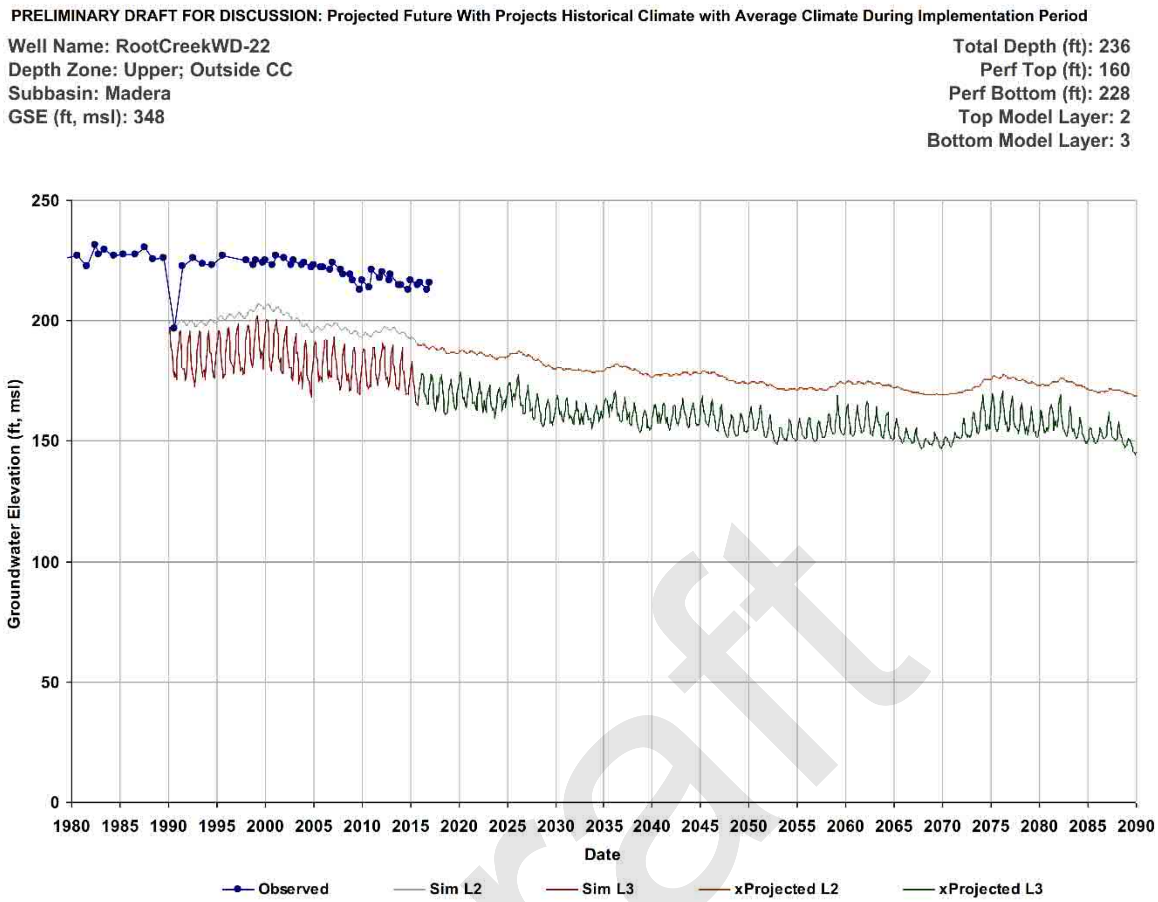


Figure 4-8 - Well 22 Groundwater Elevation Regional Model Projections

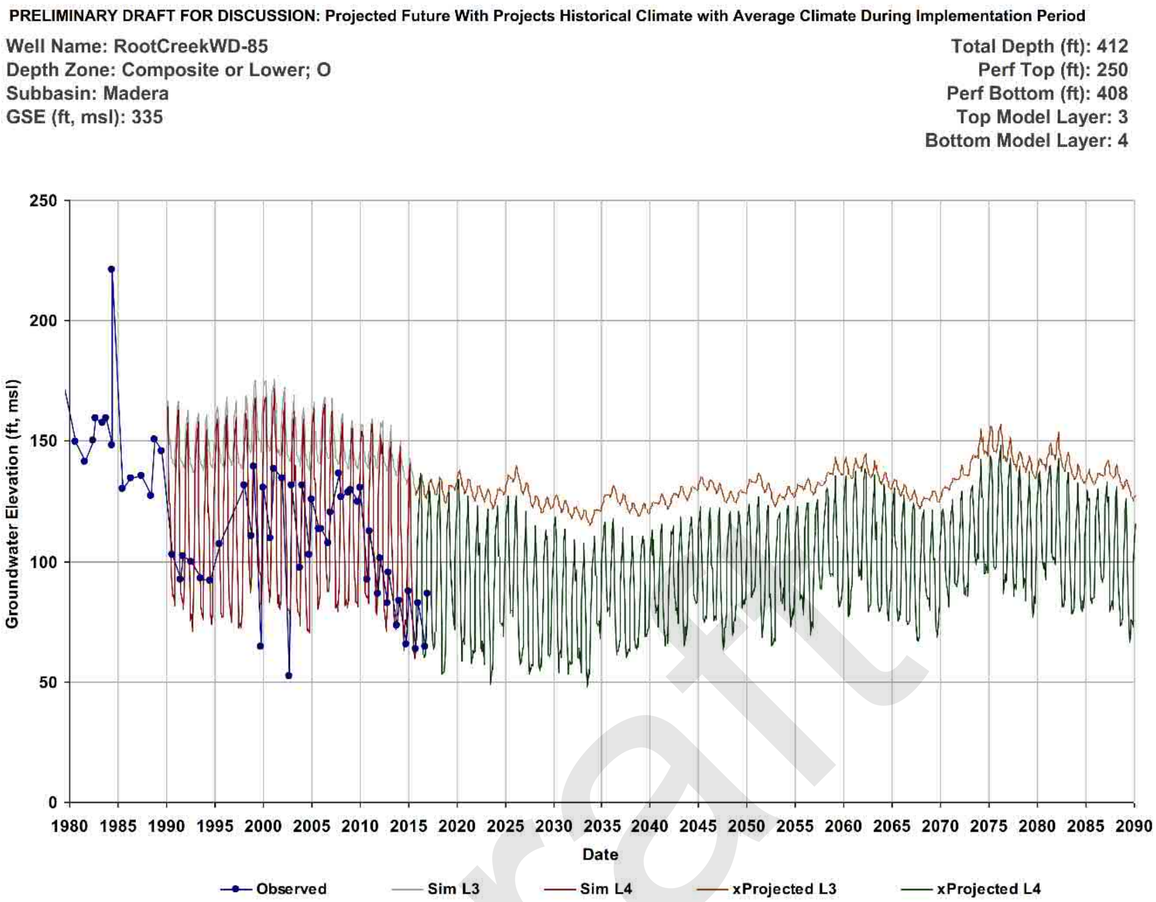


Figure 4-9 - Well 85 Groundwater Elevation Regional Model Projections

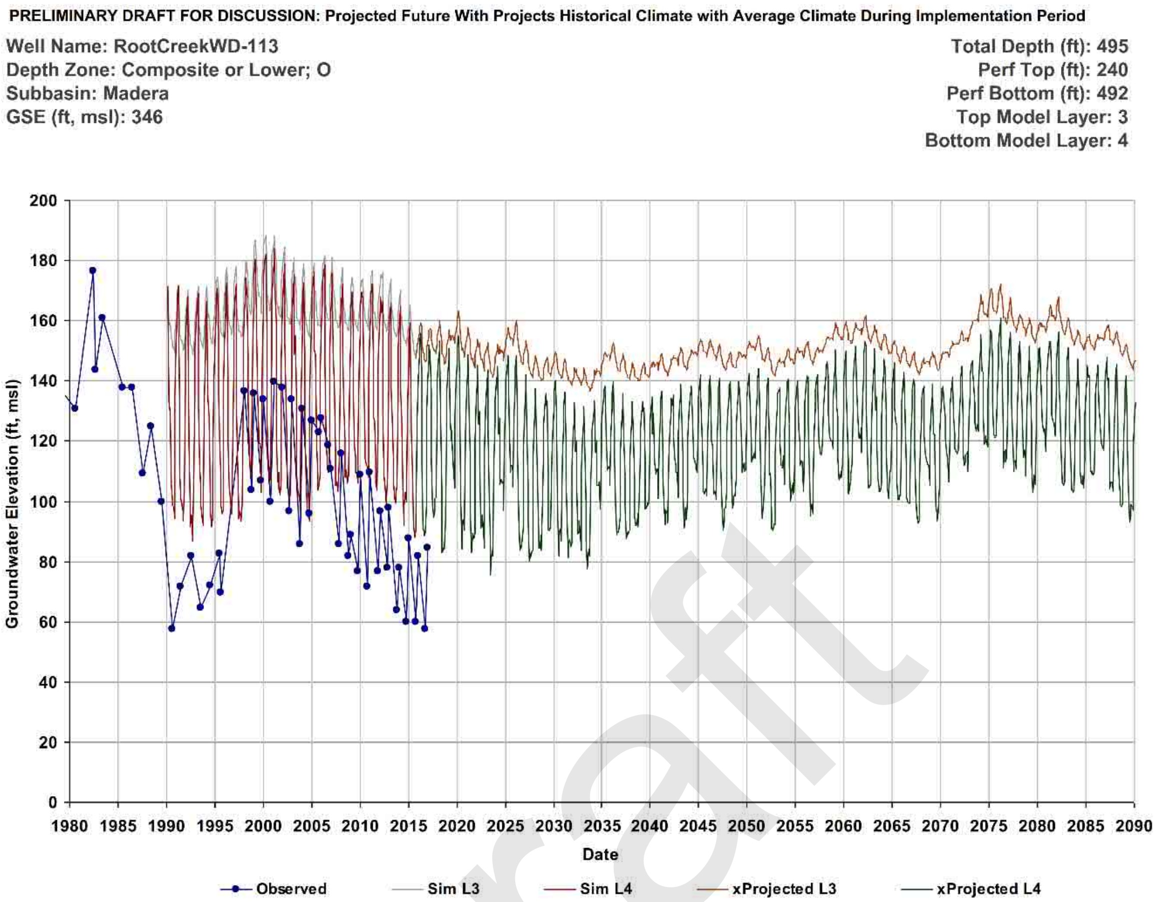


Figure 4-10 - Well 113 Groundwater Elevation Regional Model Projections

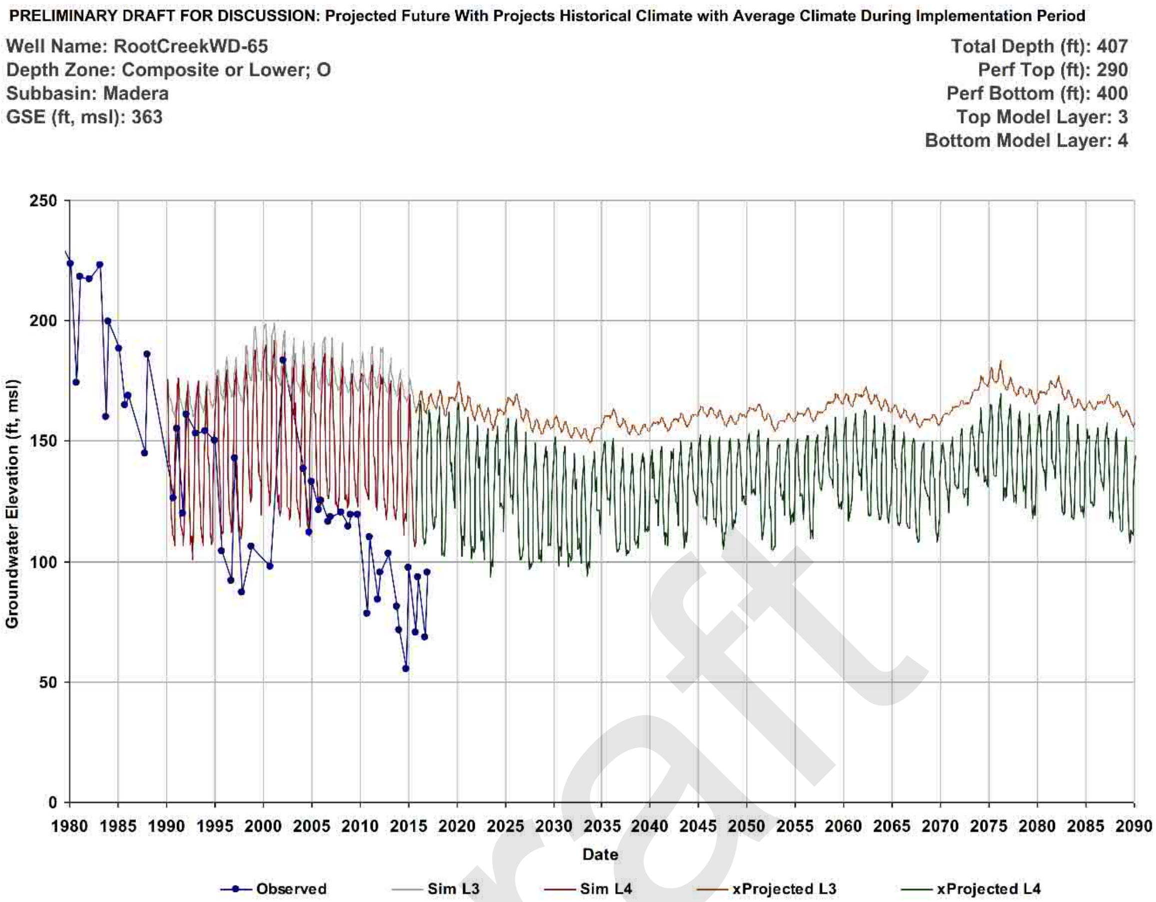


Figure 4-11 - Well 65 Groundwater Elevation Regional Model Projections

4.2.2.2 Relationship for Each Sustainability Indicator

Regulation Requirements:

§354.28 (d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.

Groundwater levels will serve and be used as the indicator for groundwater storage change. Storage change and groundwater levels are directly related through the specific yield. Therefore, an undesirable result for the extraction of groundwater can be relayed through groundwater elevations or through a total storage volume.

4.2.2.3 Selection of Minimum Thresholds to Avoid Undesirable Results

Chronic Lowering of Groundwater Levels
As defined in Section 4.2.2.1 the following are the minimum thresholds for the following sites:

Site	Minimum Threshold*
Monitor Well 83	128.00 ft
Monitor Well 22	196.00 ft
Monitor Well 85	-24.00 ft
Monitor Well 113	-24.00 ft
Monitor Well 65	-28.00 ft

(*elevation)

Lowering of groundwater levels will have a resultant change in groundwater storage. Overall, the percentage change is small compared to the overall storage of the basin. Minimum thresholds avoid reaching the undesirable result defined earlier in this chapter of 10 consecutive years of level decline at -3.5 feet per year and another 10 years at half that rate or -1.75 feet per year. The rate of decline to reach an undesirable result is greater than the historical average rate of decline across the District and the historical rate of decline was used at each well to determine minimum thresholds.

When monitoring sites are not meeting minimum threshold requirements, stricter pumping regulations may be enforced to reverse the trend in the area and avoid undesirable results.

4.2.2.4 Impact of Minimum Thresholds on Water Uses and Users

Due to the nature of infrastructure development and program implementation, water levels will continue to drop at current rates in the next few years before programs affect the stabilization of levels. Lowering groundwater levels will continue to increase the cost of energy for pumping. If minimum threshold levels are reached, some wells will go dry and will require deepening to reach the water table.

4.2.2.5 Measurement of Minimum Thresholds

Measurement of groundwater levels will be done through the sounding tube twice a year to obtain seasonal high and seasonal low values in each of the monitoring wells. While the DWR has indicated that individual monitor wells be used to identify the measurable objective, it will be the intent of this District to compare the contour surface defined by multiple wells to the measurable objective and minimum threshold for the nearest well. For more information on the monitoring of water levels, see Chapter 5 – Monitoring Network.

4.2.3 Measurable Objectives

Regulation Requirements:

§354.30 (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.
(b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.
(c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.
(d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.
(e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.
(f) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.
(g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for finding of inadequacy of the Plan.

4.2.3.1 Description of measurable objectives

Figure 4-2 shows the trend line (green line) through the groundwater elevation data for Well 83 covering the last 20 years. Well readings in this well prior to 1997 show depths both higher and lower than the more consistent readings from about 2000 to the present. Before that date, this data set is irregular and suspect. Furthermore, the last 20 years is more representative of trends that may continue into the future. The measurable objectives have been set using the most recent water level trends and projecting the rate to year 2030. From 2030 to 2040 it is projected that levels will decline at half the rate of historical decline. By 2040 and moving forward, there should be no long-term decline, fulfilling the sustainability goal of sustainable groundwater management that avoids undesirable results. The groundwater level reached at 2040 is considered the measurable objective. It should be noted that it is expected that water level readings will continue to vary over a range of values and the average over many years will average the measurable objective that is proposed.

While the District has been proactive in acquiring surface water supplies and constructing surface water delivery systems, it is feared that others in the basin will not be so proactive, and the objectives are set with an understanding that our neighbors may not be proactive in stabilizing these regional trends. The Ranchos, to the northwest of the District, are assumed to continue their pumping practices, where the data indicates a large groundwater depression that extends into RCWD. This large drawdown is anticipated to hinder the mitigation efforts of RCWD.

4.2.3.2 Operational Flexibility

Operational flexibility is the difference between the measurable objective and minimum threshold. It allows room for extended periods of drought and seasonal variation without having to impose more stringent pumping regulation to reverse the trend. **Table 4-1** summarizes the minimum thresholds, measurable objectives, and operational flexibilities for each of the wells with sustainability criteria.

Table 4-1 Summary of Sustainability Criteria for Groundwater Levels

District Area	Well	Minimum Threshold	Measurable Objective	Operational Flexibility
		Water Elevation	*Water Elevation*	
Southern	83	128	144	16
	22	196	203	7
Northwest	85	-24	52	76
Northeast	113	-24	4	28
	65	-28	24	52

4.2.3.3 Path to achieve measurable objectives

As mentioned, the current groundwater elevation contours will be compared to the measurable objectives for each well to determine if the Plan is successful. RCWD is divided into three general areas to compare the contours to the nearest well, as shown in **Figure 4-12**. Wells 113 and 65 represent the northeast area, Well 85 represents the northwest area, and Wells 83 and 22 represent the southern area of RCWD.

To achieve the goals laid out for groundwater levels, RCWD has completed a project to bring in more surface supplies via a distribution pipeline on the north side of the District. The intent is to use surface water in place of groundwater for irrigation in years when it is available, thus directly decreasing the groundwater use. A monitoring plan has also been laid out in Chapter 5 to keep track of well levels into the future. The project on the north side of the District is anticipated to bring in enough surface water to bring the District into balance; however, more projects will be considered as necessary.

Table 4-2 Summary of Interim Milestones

District Area	Well	Minimum Threshold	Measurable Objective	Interim Milestones			
		Water Elevation	*Water Elevation*	**2020**	2025	2030	2035
Southern	83	128	144	170	162	154	149
	22	196	203	215	211	206	205
Northwest	85	-24	52	85	70	60	56
Northeast	113	-24	4	55	40	25	15
	65	-28	24	70	60	40	32

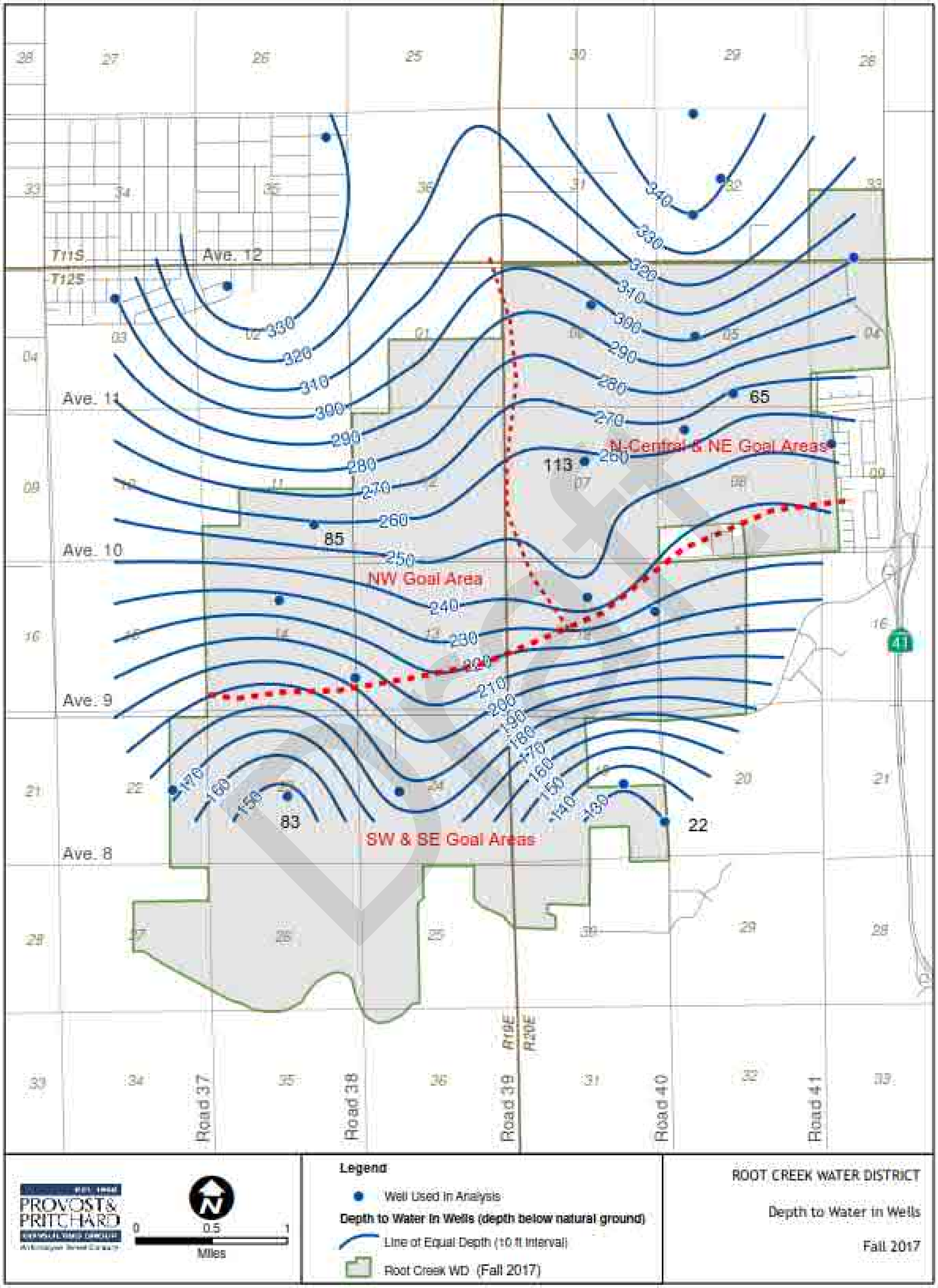


Figure 4-12 Monitoring Areas for each Well with Groundwater Level Sustainability Criteria

4.3 Groundwater Storage

The GSA overlies a deep and productive groundwater basin that thins to the north and northeast. It is estimated that current annual groundwater use can be as much as about 20,000 AF (see Water Budget Section 3.3.4), while the estimated total storage capacity within the RCWDGSA amounts to over 400,000 AF, or about 5 percent in any given year (Provost & Pritchard, 2012). The historic overdraft caused by pumping within the RCWD region was estimated by KDSA (2001) by evaluating the available data for groundwater level changes, crop pattern, and the specific yield of the alluvium. For the 9,550-acre RCWD, the average water-level decline was estimated at approximately 3.3 feet per year, which calculated to an estimated overdraft for the GSA of about 3,400 AF/yr. However, since 2001, the crop and water demands have changed as described in the Water Balance, Section 3.3 of this GSP.

As per the discussion on groundwater levels, the change in storage is directly applicable to the change in groundwater levels and the same discussion applies. Water levels will be used as a representative indicator for storage change.

4.3.1 Undesirable Results

4.3.1.1 Criteria to Define Undesirable Results

Regulation Requirements:

§354.26 (a) Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.

Undesirable results for change in groundwater storage was calculated by using groundwater levels as a proxy. Thus, the change in groundwater storage that would constitute an undesirable result is -3.5 feet/year over a 9,550-acre GSA with a specific yield of approximately 13 percent, or about 43,500 AF in any period of 10 consecutive years.

4.3.1.2 Evaluation of Multiple Minimum Thresholds

Regulation Requirements:

§354.26 (c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.

The minimum threshold for groundwater storage change is just one value in the form of a volume. This volume has been calculated using data and SMCs from all five wells used for groundwater levels. The difference between the most recent groundwater level data and the groundwater level minimum thresholds over the area of the GSA is the net maximum volume of water that can be extracted after accounting for recharge before reaching the minimum threshold.

4.3.2 Minimum Thresholds

Regulation Requirements:

§354.28 (a) Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26. (d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.

Information and criteria used to determine a minimum threshold for groundwater storage includes most recent available groundwater elevation data, specific yield data, and a GSA determined minimum threshold elevation. The groundwater level minimum threshold was determined to avoid undesirable results. Groundwater elevation data has been collected using DWR Water Data Library and local agency data. Specific yield data was analyzed in the Hydrogeological Conceptual Model to determine historical storage change and safe yield. Refer to **Section 3.1.8** for more information on specific yield data that was gathered.

4.3.2.1 Description of Minimum Thresholds

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.
(3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.
(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.
(5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.
(6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.
§354.28 (c) Minimum thresholds for each sustainability indicator shall be defined as follows:
(2) Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.

The minimum threshold for storage volume change was calculated by using current groundwater elevation contours and groundwater level minimum thresholds. The difference between the two surfaces, after accounting for specific yield, is the maximum volume of water depletion before reaching the minimum threshold. Using the change projected over the implementation period from 2020 to 2040 and the methodology outlined previously, the potential projected change if the threshold were reached is approximately 65,000 AF, which reflects a 16 percent change of the total GSA groundwater basin storage capacity.

4.3.2.2 Relationship for Each Sustainability Indicator

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(2) The relationship between the minimum thresholds for each sustainability indictor, including and explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.

Groundwater storage depletion has a direct impact on groundwater levels and vice versa. The two indicators are linked by the specific yield or the available water for pumping stored in the soil. The relationship between storage depletion and subsidence or groundwater quality varies by location and geological characteristics and is not always clearly defined. In the RCWDGSA area as outlined in Section 3.1 and 3.2, the HCM for the area of RCWDGSA do not identify areas of clay deposition suggesting that subsidence would not be anticipated. Water Quality indicators are more locally defined, and water levels and storage change are not viewed to be indicators for water quality.

4.3.2.3 Selection of Minimum Thresholds to Avoid Undesirable Results

The groundwater level minimum threshold was determined to avoid undesirable results. By using criteria set for groundwater levels to calculate thresholds for storage change, undesirable results caused by change in storage will be avoided. Potential for undesirable results arises if all storage change is coming from a localized area, in which case wells may go dry.

4.3.2.4 Impact of Minimum Thresholds on Water Uses and Users

Due to the nature of infrastructure development and program implementation, groundwater storage will continue to decrease at current rates in the next few years before programs have an effect on the stabilization of levels. Decrease in groundwater storage will continue to increase the cost of energy for pumping. If minimum threshold levels are reached, there may be some wells that go dry and will require deepening to reach the water table.

4.3.2.5 Measurement of Minimum Thresholds

Measurement of groundwater storage change will continue to be through the use of groundwater elevation contours created from a network of wells with available data. Storage change will be calculated on an annual basis using the seasonal high measurements, which is usually in the spring, and the specific yield. For more information regarding the wells in the monitoring network, refer to Chapter 5.

4.3.3 Measurable Objectives

Regulation Requirements:

§354.30 (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.
(b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.
(c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.
(d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.
(e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.
(f) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.
(g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for finding of inadequacy of the Plan.

4.3.3.1 Description of Measurable Objectives

The measurable objective for groundwater storage change is calculated based on the groundwater level measurable objectives. The volume of groundwater storage change is linked to the change in levels through the specific yield. Therefore, the objective is to stabilize storage change by the end of the 20-year implementation phase in 2040. After that, the District should see a net zero change in groundwater storage volume on a 10-year rolling average basis, to account for year-to-year variation.

The total volume of storage depletion between current levels and 2040 measurable objectives was calculated similarly to minimum thresholds. Using surfaces created by GIS software, the difference between current levels and 2040 measurable objectives was calculated and multiplied by the specific yield for a total volume of approximately 55,000 AF. This value represents the total volume of water that may be extracted from the groundwater basin within RCWD prior to 2040 to reach the sustainable goal. After 2040 the GSA should be operating within its sustainable yield to maintain groundwater levels and have a net zero change in storage. This projected change for 20 years is less than historical and relates to about 17 percent of the RCWDGSA percentage of total basin storage capacity.

4.3.3.2 Operational Flexibility

Operational flexibility is the difference between the measurable objective and minimum threshold. As previously mentioned, the success of meeting the objective is based on a rolling average, allowing room for expected overdraft in dry years as long as wet years allow for recharge.

4.3.3.3 Path to Achieve Measurable Objectives

It is expected by the GSA that historical trends will continue until 2030 due to the time it will take to build projects. From 2030 to 2040, it is anticipated that the rate of decline in groundwater levels will be half of its historical value and by 2040, there will be no long-term decline. The groundwater levels will act as a representative sustainability indicator for storage change due to the direct relationship. Mitigation of decline will be achieved through implementation of projects to bring in additional water supply and programs that will decrease water demand. Programs may be adjusted over the implementation period in response to conditions and whether or not Plan goals are being met.

4.4 Groundwater Quality

Within RCWDGSA, three general categories of groundwater usage contribute to groundwater quality including agricultural irrigation, rural residential, and municipal use. Contaminant plumes in groundwater can also be a significant factor in groundwater usage.

Groundwater quality is regulated by the State Water Resources Control Board and Regional Boards. It is past the purview of this plan to enact or prepare any enforcement regarding groundwater quality requirements. It should be noted that due to the location and surface water rights of the participants and agencies in the area that the surface water quality has significant positive impacts to the local groundwater condition. It is the goal of this plan to maintain the groundwater quality of the groundwater resource within the basin.

4.4.1 Sustainability Goal

Regulation Requirements:

§354.24 Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.

The groundwater quality sustainability goal is to maintain the overall groundwater quality within the RCWDGSA at its general current state. Within RCWDGSA the three general categories of groundwater usage are agricultural irrigation, rural residential, and municipal. The rural residential is limited to, at most, two to three wells. Contaminant plumes in groundwater can also be a significant factor in groundwater usage. The approaches to setting Sustainable Management Criteria for each are discussed below.

Agricultural Irrigation

Historically within the RCWDGSA there have been few groundwater quality issues with regards to agricultural water use. Insufficient data exists to establish a baseline for determining sustainable management criteria at this time. Groundwater quality in production wells is monitored infrequently and the data is generally not reported publicly. ILRP data points will be of relatively low density and the groundwater trend monitoring data will be obscured in reporting such that sample locations will be reported as the centroid of the sections that the monitoring points are located in. The RCWDGSA plans to rely on ILRP collected groundwater data to the extent possible and to augment the available ILRP trend data with its own data that will be collected over the next several years in order to set sustainable management criteria in the GSP 5-year update.

Over the next several years, and as individual well owner permissions are granted, a subset of the wells in the monitoring network will be monitored for groundwater quality at the same time groundwater level measurements are collected. As agricultural yields are generally proportional to EC in groundwater, EC measurements in groundwater will be collected with a hand-held meter. At this time the wells that have been identified with measurable objectives and minimum thresholds will also include the EC testing. As the information is developed over the initial 5-year horizon, a review will be made to see if additional wells should be added to the system. A minimum well density of 2 to 6 wells per township is anticipated as the more wells per township, the more representative the sampling will be of groundwater.

Negative impacts to crop yield would be an undesirable result of agricultural irrigation groundwater quality degradation. The minimum thresholds will be selected in consultation with the GSA farmers. Two or more exceedances of the minimum thresholds within a township for two consecutive years would lead to actions such as increased monitoring frequency or additional monitoring points to verify exceedances. Farming practices that could lead to groundwater quality degradation are regulated by the SWQCB and RWQCB ILRP program and its various monitoring and reporting requirements.

Rural Residential

Rural residential wells are defined as private wells not serviced by the County or community water system and are for either a single home or for multiple homes. Insufficient data exists to establish a baseline for determining sustainable management criteria. At this time, a data gap exists with regards to a current groundwater quality baseline for rural residential private wells.

As discussed above, in February 2018 the SWRCB revised the monitoring requirements for the East San Joaquin River Watershed Coalition (ESJRWC), requiring the annual monitoring and reporting of all on-farm domestic wells in the ESJRWC area. At the time of writing, it is understood that a tentative draft order has been put out for public review.

Municipal Groundwater

Monitoring of the well water within the newly established Riverstone development was initiated in 2015. Data from the water quality monitoring program is listed below:

Table 4-3 Municipal Well Water Quality Results

General Minerals	2017			2018			2019		
Inorganics	**Well 1**	**Well 2**	**Well 4**	**Well 1**	**Well 2**	**Well 4**	**Well 1**	**Well 2**	**Well 4**
Total Alkalinity as $CaCO_3$ – mg/l	78	85	100				NT	NT	NT
Bicarbonate Alkalinity as HCO_3 – mg/l	95	100	120				120	120	120
Carbonate Alkalinity as CO_3 – mg/l	ND	ND	ND				ND	ND	ND
Chloride- mg/l	60	110	57				180	70	41
Hardness – mg eqiv $CACO_3$/l	120	150	110				220	130	110
Nitrate as N – mg/l	3	2.8	1				6.4	ND	1.2
Sulfate as SO_4 – mg/l	3.5	5.5	11				6.0	4.1	13
Total Dissolved Solids	260	370	180				600	330	290
Metals									
Arsenic µg/l-	4.5	4.8	5.5				4.5	4.8	5.5
Boron – mg/l	ND	ND	ND				NT	NT	NT
Calcium – mg/l	30	43	19				62	34	28
Iron – µg/l	ND	ND	ND				200	ND	ND
Magnesium – mg/l	10	12	9				15	11	9.1
Manganese – mg/l	0.018	0.011	0.018				.003	.035	.002
Potassium – mg/l	5.2	5.4	5.2				NT	NT	NT
Sodium – mg/l	29	46	36				67	33	35
Semi-Volatile Organics									
1,2 Dibromo-3-chloropopane (DBCP)	ND	ND	ND				ND	ND	ND
Ethylene Dibromide (EDB)	ND	ND	ND				ND	ND	ND
Volatile Organics									
Various	ND	ND	ND				ND	ND	ND

Note: ND – Not detectable
NT – Not tested

Table 4-4Quarterly Source water EC Readings (umhos/cm)

Quarter	Well 1	Well 2	Well 4
Fourth Quarter 2017	406	622	380
First Quarter 2018	212	690	370
Second Quarter 2018	186	883	316
Third Quarter 2018	733	607	379
Fourth Quarter 2018	190	581	378
First Quarter 2019			

Groundwater delivered to users with concentrations exceeding MCL concentrations would be considered an undesirable result. There is no expectation this would occur and, in general, such occurrences would be rectified by the water supplier under California State regulations and oversight through treatment, avoidance, blending, backup wells, etc.

Additional municipal groundwater quality sustainable management criteria will be set in the GSP 5-year update, as applicable. At this time, it is anticipated that Minimum Thresholds for groundwater in the vicinity of the RCWDGSA will be based on the Title 22 MCLs and the Measurable Objectives will be based on the baseline for the previous 3 years. Included in Appendix 4-A is a summary of testing results that has been performed related to the municipal system.

4.4.2 Undesirable Results

4.4.2.1 Criteria to Define Undesirable Results

Regulation Requirements:

§354.26 (a) Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.

There are several potential causes of groundwater quality degradation that could lead to undesirable results. These include:

- The accumulated effects of nutrient application and other farming practices;
- One-time releases from sources of chemical contamination such as from fuel storage tanks;
- The accumulated effects of regulated and unregulated waste discharge streams from wastewater treatment facilities, septic systems, and food processors; and
- DBCP, EDB, and TCE are legacy contaminants and thus no future degradation from them is foreseen, rather efforts include managing current contamination.

For the purposes of this GSP, significant and unreasonable degradation of groundwater quality is considered when the quality prevents the beneficial use of groundwater. Groundwater quality requirements differ based on the groundwater usage category, which will be discussed in the following subsections. If exceedance of minimum thresholds occurs, well head treatment may be needed for water to be used.

4.4.2.2 Causes of Groundwater Conditions That Could Lead to Undesirable Results

Regulation Requirements:

§354.26 (b) The description of undesirable results shall include the following:
(1) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.
(2) The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.
(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.

No known information exists that suggests there are conditions that will lead to undesirable results.

4.4.2.3 Evaluation of Multiple Minimum Thresholds

Regulation Requirements:

§354.26 (c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.

Multiple Minimum thresholds are not appropriate at this time.

4.4.3 Minimum Thresholds

Regulation Requirements:

§354.28 (a) Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.
(d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.

The minimum thresholds for treated groundwater quality will be consistent with other Federal, State and local water quality standards to be protective of water uses and users. The agricultural irrigation groundwater minimum threshold is intended to protect crop yields, the municipal groundwater minimum thresholds are intended to be protective of human health, and the private domestic groundwater minimum threshold is intended to be protective of groundwater quality degradation beyond baseline levels.

<u>Municipal Groundwater</u>
For municipally supplied water, groundwater quality degradation leading to constituent concentrations above levels protective of human health in drinking water is an undesirable result. Groundwater data will be tabulated and discussed in the first GSP 5-year update. At this time, it is anticipated that Minimum Thresholds will be based on the Title 22 MCLs. Only in rare circumstances would municipally supplied groundwater with concentrations in excess of MCLs reach domestic users and in general such occurrences would be rectified by the water supplier under California State regulations and oversight through treatment, avoidance, blending, backup wells, etc.

4.4.3.1 Description of Minimum Thresholds

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.
(2) The relationship between the minimum thresholds for each sustainability indictor, including and explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.
(3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.
(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.
(5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.
(6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.

Agricultural Irrigation

For agricultural irrigation water, groundwater quality degradation leading to reduced crop production is an undesirable result. A minimum threshold will be further evaluated in consultation with the GSA farmers and discussed in more detail in the first GSP 5-year update.

Rural Residential

For rural residential domestic wells, the minimum threshold is to maintain baseline levels. The RCWDGSA will rely on the annual on-farm domestic well water quality data that will be generated by the ILRP program as discussed above. Sustainable management criteria will be set in the GSP 5-year update once the ILRP data is collected and analyzed. The ILRP on-farm groundwater quality data will be available from the RWQCB and shall be reported in the future in subsequent GSP updates.

Municipal Groundwater

For municipally supplied water, groundwater quality degradation leading to constituent concentrations above levels protective of human health in drinking water is the minimum threshold. Currently, the three municipal wells in the District do not require well head treatment and are within Federal and State requirements for drinking water quality. Groundwater data will be requested from the water purveyors and discussed in the first GSP 5-year update. At this time, the minimum threshold for municipal wells will be based on the Title 22 MCLs. Only in rare circumstances would municipally supplied groundwater with concentrations in excess of MCLs reach domestic users, and, in general, such occurrences would be rectified by the water supplier under California State regulations and oversight through treatment, avoidance, blending, backup wells, etc. RCWDGSA has no responsibility with regards to municipal groundwater.

4.4.3.2 Relationship for Each Sustainability Indicator

Regulation Requirements:

§354.28 (c) Minimum thresholds for each sustainability indicator shall be defined as follows:
(4) Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be used on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.

4.4.3.3 Selection of Minimum Thresholds to Avoid Undesirable Results

For the purposes of this plan, an undesirable result is when the water can no longer be beneficially used due to degradation of quality. Minimum thresholds have been set such that if those levels are reached, it is recommended that other water management strategies may be used, such as blending of sources or well head treatment, in order to beneficially use the water. If this were to occur, strategies will need to be implemented to improve the quality of the groundwater to avoid minimum thresholds.

4.4.3.4 Impact of Minimum Thresholds on Water Uses and Users

Groundwater quality degradation has potential effects on urban areas and rural residential drinking water; however, if minimum thresholds are met, there should be little to no impact on municipal users. Irrigation water quality is a critical factor in crop production and can be complicated as not all crops have the same sensitivity to water quality. Groundwater with high electroconductivity (EC), TDS concentrations or general mineral concentrations can cause issues for plants and soil health, leading to crop yield impacts. High salinity content in irrigation water can detract from the amount of water and nutrient uptake in plant roots and leads to a crusty top layer in soil that makes sprouting difficult.

4.4.3.5 Measurement of Minimum Thresholds

Agricultural Irrigation

Over the next several years, as individual well owner permissions are granted, a subset of the wells in the monitoring network will be monitored for groundwater quality at the same time groundwater level measurements are collected. As agricultural yields are generally proportional to EC in groundwater, EC measurements in groundwater will be collected with a hand-held meter. A minimum well density of 2 to 6 wells per township is anticipated.

Rural Residential

RCWDGSA will rely on annual on-farm domestic well water quality data that will be generated by the ILRP laboratory testing program as discussed above.

Municipal Groundwater

The RCWD will continue to review results of monitoring for municipal groundwater supplies. The water quality is routinely monitored through a laboratory testing program as required by California State regulations for water suppliers.

4.4.4 Measurable Objectives

Regulation Requirements:

§354.30 (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.
(b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.
(c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.
(d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.
(e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.
(f) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.
(g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for finding of inadequacy of the Plan.

4.4.4.1 Description of Measurable Objectives

Agricultural Irrigation
The measurable objective for water quality in agricultural wells in RCWD is to maintain baseline water quality conditions, meaning not to make it worse. To quantify the conditions, RCWD will rely on ILRP data in addition to its own sampling over the next 5-year period. Measurable objectives, margins of safety, and milestones will be discussed as appropriate in the subsequent GSP update.

Rural Residential
Private rural residential wells do not get monitored by State agencies and therefore do not have thorough data. Although the minimum threshold set is to avoid making current conditions worse, the measurable objective will be refined over the next 5-year period as data is gathered.

Municipal Groundwater
The measurable objective for municipal groundwater is to keep all wells operating at a groundwater quality at or above that required by the State and Federal standards in order to avoid well head treatment.

4.4.4.2 Operational Flexibility

The operational flexibility is considered the difference between the measurable objectives and the minimum thresholds; therefore, it is different depending on water use and current conditions.

4.4.4.3 Path to Achieve Measurable Objectives

RCWDGSA will utilize ILRP data moving forward and will have a better idea of current groundwater quality conditions. By the 2025 update, the goal is to have a comprehensive set of water quality data, by which objectives and minimum thresholds can be updated. Problem areas will be identified and monitored thoroughly during the subsequent 5 years. For the 2030 update, if problem areas still exist, strategies will be determined for mitigating the issues and maintaining good water quality. The last 10 years will be implementation of projects or strategies, if needed, for maintenance of measurable objectives.

4.5 Land Subsidence

Regulation Requirements:

§354.26 (d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.

§354.28 (e) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.

Land subsidence and especially differential settlement can cause significant damage to structures on the land surface. From review of several sources (see **Section 3.2.7**), Root Creek Water District appears to be experiencing minimal land subsidence. Through stakeholder outreach there will continue to be discussion to determine if there is any information to the contrary and if there is any evidence to suggest a difference. Furthermore, projects that will be implemented are meant to stabilize groundwater levels and decrease groundwater pumping. It is planned that there will be periodic checkups to identify if this assertion continues to be true. The simplest means to continue this checkup is to review the surveys performed by Caltrans on State Highway 41.

4.6 Interconnected Surface Water and Groundwater

Regulation Requirements:

§354.26 (d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.

§354.28 (e) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.

Information to evaluate the presence of interconnected surface water systems in the RCWDGSA is minimal and inferred in a few locations along the San Joaquin River (see **Section 3.2.8**). In general, although the model reports and regional studies imply a lack of continuous connection between surface water and groundwater in RCWD, the location specific data from the SJRRP indicate that there may be a connection at some locations during some hydrologically wet conditions. Therefore, it is currently inconclusive whether there is an interconnected groundwater and surface water system along the portion of the San Joaquin River that runs on the south border of RCWD. The minimum threshold for interconnected surface water should be reported in a rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial users. However, should the system not be connected, this cannot be quantified.

There are currently no undesirable results related to interconnected surface water that are occurring in the GSA and it is highly unlikely that they will occur in the planning and implementation period for the Plan. In other locations throughout the GSA, away from the San Joaquin River, groundwater level depths are in excess of 50 feet, which was the criterion used to determine a lack of interconnection with surface water. As stated in the regulations above and per section 23 CCR §354.26 (d) and §354.28 (e*), an agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results.* Data will continue to be gathered by USGS and the SJRRP in the following years, which will be used by RCWD to monitor groundwater levels adjacent to the river.

4.7 Seawater Intrusion

Regulation Requirements:

§354.26 (d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.

§354.28 (e) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.

By definition, seawater intrusion occurs when saline water from the ocean infiltrates the groundwater system and begins to flow into areas of freshwater due to pressure differentials, in many cases caused by groundwater pumping. The Madera Subbasin and RCWDGSA do not need to account for seawater intrusion since they are not located adjacent to the Pacific Ocean or coastal waters.

4.8 References

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Appendix 4-A -Summary of Testing Results Related to the Municipal System

DATE: 1/21/2019

STATE OF CALIFORNIA

LAST SAMPLE DATE AND MONITORING SCHEDULE

SYSTEM NO: 2010016 NAME: RIVERSTONE/ROOTCREEK WATER DISTRICT COUNTY: MADERA

SOURCE NO: 001 NAME: WELL NO. 1 CLASS: CMGA STATUS: Active

PSCODE	GROUP/CONSTITUENT IDENTIFICATION	LAST RESULT	UNITS	MCL	DLR	LAST SAMPLE	FREQ MONTHS	NEXT SAMPLE DUE	NOTES
2010016 - 001	2010016 RIVERSTONE/ROOTCREEK WATER DISTRICT	001	WELL NO. 1						
	GP SECONDARY/GP								
	00440 BICARBONATE ALKALINITY	120	MG/L	--------	--------	2016/05/27	36	2019/05	
	00916 CALCIUM	62	MG/L	--------	--------	2016/05/27	36	2019/05	
	00445 CARBONATE ALKALINITY	< ND	MG/L	--------	--------	2016/05/27	36	2019/05	
	00940 CHLORIDE	180	MG/L	500	--------	2016/05/27	36	2019/05	
	00081 COLOR	< ND	UNITS	15	--------	2016/05/27	36	2019/05	
	01042 COPPER	< ND	UG/L	1000	50	2016/05/27	36	2019/05	
	38260 FOAMING AGENTS (MBAS)	< ND	MG/L	.5	--------	2016/05/27	36	2019/05	
	00900 HARDNESS (TOTAL) AS CACO3	220	MG/L	--------	--------	2016/05/27	36	2019/05	
	71830 HYDROXIDE ALKALINITY	< ND	MG/L	--------	--------	2016/05/27	36	2019/05	
	01045 IRON	200	UG/L	300	100	2016/05/27	36	2019/05	
	00927 MAGNESIUM	15	MG/L	--------	--------	2016/05/27	36	2019/05	
	01055 MANGANESE	2.5	UG/L	50	20	2016/11/21	36	2019/11	
	00086 ODOR THRESHOLD @ 60 C	1.0	TON	3	1	2016/05/27	36	2019/05	
	00403 PH, LABORATORY	7.8		--------	--------	2016/05/27	36	2019/05	
	01077 SILVER	< ND	UG/L	100	10	2016/05/27	36	2019/05	
	00929 SODIUM	67	MG/L	--------	--------	2016/05/27	36	2019/05	
	00095 SPECIFIC CONDUCTANCE	820	US	1600	--------	2016/05/27	36	2019/05	
	00945 SULFATE	6.0	MG/L	500	.5	2016/05/27	36	2019/05	
	70300 TOTAL DISSOLVED SOLIDS	600	MG/L	1000	--------	2016/05/27	36	2019/05	
	82079 TURBIDITY, LABORATORY	0.49	NTU	5	.1	2016/05/27	36	2019/05	
	01092 ZINC	< ND	UG/L	5000	50	2016/05/27	36	2019/05	
	IO INORGANIC								
	01105 ALUMINUM	< ND	UG/L	1000	50	2016/05/27	36	2019/05	
	01097 ANTIMONY	< ND	UG/L	6	6	2016/05/27	36	2019/05	
	01002 ARSENIC	4.5	UG/L	10	2	2016/05/27	36	2019/05	
	01007 BARIUM	320	UG/L	1000	100	2016/05/27	36	2019/05	
	01012 BERYLLIUM	< ND	UG/L	4	1	2016/05/27	36	2019/05	
	01027 CADMIUM	< ND	UG/L	5	1	2016/05/27	36	2019/05	

LAST SAMPLE DATE AND MONITORING SCHEDULE

SYSTEM NO: 2010016 NAME: RIVERSTONE/ROOTCREEK WATER DISTRICT COUNTY: MADERA

SOURCE NO: NAME: WELL NO. 1 CLASS: CMGA STATUS: Active

PSCODE		GROUP/CONSTITUENT IDENTIFICATION		LAST RESULT	UNITS	MCL	DLR	LAST SAMPLE	FREQ MONTHS	NEXT SAMPLE DUE	NOTES
2010016 - 001	IO	INORGANIC									
	01034	CHROMIUM (TOTAL)	<	ND	UG/L	50	10	2016/05/27	36	2019/05	
	00951	FLUORIDE (F) (NATURAL-SOURCE)	<	ND	MG/L	2	.1	2016/05/27	36	2019/05	
	71900	MERCURY	<	ND	UG/L	2	1	2016/05/27	36	2019/05	
	01067	NICKEL	<	ND	UG/L	100	10	2016/05/27	36	2019/05	
	A-031	PERCHLORATE	<	4	UG/L	6	4	2016/11/21	36	2019/11	
	01147	SELENIUM	<	ND	UG/L	50	5	2016/05/27	36	2019/05	
	01059	THALLIUM	<	ND	UG/L	2	1	2016/05/27	36	2019/05	
	NI	NITRATE/NITRITE									
	00618	NITRATE (AS N)		6.4	mg/L	10	.4	2018/04/03	12	2019/04	
	00620	NITRITE (AS N)	<	ND	mg/L	1	.4	2016/05/27	36	2019/05	
	RA	RADIOLOGICAL									
	01501	GROSS ALPHA	<	3	PCI/L	15	3	2017/04/17	72	2023/04	
	S1	REGULATED VOC									
	34506	1,1,1-TRICHLOROETHANE	<	ND	UG/L	200	.5	2018/04/03	72	2024/04	
	34516	1,1,2,2-TETRACHLOROETHANE	<	ND	UG/L	1	.5	2018/04/03	72	2024/04	
	34511	1,1,2-TRICHLOROETHANE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
	34496	1,1-DICHLOROETHANE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
	34501	1,1-DICHLOROETHYLENE	<	ND	UG/L	6	.5	2018/04/03	72	2024/04	
	34551	1,2,4-TRICHLOROBENZENE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
	34536	1,2-DICHLOROBENZENE	<	ND	UG/L	600	.5	2018/04/03	72	2024/04	
	34531	1,2-DICHLOROETHANE	<	ND	UG/L	.5	.5	2018/04/03	72	2024/04	
	34541	1,2-DICHLOROPROPANE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
	34561	1,3-DICHLOROPROPENE (TOTAL)	<	ND	UG/L	.5	.5	2018/04/03	72	2024/04	
	34571	1,4-DICHLOROBENZENE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
	34030	BENZENE	<	ND	UG/L	1	.5	2018/04/03	72	2024/04	
	32102	CARBON TETRACHLORIDE	<	ND	UG/L	.5	.5	2018/04/03	72	2024/04	
	77093	CIS-1,2-DICHLOROETHYLENE	<	ND	UG/L	6	.5	2018/04/03	72	2024/04	
	34423	DICHLOROMETHANE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
	34371	ETHYLBENZENE	<	ND	UG/L	300	.5	2018/04/03	72	2024/04	

LAST SAMPLE DATE AND MONITORING SCHEDULE

SYSTEM NO: 2010016 NAME: RIVERSTONE/ROOTCREEK WATER DISTRICT COUNTY: MADERA

SOURCE NO: NAME: WELL NO. 1 CLASS: CMGA STATUS: Active

PSCODE		GROUP/CONSTITUENT IDENTIFICATION			LAST RESULT	UNITS	MCL	DLR	LAST SAMPLE	FREQ MON THS	NEXT SAMPLE DUE	NOTES
2010016 - 001	S1	46491	METHYL-TERT-BUTYL-ETHER (MTBE)	<	ND	UG/L	13	3	2018/04/03	72	2024/04	
		34301	MONOCHLOROBENZENE	<	ND	UG/L	70	.5	2018/04/03	72	2024/04	
		77128	STYRENE	<	ND	UG/L	100	.5	2018/04/03	72	2024/04	
		34475	TETRACHLOROETHYLENE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
		34010	TOLUENE	<	ND	UG/L	150	.5	2018/04/03	72	2024/04	
		34546	TRANS-1,2-DICHLOROETHYLENE	<	ND	UG/L	10	.5	2018/04/03	72	2024/04	
		39180	TRICHLOROETHYLENE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
		34488	TRICHLOROFLUOROMETHANE	<	ND	UG/L	150	5	2018/04/03	72	2024/04	
		81611	TRICHLOROTRIFLUOROETHANE (FREON 113)	<	ND	UG/L	1200	10	2018/04/03	72	2024/04	
		39175	VINYL CHLORIDE	<	ND	UG/L	.5	.5	2018/04/03	72	2024/04	
		81551	XYLENES (TOTAL)	<	ND	UG/L	1750	0.5	2018/04/03	72	2024/04	
	S2	**REGULATED SOC**										
		77443	1,2,3-TRICHLOROPROPANE (1,2,3-TCP)	<	ND	UG/L	0.005	0.005	2018/07/10	36	2021/07	
		77825	ALACHLOR	<	ND	UG/L	2	1	2018/04/03	36	2021/04	
		39033	ATRAZINE	<	ND	UG/L	1	.5	2018/04/03	36	2021/04	
		38761	DIBROMOCHLOROPROPANE (DBCP)	<	ND	UG/L	.2	.01	2018/04/03	36	2021/04	
		77651	ETHYLENE DIBROMIDE (EDB)	<	ND	UG/L	.05	.02	2018/04/03	36	2021/04	
		39055	SIMAZINE	<	ND	UG/L	4	1	2018/04/03	36	2021/04	

LAST SAMPLE DATE AND MONITORING SCHEDULE

SYSTEM NO: 2010016 NAME: RIVERSTONE/ROOTCREEK WATER DISTRICT COUNTY: MADERA

SOURCE NO: 002 NAME: WELL NO. 2 CLASS: CMGA STATUS: Active

PSCODE	GROUP/CONSTITUENT IDENTIFICATION		LAST RESULT	UNITS	MCL	DLR	LAST SAMPLE	FREQ MONTHS	NEXT SAMPLE DUE	NOTES
2010016 - 002	**2010016 RIVERSTONE/ROOTCREEK WATER DISTRICT**		**002**	**WELL NO. 2**						
	GP SECONDARY/GP									
	00440 BICARBONATE ALKALINITY		120	MG/L	--------	--------	2016/05/27	36	2019/05	
	00916 CALCIUM		34	MG/L	--------	--------	2016/05/27	36	2019/05	
	00445 CARBONATE ALKALINITY	<	ND	MG/L	--------	--------	2016/05/27	36	2019/05	
	00940 CHLORIDE		70	MG/L	500	--------	2016/05/27	36	2019/05	
	00081 COLOR	<	ND	UNITS	15	--------	2016/05/27	36	2019/05	
	01042 COPPER	<	ND	UG/L	1000	50	2016/05/27	36	2019/05	
	38260 FOAMING AGENTS (MBAS)	<	ND	MG/L	.5	--------	2016/05/27	36	2019/05	
	00900 HARDNESS (TOTAL) AS CACO3		130	MG/L	--------	--------	2016/05/27	36	2019/05	
	71830 HYDROXIDE ALKALINITY	<	ND	MG/L	--------	--------	2016/05/27	36	2019/05	
	01045 IRON	<	ND	UG/L	300	100	2016/05/27	36	2019/05	
	00927 MAGNESIUM		11	MG/L	--------	--------	2016/05/27	36	2019/05	
	01055 MANGANESE		35	UG/L	50	20	2016/11/15	36	2019/11	
	00086 ODOR THRESHOLD @ 60 C		1.0	TON	3	1	2016/05/27	36	2019/05	
	00403 PH, LABORATORY		7.6		--------	--------	2016/05/27	36	2019/05	
	01077 SILVER	<	ND	UG/L	100	10	2016/05/27	36	2019/05	
	00929 SODIUM		33	MG/L	--------	--------	2016/05/27	36	2019/05	
	00095 SPECIFIC CONDUCTANCE		450	US	1600	--------	2016/05/27	36	2019/05	
	00945 SULFATE		4.1	MG/L	500	.5	2016/05/27	36	2019/05	
	70300 TOTAL DISSOLVED SOLIDS		330	MG/L	1000	--------	2016/05/27	36	2019/05	
	82079 TURBIDITY, LABORATORY		0.39	NTU	5	.1	2016/05/27	36	2019/05	
	01092 ZINC	<	ND	UG/L	5000	50	2016/05/27	36	2019/05	
	IO INORGANIC									
	01105 ALUMINUM	<	ND	UG/L	1000	50	2016/05/27	36	2019/05	
	01097 ANTIMONY	<	ND	UG/L	6	6	2016/05/27	36	2019/05	
	01002 ARSENIC		4.8	UG/L	10	2	2016/05/27	36	2019/05	
	01007 BARIUM		200	UG/L	1000	100	2016/05/27	36	2019/05	
	01012 BERYLLIUM	<	ND	UG/L	4	1	2016/05/27	36	2019/05	
	01027 CADMIUM	<	ND	UG/L	5	1	2016/05/27	36	2019/05	

LAST SAMPLE DATE AND MONITORING SCHEDULE

SYSTEM NO: 2010016 NAME: RIVERSTONE/ROOTCREEK WATER DISTRICT COUNTY: MADERA

SOURCE NO: NAME: WELL NO. 2 CLASS: CMGA STATUS: Active

PSCODE	GROUP/CONSTITUENT IDENTIFICATION			LAST RESULT	UNITS	MCL	DLR	LAST SAMPLE	FREQ MONTHS	NEXT SAMPLE DUE	NOTES
2010016 - 002	**IO**	**INORGANIC**									
	01034	CHROMIUM (TOTAL)	<	ND	UG/L	50	10	2016/05/27	36	2019/05	
	00951	FLUORIDE (F) (NATURAL-SOURCE)	<	ND	MG/L	2	.1	2016/05/27	36	2019/05	
	71900	MERCURY	<	ND	UG/L	2	1	2016/05/27	36	2019/05	
	01067	NICKEL	<	ND	UG/L	100	10	2016/05/27	36	2019/05	
	A-031	PERCHLORATE	<	4	UG/L	6	4	2016/11/15	36	2019/11	
	01147	SELENIUM	<	ND	UG/L	50	5	2016/05/27	36	2019/05	
	01059	THALLIUM	<	ND	UG/L	2	1	2016/05/27	36	2019/05	
	NI	**NITRATE/NITRITE**									
	00618	NITRATE (AS N)	<	ND	mg/L	10	.4	2018/04/03	12	2019/04	
	00620	NITRITE (AS N)	<	ND	mg/L	1	.4	2016/05/27	36	2019/05	
	RA	**RADIOLOGICAL**									
	01501	GROSS ALPHA		9.8	PCI/L	15	3	2017/04/24	36	2020/04	
	S1	**REGULATED VOC**									
	34506	1,1,1-TRICHLOROETHANE	<	ND	UG/L	200	.5	2018/04/03	72	2024/04	
	34516	1,1,2,2-TETRACHLOROETHANE	<	ND	UG/L	1	.5	2018/04/03	72	2024/04	
	34511	1,1,2-TRICHLOROETHANE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
	34496	1,1-DICHLOROETHANE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
	34501	1,1-DICHLOROETHYLENE	<	ND	UG/L	6	.5	2018/04/03	72	2024/04	
	34551	1,2,4-TRICHLOROBENZENE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
	34536	1,2-DICHLOROBENZENE	<	ND	UG/L	600	.5	2018/04/03	72	2024/04	
	34531	1,2-DICHLOROETHANE	<	ND	UG/L	.5	.5	2018/04/03	72	2024/04	
	34541	1,2-DICHLOROPROPANE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
	34561	1,3-DICHLOROPROPENE (TOTAL)	<	ND	UG/L	.5	.5	2018/04/03	72	2024/04	
	34571	1,4-DICHLOROBENZENE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
	34030	BENZENE	<	ND	UG/L	1	.5	2018/04/03	72	2024/04	
	32102	CARBON TETRACHLORIDE	<	ND	UG/L	.5	.5	2018/04/03	72	2024/04	
	77093	CIS-1,2-DICHLOROETHYLENE	<	ND	UG/L	6	.5	2018/04/03	72	2024/04	
	34423	DICHLOROMETHANE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
	34371	ETHYLBENZENE	<	ND	UG/L	300	.5	2018/04/03	72	2024/04	

LAST SAMPLE DATE AND MONITORING SCHEDULE

SYSTEM NO: 2010016 NAME: RIVERSTONE/ROOTCREEK WATER DISTRICT COUNTY: MADERA

SOURCE NO: NAME: WELL NO. 2 CLASS: CMGA STATUS: Active

PSCODE		GROUP/CONSTITUENT IDENTIFICATION			LAST RESULT	UNITS	MCL	DLR	LAST SAMPLE	FREQ MON THS	NEXT SAMPLE DUE	NOTES
2010016 - 002	S1	46491	METHYL-TERT-BUTYL-ETHER (MTBE)	<	ND	UG/L	13	3	2018/04/03	72	2024/04	
		34301	MONOCHLOROBENZENE	<	ND	UG/L	70	.5	2018/04/03	72	2024/04	
		77128	STYRENE	<	ND	UG/L	100	.5	2018/04/03	72	2024/04	
		34475	TETRACHLOROETHYLENE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
		34010	TOLUENE	<	ND	UG/L	150	.5	2018/04/03	72	2024/04	
		34546	TRANS-1,2-DICHLOROETHYLENE	<	ND	UG/L	10	.5	2018/04/03	72	2024/04	
		39180	TRICHLOROETHYLENE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
		34488	TRICHLOROFLUOROMETHANE	<	ND	UG/L	150	5	2018/04/03	72	2024/04	
		81611	TRICHLOROTRIFLUOROETHANE (FREON 113)	<	ND	UG/L	1200	10	2018/04/03	72	2024/04	
		39175	VINYL CHLORIDE	<	ND	UG/L	.5	.5	2018/04/03	72	2024/04	
		81551	XYLENES (TOTAL)	<	ND	UG/L	1750	0.5	2018/04/03	72	2024/04	
	S2	REGULATED SOC										
		77443	1,2,3-TRICHLOROPROPANE (1,2,3-TCP)	<	ND	UG/L	0.005	0.005	2018/07/10	36	2021/07	
		77825	ALACHLOR	<	ND	UG/L	2	1	2018/04/03	36	2021/04	
		39033	ATRAZINE	<	ND	UG/L	1	.5	2018/04/03	36	2021/04	
		38761	DIBROMOCHLOROPROPANE (DBCP)	<	ND	UG/L	.2	.01	2018/04/03	36	2021/04	
		77651	ETHYLENE DIBROMIDE (EDB)	<	ND	UG/L	.05	.02	2018/04/03	36	2021/04	
		39055	SIMAZINE	<	ND	UG/L	4	1	2018/04/03	36	2021/04	

LAST SAMPLE DATE AND MONITORING SCHEDULE

SYSTEM NO: 2010016 NAME: RIVERSTONE/ROOTCREEK WATER DISTRICT COUNTY: MADERA

SOURCE NO: 003 NAME: WELL NO. 4 (3) CLASS: CMGA STATUS: Active

PSCODE	GROUP/CONSTITUENT IDENTIFICATION			LAST RESULT	UNITS	MCL	DLR	LAST SAMPLE	FREQ MON THS	NEXT SAMPLE DUE	NOTES
2010016 - 003	**2010016**	**RIVERSTONE/ROOTCREEK WATER DISTRICT**		**003**	**WELL NO. 4 (3)**						
GP	**SECONDARY/GP**										
	00440	BICARBONATE ALKALINITY		120	MG/L	--------	--------	2016/06/27	36	2019/06	
	00916	CALCIUM		28	MG/L	--------	--------	2016/06/27	36	2019/06	
	00445	CARBONATE ALKALINITY	<	ND	MG/L	--------	--------	2016/06/27	36	2019/06	
	00940	CHLORIDE		41	MG/L	500	--------	2016/06/27	36	2019/06	
	00081	COLOR		5.0	UNITS	15	--------	2016/06/27	36	2019/06	
	01042	COPPER	<	ND	UG/L	1000	50	2016/06/27	36	2019/06	
	38260	FOAMING AGENTS (MBAS)	<	ND	MG/L	.5	--------	2016/06/27	36	2019/06	
	00900	HARDNESS (TOTAL) AS CACO3		110	MG/L	--------	--------	2016/06/27	36	2019/06	
	71830	HYDROXIDE ALKALINITY	<	ND	MG/L	--------	--------	2016/06/27	36	2019/06	
	01045	IRON	<	ND	UG/L	300	100	2016/06/27	36	2019/06	
	00927	MAGNESIUM		9.1	MG/L	--------	--------	2016/06/27	36	2019/06	
	01055	MANGANESE		1.9	UG/L	50	20	2016/11/28	36	2019/11	
	00086	ODOR THRESHOLD @ 60 C		1.0	TON	3	1	2016/06/27	36	2019/06	
	00403	PH, LABORATORY		7.8		--------	--------	2016/06/27	36	2019/06	
	01077	SILVER	<	ND	UG/L	100	10	2016/06/27	36	2019/06	
	00929	SODIUM		35	MG/L	--------	--------	2016/06/27	36	2019/06	
	00095	SPECIFIC CONDUCTANCE		380	US	1600	--------	2016/06/27	36	2019/06	
	00945	SULFATE		13	MG/L	500	.5	2016/06/27	36	2019/06	
	70300	TOTAL DISSOLVED SOLIDS		290	MG/L	1000	--------	2016/06/27	36	2019/06	
	82079	TURBIDITY, LABORATORY		0.23	NTU	5	.1	2016/06/27	36	2019/06	
	01092	ZINC	<	ND	UG/L	5000	50	2016/06/27	36	2019/06	
IO	**INORGANIC**										
	01105	ALUMINUM		6.1	UG/L	1000	50	2016/06/27	36	2019/06	
	01097	ANTIMONY	<	ND	UG/L	6	6	2016/06/27	36	2019/06	
	01002	ARSENIC		5.5	UG/L	10	2	2016/06/27	36	2019/06	
	01007	BARIUM		160	UG/L	1000	100	2016/06/27	36	2019/06	
	01012	BERYLLIUM	<	ND	UG/L	4	1	2016/06/27	36	2019/06	
	01027	CADMIUM	<	ND	UG/L	5	1	2016/06/27	36	2019/06	

LAST SAMPLE DATE AND MONITORING SCHEDULE

SYSTEM NO: 2010016 NAME: RIVERSTONE/ROOTCREEK WATER DISTRICT COUNTY: MADERA

SOURCE NO: NAME: WELL NO. 4 (3) CLASS: CMGA STATUS: Active

PSCODE		GROUP/CONSTITUENT IDENTIFICATION			LAST RESULT	UNITS	MCL	DLR	LAST SAMPLE	FREQ MON THS	NEXT SAMPLE DUE	NOTES
2010016 - 003	IO	INORGANIC										
		01034	CHROMIUM (TOTAL)		2.1	UG/L	50	10	2016/06/27	36	2019/06	
		00951	FLUORIDE (F) (NATURAL-SOURCE)		0.18	MG/L	2	.1	2016/06/27	36	2019/06	
		71900	MERCURY	<	ND	UG/L	2	1	2016/06/27	36	2019/06	
		01067	NICKEL	<	ND	UG/L	100	10	2016/06/27	36	2019/06	
		A-031	PERCHLORATE	<	4	UG/L	6	4	2016/11/28	36	2019/11	
		01147	SELENIUM	<	ND	UG/L	50	5	2016/06/27	36	2019/06	
		01059	THALLIUM	<	ND	UG/L	2	1	2016/06/27	36	2019/06	
	NI	NITRATE/NITRITE										
		00618	NITRATE (AS N)		1.2	mg/L	10	.4	2018/04/03	12	2019/04	
		00620	NITRITE (AS N)	<	ND	mg/L	1	.4	2016/06/27	36	2019/06	
	RA	RADIOLOGICAL										
		01501	GROSS ALPHA		4.0	PCI/L	15	3	2017/04/28	72	2023/04	
	S1	REGULATED VOC										
		34506	1,1,1-TRICHLOROETHANE	<	ND	UG/L	200	.5	2018/04/03	72	2024/04	
		34516	1,1,2,2-TETRACHLOROETHANE	<	ND	UG/L	1	.5	2018/04/03	72	2024/04	
		34511	1,1,2-TRICHLOROETHANE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
		34496	1,1-DICHLOROETHANE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
		34501	1,1-DICHLOROETHYLENE	<	ND	UG/L	6	.5	2018/04/03	72	2024/04	
		34551	1,2,4-TRICHLOROBENZENE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
		34536	1,2-DICHLOROBENZENE	<	ND	UG/L	600	.5	2018/04/03	72	2024/04	
		34531	1,2-DICHLOROETHANE	<	ND	UG/L	.5	.5	2018/04/03	72	2024/04	
		34541	1,2-DICHLOROPROPANE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
		34561	1,3-DICHLOROPROPENE (TOTAL)	<	ND	UG/L	.5	.5	2018/04/03	72	2024/04	
		34571	1,4-DICHLOROBENZENE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
		34030	BENZENE	<	ND	UG/L	1	.5	2018/04/03	72	2024/04	
		32102	CARBON TETRACHLORIDE	<	ND	UG/L	.5	.5	2018/04/03	72	2024/04	
		77093	CIS-1,2-DICHLOROETHYLENE	<	ND	UG/L	6	.5	2018/04/03	72	2024/04	
		34423	DICHLOROMETHANE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
		34371	ETHYLBENZENE	<	ND	UG/L	300	.5	2018/04/03	72	2024/04	

LAST SAMPLE DATE AND MONITORING SCHEDULE

SYSTEM NO: 2010016 NAME: RIVERSTONE/ROOTCREEK WATER DISTRICT COUNTY: MADERA

SOURCE NO: NAME: WELL NO. 4 (3) CLASS: CMGA STATUS: Active

PSCODE		GROUP/CONSTITUENT IDENTIFICATION			LAST RESULT	UNITS	MCL	DLR	LAST SAMPLE	FREQ MON THS	NEXT SAMPLE DUE	NOTES
2010016 - 003	S1	46491	METHYL-TERT-BUTYL-ETHER (MTBE)	<	ND	UG/L	13	3	2018/04/03	72	2024/04	
		34301	MONOCHLOROBENZENE	<	ND	UG/L	70	.5	2018/04/03	72	2024/04	
		77128	STYRENE	<	ND	UG/L	100	.5	2018/04/03	72	2024/04	
		34475	TETRACHLOROETHYLENE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
		34010	TOLUENE	<	ND	UG/L	150	.5	2018/04/03	72	2024/04	
		34546	TRANS-1,2-DICHLOROETHYLENE	<	ND	UG/L	10	.5	2018/04/03	72	2024/04	
		39180	TRICHLOROETHYLENE	<	ND	UG/L	5	.5	2018/04/03	72	2024/04	
		34488	TRICHLOROFLUOROMETHANE	<	ND	UG/L	150	5	2018/04/03	72	2024/04	
		81611	TRICHLOROTRIFLUOROETHANE (FREON 113)	<	ND	UG/L	1200	10	2018/04/03	72	2024/04	
		39175	VINYL CHLORIDE	<	ND	UG/L	.5	.5	2018/04/03	72	2024/04	
		81551	XYLENES (TOTAL)	<	ND	UG/L	1750	0.5	2018/04/03	72	2024/04	
	S2	REGULATED SOC										
		77443	1,2,3-TRICHLOROPROPANE (1,2,3-TCP)	<	ND	UG/L	0.005	0.005	2018/07/10	36	2021/07	
		77825	ALACHLOR	<	ND	UG/L	2	1	2018/04/03	36	2021/04	
		39033	ATRAZINE	<	ND	UG/L	1	.5	2018/04/03	36	2021/04	
		38761	DIBROMOCHLOROPROPANE (DBCP)	<	ND	UG/L	.2	.01	2018/04/03	36	2021/04	
		77651	ETHYLENE DIBROMIDE (EDB)	<	ND	UG/L	.05	.02	2018/04/03	36	2021/04	
		39055	SIMAZINE	<	ND	UG/L	4	1	2018/04/03	36	2021/04	

LAST SAMPLE DATE AND MONITORING SCHEDULE

SYSTEM NO: 2010016 NAME: RIVERSTONE/ROOTCREEK WATER DISTRICT COUNTY: MADERA

SOURCE NO: 900 NAME: ST2DBP - 421 W. GRANT AVENUE CLASS: DBPA STATUS: Active

PSCODE		GROUP/CONSTITUENT IDENTIFICATION			LAST RESULT	UNITS	MCL	DLR	LAST SAMPLE	FREQ MON THS	NEXT SAMPLE DUE	NOTES
2010016 - 900		2010016	RIVERSTONE/ROOTCREEK WATER DISTRICT		900	ST2DBP - 421 W. GRANT AVENUE						
	D BP	DISINFECTION BYPRODUCTS										
		32101	BROMODICHLOROMETHANE (THM)		0.52	UG/L	--------	1	2018/08/07	12	2019/08	
		32104	BROMOFORM (THM)		1.2	UG/L	--------	1	2018/08/07	12	2019/08	
		32106	CHLOROFORM (THM)	<	ND	UG/L	--------	1	2018/08/07	12	2019/08	
		82721	DIBROMOACETIC ACID (DBAA)	<	ND	UG/L	--------	1	2018/08/07	12	2019/08	
		32105	DIBROMOCHLOROMETHANE (THM)		1.2	UG/L	--------	1	2018/08/07	12	2019/08	
		77288	DICHLOROACETIC ACID (DCAA)	<	ND	UG/L	--------	1	2018/08/07	12	2019/08	
		A-049	HALOACETIC ACIDS (5) (HAA5)		0.0	UG/L	60	--------	2018/08/07	12	2019/08	
		A-041	MONOBROMOACETIC ACID (MBAA)	<	ND	UG/L	--------	1	2018/08/07	12	2019/08	
		A-042	MONOCHLOROACETIC ACID (MCAA)	<	ND	UG/L	--------	2	2018/08/07	12	2019/08	
		82080	TOTAL TRIHALOMETHANES		2.9	UG/L	80	--------	2018/08/07	12	2019/08	
		82723	TRICHLOROACETIC ACID (TCAA)	<	ND	UG/L	--------	1	2018/08/07	12	2019/08	

LAST SAMPLE DATE AND MONITORING SCHEDULE

SYSTEM NO: 2010016 NAME: RIVERSTONE/ROOTCREEK WATER DISTRICT COUNTY: MADERA

SOURCE NO: 901 NAME: ST2DBP - 571 S. CASCADE WAY CLASS: DBPA STATUS: Active

PSCODE		GROUP/CONSTITUENT IDENTIFICATION			LAST RESULT	UNITS	MCL	DLR	LAST SAMPLE	FREQ MONTHS	NEXT SAMPLE DUE	NOTES
2010016 - 901		**2010016**	**RIVERSTONE/ROOTCREEK WATER DISTRICT**		**901**	**ST2DBP - 571 S. CASCADE WAY**						
	DBP	**DISINFECTION BYPRODUCTS**										
		32101	BROMODICHLOROMETHANE (THM)		0.60	UG/L	--------	1	2018/08/07	12	2019/08	
		32104	BROMOFORM (THM)		1.1	UG/L	--------	1	2018/08/07	12	2019/08	
		32106	CHLOROFORM (THM)	<	ND	UG/L	--------	1	2018/08/07	12	2019/08	
		82721	DIBROMOACETIC ACID (DBAA)	<	ND	UG/L	--------	1	2018/08/07	12	2019/08	
		32105	DIBROMOCHLOROMETHANE (THM)		1.2	UG/L	--------	1	2018/08/07	12	2019/08	
		77288	DICHLOROACETIC ACID (DCAA)	<	ND	UG/L	--------	1	2018/08/07	12	2019/08	
		A-049	HALOACETIC ACIDS (5) (HAA5)		0.0	UG/L	60	--------	2018/08/07	12	2019/08	
		A-041	MONOBROMOACETIC ACID (MBAA)	<	ND	UG/L	--------	1	2018/08/07	12	2019/08	
		A-042	MONOCHLOROACETIC ACID (MCAA)	<	ND	UG/L	--------	2	2018/08/07	12	2019/08	
		82080	TOTAL TRIHALOMETHANES		2.8	UG/L	80	--------	2018/08/07	12	2019/08	
		82723	TRICHLOROACETIC ACID (TCAA)	<	ND	UG/L	--------	1	2018/08/07	12	2019/08	

5 Monitoring Network

Regulation Requirements:

> **§354.32** This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.

Monitoring is a fundamental component of a groundwater management program and is needed to measure progress towards groundwater sustainability. **Table 5-1** includes the monitoring programs of sustainability indicators needed to comply with SGMA monitoring and reporting requirements.

Table 5-1 Monitoring Requirements

Groundwater Levels

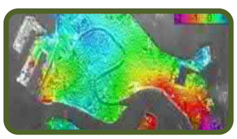
- Monitoring of static groundwater levels each Spring and Fall

Groundwater Storage

- Measurement of the annual change in groundwater storage

Water Quality

- Monitoring for water quality degradation that could impact available groundwater supplies

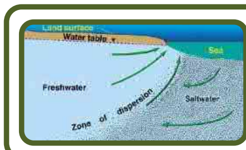


Land Subsidence

- Surface land subsidence caused by groundwater extraction

Depletion of Interconnected Surface Water

- Loss of permanent connections between surface water and groundwater



Seawater Intrusion

- Intrusion of seawater into local aquifers. This is not applicable to the NFKGSA

As mentioned in the previous chapter on Sustainable Management Criteria, some indicators do not apply to RCWDGSA (seawater intrusion, land subsidence, and interconnected surface water) and, therefore, do not have a designated monitoring program. Monitoring programs for the sustainability indicators are described below for the basin and for RCWD, including a brief description of the history of the monitoring programs, proposed monitoring to comply with SGMA, and the adequacy and scientific rationale for each monitoring network. More detail on existing historical monitoring programs in the basin can be found in Section 2.2.1.

5.1 Introduction

Regulation Requirements:

> **§354.34(a)** Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan Implementation.

It should be recognized that the RCWDGSA intends to work with the other GSA's of the Subbasin to develop a system that covers the entire basin. The other GSA's are understood to be frantically completing drafts of Groundwater Sustainability Plans and at this time due to short time frames there has been more attention focused on the preparation of draft documents and less time on coordination of the plans and actions. To this end, the following monitoring programs are meant to be incorporated into the plans covering the remainder of the basin and will be used to compare and develop documentation for support of annual updates.

This chapter identifies and describes the monitoring networks being developed by RCWDGSA that will collect data to determine short-term, seasonal, and long-term trends in groundwater and related surface conditions. This data will yield information necessary to support the implementation of this Plan, evaluation of the effectiveness of this Plan, and decision making by RCWDGSA management. The results of historical monitoring efforts can be found in Section 3.2 – Current and Historical Groundwater Conditions. The analysis of historical groundwater conditions has shown where data gaps currently exist and was used when creating the future monitoring networks.

5.1.1 Monitoring Network Objectives

Regulation Requirements:

> **§354.34(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:
> 1) Demonstrate progress toward achieving measurable objectives described in the Plan.
> 2) Monitor impacts to the beneficial uses or users of groundwater
> 3) Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.
> 4) Quantify annual changes in water budget components.

The objectives of the various monitoring programs include the following:
1. Establish a baseline for future monitoring.
2. Provide warning of potential future problems.
3. Use data gathered to generate information for water resources evaluation.
4. Help to quantify annual changes in water budget components.
5. Develop meaningful long-term trends in groundwater characteristics.
6. Provide comparable data from various places in the Plan Area.
7. Demonstrate progress toward achieving measurable objectives described in the Plan.
8. Monitor changes in groundwater conditions relative to minimum thresholds.
9. Monitor impacts to the beneficial uses or users of groundwater.

5.1.2 Implementation of Monitoring Network

Groundwater monitoring has been performed in the RCWD area for only the last few decades with groundwater contour mapping initiated during 1998. Prior to that date some information is available, consisting almost entirely of depth to groundwater measurements in some site-specific wells. So, while regional data is not available, there is some record as to change in groundwater conditions from the late 1970s forward. These programs will continue and may expand, as needed, to comply with SGMA monitoring requirements.

New monitoring networks will be developed, and existing networks enhanced when necessary, using the Data Quality Objective (DQO) process, which follows the U.S. EPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006). The DQO process is also outlined in the DWR's Best Management Practices for monitoring networks (2016a) and monitoring protocols (2016b). The DQO process helps to ensure a repeatable and robust approach to collecting data with a specific goal in mind and includes the following steps:

1. State the problem.
2. Identify the goal.
3. Identify the inputs.
4. Define the boundaries of the area/issue being studied.
5. Develop an analytical approach.
6. Specify performance or acceptance criteria.
7. Develop a plan for obtaining data.

5.1.3 Sustainability Indicator Monitoring Networks

Regulation Requirements:

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.
§354.34(g)(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.
§354.38(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

The following sections 5.2 through 5.7 include descriptions of the GSA's monitoring networks designed to meet criteria for the six sustainability indicators: groundwater levels, groundwater storage, water quality, land subsidence, depletion of interconnected surface water, and seawater intrusion. For each applicable sustainability indicator, the adequacy of the monitoring network is discussed, as well as the quantitative values for the minimum thresholds, measurable objectives, and interim milestones. The sections also include a review of each monitoring network for monitoring frequency and density, identification of data gaps, plans to fill data gaps, and future site selection. This information will be reviewed and evaluated during each five-year assessment.

There are three general types of data gaps to consider for monitoring networks:

1. Temporal: Insufficient frequency of monitoring. For instance, data may be available from a well only in the fall since it is rarely idle in the spring. In addition, a privately owned well may have sporadic access due to locked security fencing, roaming dogs, change in ownership, etc.
2. Spatial: Insufficient number or density of monitoring sites in a specific area.
3. Insufficient quality of data: Data may be available but be of poor or questionable accuracy. Poor data may at times be worse than no data, since it could lead to incorrect assumptions or biases. The data may not appear consistent with other data in the area or with past readings at the monitoring site. The monitoring site may not meet all the desired criteria to provide reliable data, such as having

information on perforation depth, etc. Past experiences have shown that well location information on Well Construction Reports is often poor, making it difficult or impossible to match wells with their well logs.

5.2 Groundwater Levels Monitoring

Regulation Requirements:

§354.34(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:
§354.34(c)(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:

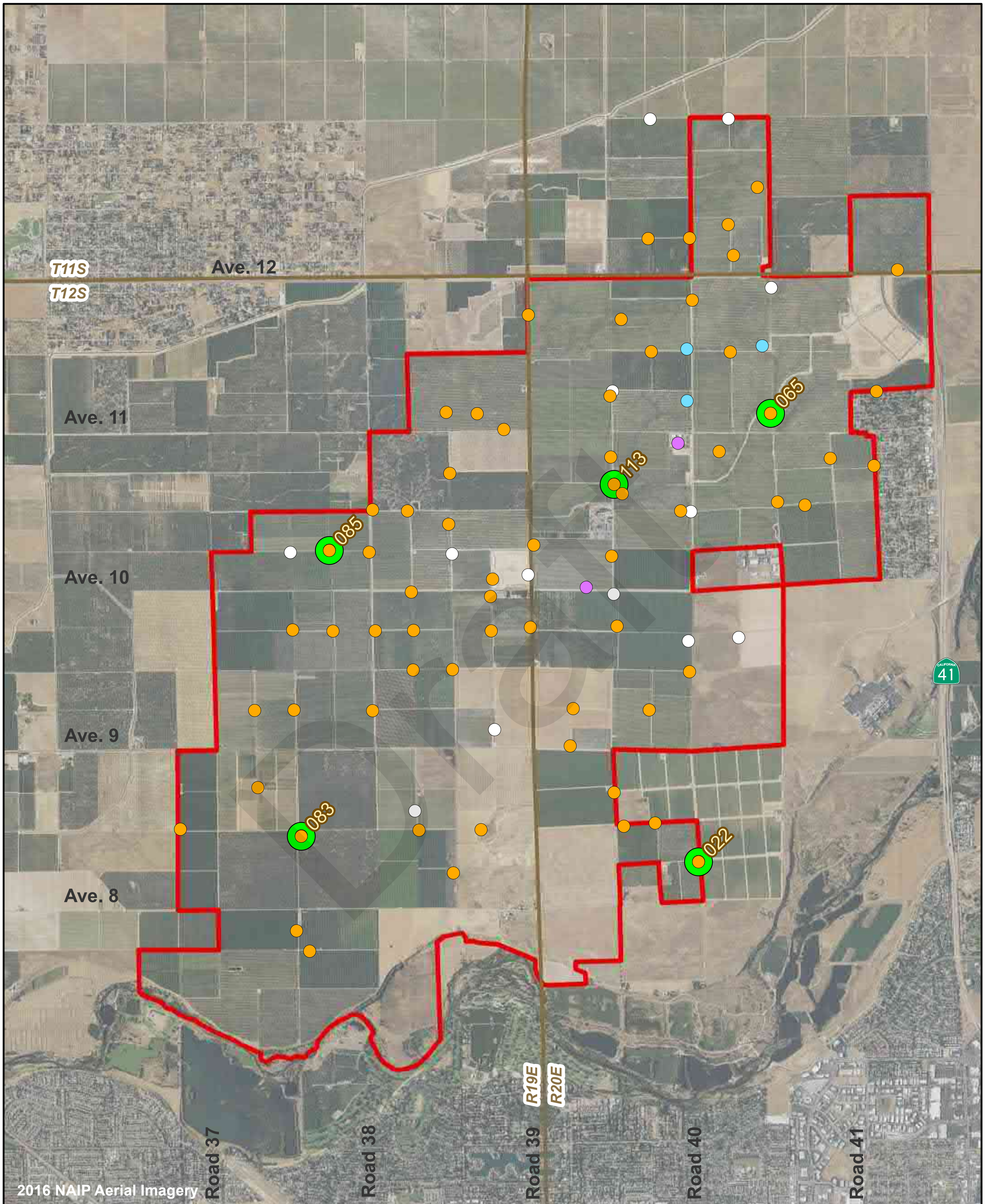
A. A sufficient density of monitor wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.
B. Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.

5.2.1 Monitoring Network Description

As discussed in Section 2.2.1 and Section 3.2.1, groundwater level monitoring in the RCWD area reaches back to the 1970s in some wells, but District wide monitoring of 23 wells began in 1998 with both spring and fall measurements. The data obtained in the spring reflects the "seasonal high" water table, as the measurements are made prior to pumping, while the fall measurements are taken after a full season of crop irrigation pumping. RCWD uses some of their wells to participate in volunteer regional monitoring through CASGEM. Groundwater level data is also collected just outside the district, to better understand groundwater conditions on its borders. The District uses the data from all wells to generate semi-annual groundwater contour maps for studying groundwater elevation and flow change over time. Wells measured in historical monitoring efforts include:

- Municipal wells: Most municipal wells are available for monitoring.
- Dedicated Monitor Wells: Dedicated monitor wells are in the GSA, such as next to production wells and at groundwater banks and wastewater treatment plants. These are the most useful monitoring points. A select group of monitor wells has been added to the network and will be monitored biannually.
- Private Wells: Most wells in the GSA are privately owned. Local growers sometimes test water quality as part of an agronomic analysis, but this data is private and generally not available to the GSA. Sometimes these wells cannot be monitored if the pump is running or there are access issues, such as locked gates.
- Wells in Adjacent GSAs: Groundwater level data from adjoining areas, including other agencies to the north, south, and west of the Root Creek GSA, will also be collected to help provide better interpretation of GSA boundary flow conditions. (*Note: long term agreements still need to be prepared to collect/share data with adjacent GSAs)* Groundwater levels to the east of the GSA would not be useful, since the alluvial groundwater basin ends on the eastern border of the RCGSA with the adjacent Sierra Nevada.

While it is the intent of RCWD to continue monitoring those 23 wells, only a subset of them will be a part of the designated monitoring network for the purposes of this GSP. For consistency, RCWD would like to use the same five wells in its monitoring network for groundwater levels as were used for setting Sustainable Management Criteria, which can be seen in **Figure 5-1**. By using the same wells for future monitoring purposes, direct evaluation of current conditions against the measurable objectives is possible. Additionally, these five wells already have good historical data dating back to the 1970s, allowing for a more accurate trend to be established in the first ten years of implementation rather than starting from scratch.



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N
0 0.25 0.5
Miles

Root Creek WD
Well With Data 1970s to Current

Well
- Ag
- Domestic
- Municipal
- Ag (Abandoned)

Root Creek WD

Figure 5-1

Wells for Monitoring Groundwater Levels

5/23/2019: G:\Root Creek WD-1249\Projects\124917002-GMP Update like GSP\GIS\Map\Report\Gen\Wells_data1970s_SMC.mxd

5.2.1.1 Site Selection

Regulation Requirements:

> **§354.34(g)** Each Plan shall describe the following information about the monitoring network:
> **(1)** Scientific rationale for the monitoring site selection process.

The scientific rationale for the groundwater level monitoring network includes the following:

1. The network exceeds the minimum density goal.
2. The existing network has performed adequately for several decades in providing information for annual reporting, groundwater contour maps, and estimation of storage change.
3. Many existing wells have a significant period of record (i.e., greater than 20 years) and are useful for long-term evaluations.

The following scientific rationale will be used to add new wells, if necessary:

- Avoid wells located near water bodies such as canals, reservoirs, etc.
- Select dedicated monitor wells over production wells where feasible.
- Select wells with available construction information (i.e., depth, perforated interval).
- Avoid domestic wells since they are rarely idle.

5.2.2 Quantitative Values

Table 5-2 summarizes the sustainable management criteria set for groundwater levels from Chapter 4.

Table 5-2 Sustainable Management Criteria for Groundwater Levels

District Area	Well	Minimum Threshold	Measurable Objective	Interim Milestones			
		Water Elevation	*Water Elevation*	**2020**	2025	2030	2035
Southern	83	128	144	170	162	154	149
	22	196	203	215	211	206	205
Northwest	85	-24	52	85	70	60	56
Northeast	113	-24	4	55	40	25	15
	65	-28	24	70	60	40	32

The five designated monitoring wells will be measured each fall and spring. The trend of the groundwater levels will be compared to the interim milestones every five years to make sure the GSA is on track for successfully implementing the Plan.

5.2.3 Monitoring Frequency and Density

Regulation Requirements:

§354.34(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: 1) Amount of current and projected groundwater use. 2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow. 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. 4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

Groundwater levels will be monitored in the spring (January) and fall (October) of each year. This differs slightly from historical measurements but provides consistency for future data collection. Spring measurements are designed to capture the recovery of the groundwater basin after an extended period of minimal agricultural and landscape irrigation demand, assuming a normal rainfall and before pumping for the new year occurs. The fall measurement would capture a period after peak irrigation and summertime urban demands have ceased, thereby showing the cumulative impacts on the groundwater basin before any natural recovery has taken place.

Hopkins and Anderson (2016) provide recommendations for groundwater-level monitor well densities ranging from 1 well per 150 square miles to 1 well per 25 square miles based on the quantity of groundwater pumped. Groundwater pumping from the 9,550-acre (15 square mile) RCWD averaged 19,854 AF/year between the years 2014 to 2017 and may exceed this value even after groundwater usage declines to comply with SGMA. As a result, a minimum well density goal of 1 well/75 square miles is recommended. However, this is a bare minimum density and RCWD will maintain a much denser network. The five wells shown above for the monitoring network provides a density of 1 well/3.4 square miles.

A limited number of wells outside of the GSA will also be monitored to evaluate boundary conditions and how neighboring agencies are affecting the ability of RCWD to implement the GSP. Additional outside monitoring wells may be added to this group to increase understanding of the groundwater conditions. However, these wells are monitored by other agencies, so data collection is outside of the GSA's control, but there is a desire to obtain at least 2 wells per Township, if feasible.

5.2.4 Identification of Data Gaps

Regulation Requirements:

§354.38(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency. **§354.38(c)** If the monitoring network contains data gaps, the Plan shall include a description of the following: 1) The location and reason for data gaps in the monitoring network. 2) Local issues and circumstances that limit or prevent monitoring.

The existing groundwater level monitoring network has performed adequately for several decades in preparing groundwater contour maps and identifying groundwater level trends. Groundwater contour mapping could be more accurate if another well or two is added closer to the San Joaquin river to portray groundwater levels in this area. However, the largest data gap for the monitoring network is well construction information and data outside the boundaries of the GSA. Depth to the bottom of the well and to the perforated interval is crucial for understanding which aquifer is being monitored and is required by SGMA guidelines. This information is known for the three municipal wells in the District and a few others, but most are unknown, including the monitoring network wells. Thus, this information will need to be obtained from the grower or by means of videoing.

Temporal Data Gaps: There are currently no temporal data gaps in the network. If some wells (i.e., private wells) are not accessible in both the spring and the fall, then there could be a temporal gap. However, the existing network currently has enough redundancy so that temporal gaps are not an issue.

Spatial Data Gaps: There are currently no spatial gaps in the network. Section 5.2.3 discusses that monitor well density far exceeds the minimum goal of 1 well/75 square miles.

Insufficient Quality of Data: Currently, most of the wells monitored in unincorporated areas are privately owned. Specific well construction information, including depth and perforated interval, is not known for many wells. While these wells do not provide ideal data points, they will continue to be used until additional well attribute data can be collected.

5.2.4.1 Plans to Fill Data Gaps

Regulation Requirements:

> **§354.38 (d)** Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

The groundwater-level network has a data quality gap as well construction information is missing for some wells in rural areas. However, existing data is adequate to assess aquifer characteristics in the GSA. These data gaps can be filled using the four alternatives below:

- **Collect well completion reports.** Well Completion Reports will provide the needed information. These could be collected from the landowner or Department of Water Resources; however, several challenges exist. First, landowners may not have the report or may not be willing to provide them. The GSA has found it very difficult to match up Well Completion Reports from DWR with actual wells, since so many have been drilled in the area, and location maps in the reports are often poor or erroneous.
- **Perform a video inspection of each well to obtain construction information.** A video inspection can be performed on desired wells to determine the total depth and perforated interval. The cost of each inspection is about $1,500 (2017), but up to $15,000 may also be needed to lift a pump to provide access. Additional costs would also be incurred for administration and outreach to landowners. Permission would be needed from the well owner; however, they may agree since they would obtain a free well assessment.
- **Replace monitoring point with a dedicated monitor well:** Dedicated monitor wells could be installed and used in place of private wells. The construction information would be known and there would be no access issues. Dedicated monitor wells are expensive to construct, and their installation will depend on available funding. New monitor wells do not have a history and even though the well completion is not known the historical data is invaluable to an understanding of the change over time.
- **Replace monitor point with another private well.** Private wells without construction information could be replaced with another private well that has well construction information. This may be simpler and less costly than a video inspection. However, replacing monitor well locations is not always desirable, since it is preferred to continue measurements in wells that have a long period of record (i.e., long hydrograph).

The GSA will continue to collect information on the wells in the network until additional data becomes necessary to complete monitoring or assessment tasks.

5.3 Groundwater Storage Monitoring

Regulation Requirements:

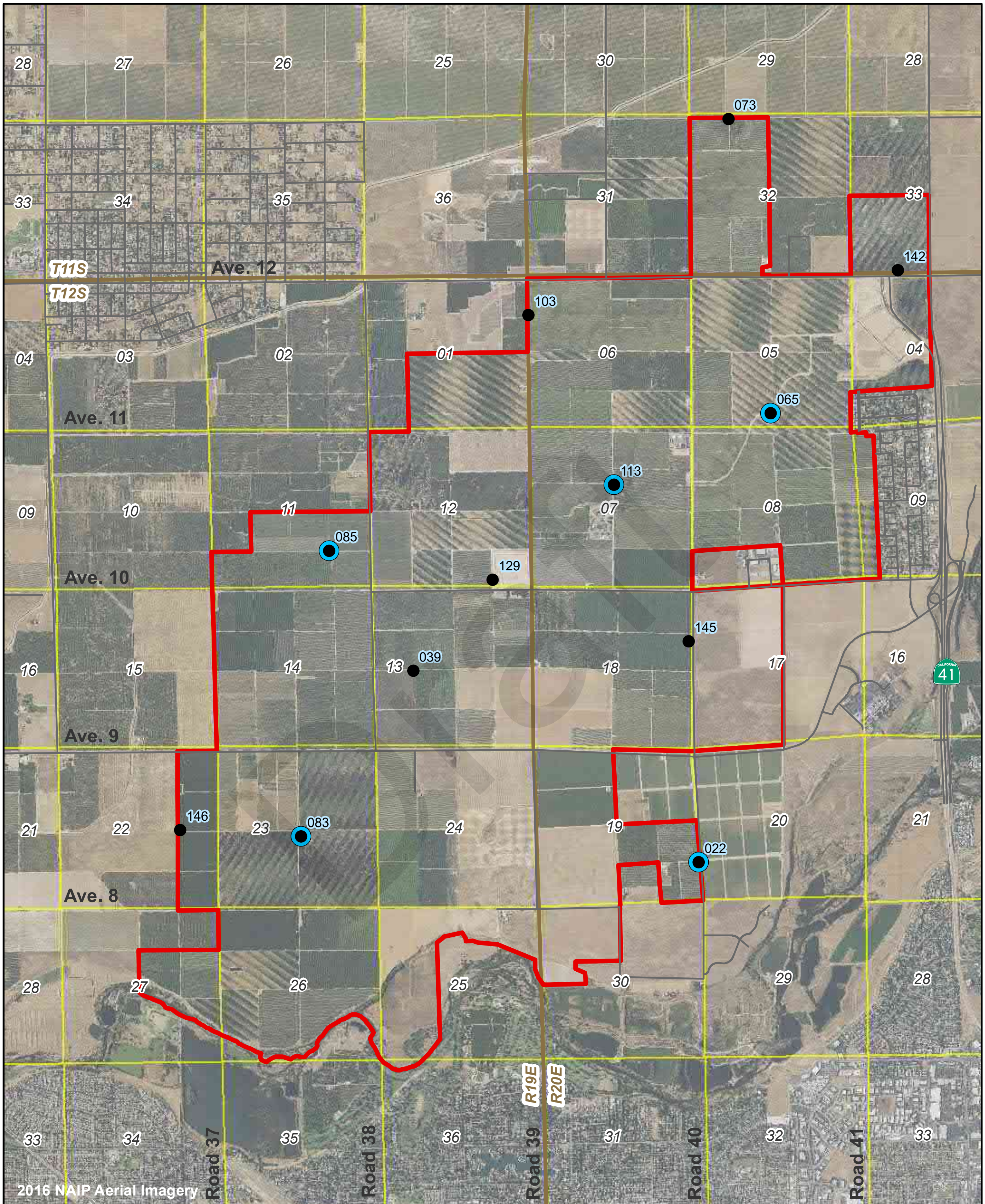
§354.34(c)(2) Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.

5.3.1 Monitoring Network Description

Historical estimated changes in groundwater storage are discussed in Chapter 3.2 – Current and Historical Groundwater Conditions. Section 3.2.3 reports the method and estimated change in storage for the period of 1999 to 2017. The general methodology used in those efforts will continue to be used by the GSA in the monitoring of storage change moving forward.

A three-dimensional surface representing the groundwater table is prepared to estimate groundwater levels and the change in storage. This yearly change in depth of the water table between spring measurements is multiplied by the specific yield, which varies by depth, and is then multiplied by the area of the District. Specific yield values within RCWD have been identified within Township 12 for varying depths: 0-50ft, 50-100ft, 100-200ft, and 200-300ft below the ground surface by Davis et al. (1959) and Williamson et al. (1989). In some areas, specific yield data is limited to one value from 10-300 feet.

As mentioned, to calculate change in groundwater storage, specific yield and groundwater levels must be known. Therefore, the monitoring network for measuring change in groundwater storage volume consists of the same five wells as the monitoring network for groundwater levels. However, in order to create more accurate groundwater contour maps, especially on the borders of the District, wells outside of District boundaries are necessary. It is proposed to add an additional five wells to the groundwater storage monitoring network as shown on **Figure 5-2.**



Root Creek WD

All Sites To Be Monitored

Representative Monitoring Site (Levels and Storage)

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0 0.25 0.5 Miles

Root Creek WD

Figure 5-2

Storage Change Monitoring Network

5.3.1.1 Site Selection

Regulation Requirements:

§354.34(g) Each Plan shall describe the following information about the monitoring network: **(1)** Scientific rationale for the monitoring site selection process.

Change in groundwater storage is based on a simple calculation involving the specific yield and change in groundwater levels. The groundwater level monitoring sites are discussed above. Specific yield values were acquired from several publications (see **Section 3.1.8.2**) and are based on textural analysis of numerous Well Completion Reports as well as pump tests that have recently been performed. While this method is subject to some error, it is considered a reliable method to estimate storage change since it is based largely on measured data. Storage change can also be estimated with a water balance exercise, but that is subject to significant uncertainty and cumulative errors from numerous parameters.

5.3.2 Quantitative Values

See **Section 5.2.2.**

5.3.3 Monitoring Frequency and Density

Regulation Requirements:

§354.34(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: 5) Amount of current and projected groundwater use. 6) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow. 7) 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. 8) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

Groundwater storage change will be estimated annually, based on spring groundwater levels. Groundwater storage changes will be based largely on the geographic availability of specific yield data (see **Section 3.1.8**). The areas used are considered reasonable, since overdraft is typically estimated on a regional scale; estimating overdraft on a very small or local scale may provide misleading results. Only wells with reasonable and reliable data will be used to develop groundwater contours and estimate storage change.

5.3.4 Identification of Data Gaps

Regulation Requirements:

§354.38(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency. **§354.38(c)** If the monitoring network contains data gaps, the Plan shall include a description of the following: 3) The location and reason for data gaps in the monitoring network. 4) Local issues and circumstances that limit or prevent monitoring.

Groundwater storage capacity has been calculated for many years using local groundwater levels and specific yield values. This methodology has proved adequate in estimating annual change in groundwater storage. Groundwater storage calculations are largely dependent on the groundwater level network and the accuracy of measurements. Over the years, the density of wells used to create groundwater level contours has been good; however, due to a lack of knowledge on well depth, it is not always known whether each well is representing confined or unconfined conditions. Additionally, specific yield values are highly variable due to the spatial variance in soil properties, leading to uncertainty in groundwater storage calculations.

5.3.4.1 Plans to Fill Data Gaps

Regulation Requirements:

§354.38 (d) Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

Each of the wells in the monitoring network is required to have well construction information including perforation depth and total depth. Seciton 5.2.4.1 discusses various options for this. As for specific yield, well completion reports can be used to estimate specific yield values based on soil type listed, and pump tests on newer wells will be used to make verify the specific yield values that are used in the computations.

5.4 Water Quality Monitoring

Regulation Requirements:

§354.34(c)(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.

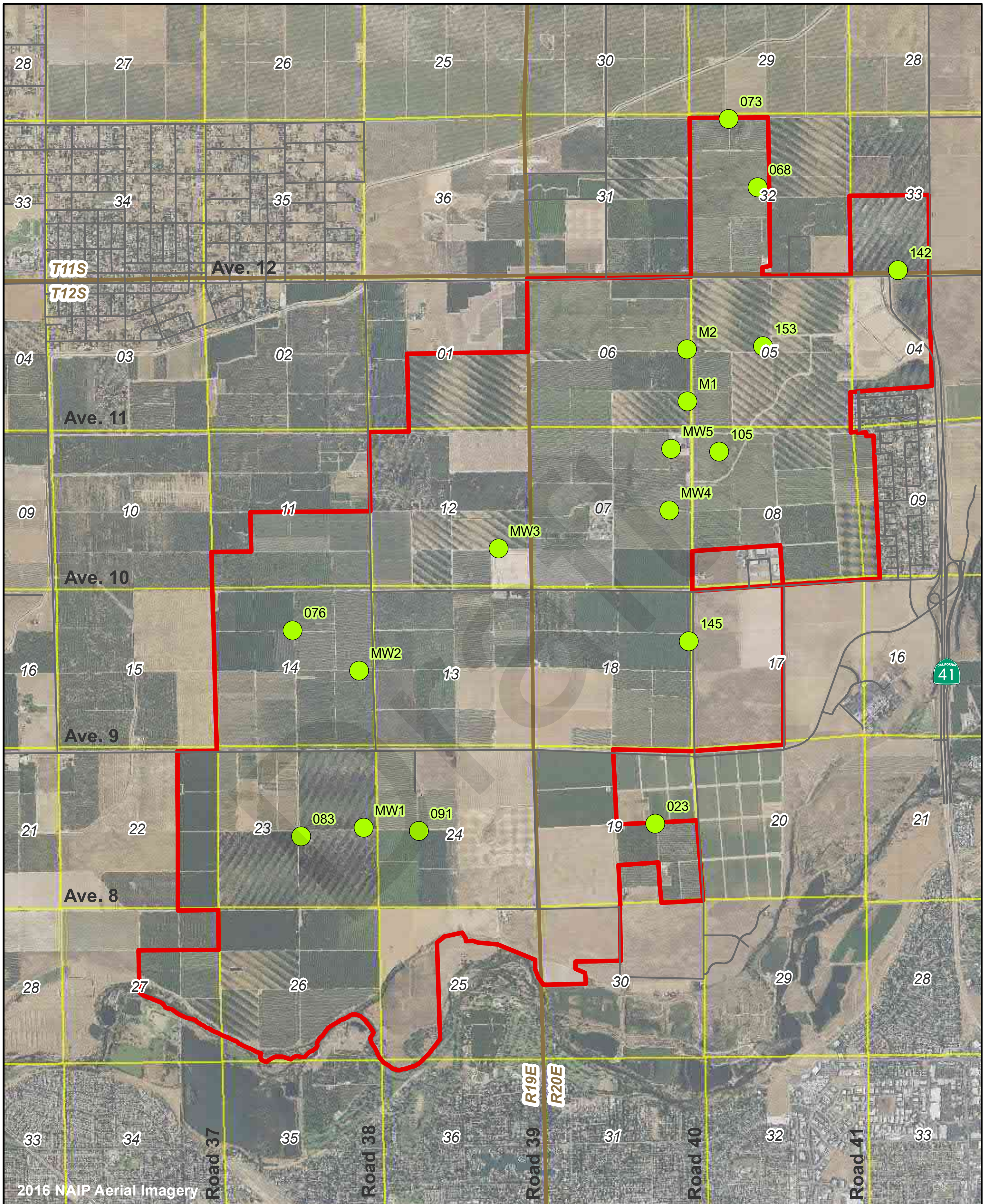
5.4.1 Monitoring Network Description

Water quality monitoring for the GSA will consist of measurement at the municipal wells as required by the Department of Drinking Water, annual monitoring of monitor wells associated with the Riverstone wastewater treatment plant and required by the Regional Water Quality Control Board (RWQCB) and annual monitoring from agricultural wells used for groundwater levels associated with this plan as well as CASGEM wells that are part of the State monitoring program. A figure showing these wells is included on **Figure 5-3**

Water quality monitoring is an important aspect of groundwater management in the area and serves the following purposes:

1. Spatially characterize water quality according to soil types, soil salinity, geology, surface water quality, and land use;
2. Compare constituent levels at a specific well over time (i.e., years and decades);
3. Determine the extent of groundwater quality problems in specific areas;
4. Identify groundwater quality protection and enhancement needs;
5. Determine water treatment needs;
6. Identify impacts of recharge and surface water use on water quality;
7. Identify suitable crop types that are compatible with the water characteristics; and
8. Monitor the migration of contaminant plumes (such as nitrate).

Numerous agencies play important roles in the monitoring and regulation of groundwater quality. These agencies include the RWQCB, Environmental Protection Agency, Department of Toxic Substances Control, Madera County, USGS, and State Water Resources Control Board. RCWD will collect and review pertinent water quality data and regulations published by these agencies.



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0 0.25 0.5
Miles

Root Creek WD

Water Quality Monitoring Sites

Root Creek WD

Figure 5-3

Water Quality Monitoring Sites

Historically, there has not been a dedicated regularly monitored network of wells concerning groundwater quality in RCWD. In 2003, a detailed assessment of water quality was made as part of a Local Groundwater Assistance Grant from DWR. The assessment evaluated 15 deep and shallow wells throughout the District (KDSA and P&P, 2003). At that time, the information represented a more complete horizontal and vertical water quality data set, thus allowing for a more detailed understanding of water quality in the area. Information from the 2003 study is discussed in more detail in Section 3.2.5 – Groundwater Quality Issues. The rest of this section discusses existing and proposed water-quality monitoring programs in the GSA.

The 2012 GMP stated the District would begin measuring electrical conductivity in monitoring wells each year and would periodically perform detailed testing to verify that the water quality was not degrading. Since the District now delivers groundwater for urban uses, its municipal wells are tested per regulatory standards for drinking water quality. Many landowners test the water quality of their domestic and irrigation wells on a regular basis and some provide the results to RCWD; however, the results are proprietary and are not released to the public.

Following are descriptions of the various water quality monitoring programs proposed for the GSA.

Municipal Water. In recent years, RCWD has become the municipal water supplier for the Riverstone Development Project located in northeastern portion of the District. RCWD is the public agency responsible for providing potable water along with wastewater collection, treatment, and disposal services for the Riverstone community. The Riverstone development is reliant on groundwater and the District operates three potable water production wells, which do not require well head treatment. RCWD tests water quality on a routine basis for state and federally regulated inorganic and organic constituents, as well as coliform bacteria, as required by the Division of Drinking Water (DDW). The District prepares annual Consumer Confidence Reports to inform the public of water quality issues, as required by the State of California. The first Consumer Confidence Report was dated July 1, 2018, for 2017. It is anticipated that these three municipal production wells will be in the monitoring network for groundwater quality for the purposes of this GSP.

Rural Domestic Water Supply. There is no formal testing program for domestic water users in unincorporated areas. However, many landowners test the water quality in their domestic wells, but this data is private and generally not available to the GSA or other water agencies. An agreement will need to be formed with homeowners in rural areas to regularly sample domestic wells for groundwater quality information. It is thought that there are only two wells that meet this classification and no efforts will be made to gain access to this information.

Agricultural Water Suppliers. Agricultural water wells in the GSA are privately owned and are not required to be monitored for water quality. Groundwater quality in the area is generally excellent for agriculture irrigation purposes (P&P, 2012). In addition, high-quality surface water recharges the groundwater from deep percolation of irrigation water and seepage from the San Joaquin River, which helps to further improve groundwater quality. For the purposes of this GSP and meeting monitoring requirements for measuring the success of implementation, the Irrigated Lands Regulatory Program (ILRP) will be utilized.

Irrigated Lands Regulatory Program. The ILRP was initiated in 2003 to address pollutant discharges to surface water and groundwater from commercially irrigated lands. The primary purpose of the ILRP is to address key pollutants of concern including salinity, nitrates, and pesticides introduced through runoff or infiltration of irrigation water and stormwater. The program is administered by the Central Valley RWQCB. The RCWD landowners participate in the East San Joaquin Valley Water Quality Coalition (Coalition) to pool resources and combine regional efforts to comply with the regulatory requirements of the ILRP. The Coalition began monitoring surface water quality in 2004.

To date, the Coalition regularly reviews hydrologic and water quality data for the area extending from the Stanislaus River in Modesto County to the San Joaquin River in Madera County including surface water delivered directly to RCWD. In February 2018, the Coalition released a *Groundwater Quality Trends Monitoring Workplan: Phase III Specific Network Wells* (Workplan). The Workplan is the final part of a multi-phase approach to developing the complete Workplan and presents results from ongoing Coalition efforts to establish a network of wells to use for the Groundwater Quality Trend Monitoring (GQTM) program. The RWQCB will ultimately decide whether the program has an adequate density of monitoring sites and proper scientific rationale. The Phase III Workplan presents a monitoring network design that has been refined to include a targeted set of domestic wells supplemented by data from public water system (PWS) wells. In the RCWDGSA area, there are five PWS wells (C61 to C65) located around the eastern margin of the GSA that provide supplementary data for the trend monitoring (Luhdorff et al., 2018). Annual reports will summarize findings of the trend analyses. In 2017, the Coalition's Annual Report described the results of the first year that growers in the three Central Valley water quality coalitions turned in nitrogen fertilizer application information.

5.4.1.1 Site Selection

Regulation Requirements:

> **§354.34(g)** Each Plan shall describe the following information about the monitoring network:
> **(1)** Scientific rationale for the monitoring site selection process.

The scientific rationale for the existing water quality monitoring sites is based primarily on State monitoring requirements, and specific monitoring programs established by regulatory agencies. The scientific rationale for the ILRP groundwater quality monitoring is currently being established.

5.4.2 Quantitative Values

To summarize the Sustainable Management Criteria set in Chapter 4, RCWD has minimum thresholds set for agricultural water quality, municipal water quality, and rural domestic water quality. Total dissolved solids and nitrogen are used for water quality indicators for agricultural water with minimum thresholds of 1,200 mg/L and 30 mg/L respectively. The minimum threshold for rural residential water quality is to maintain current conditions and not worsen water quality, while for the three municipal wells, the minimum threshold is to maintain water quality at or above state and federal water quality standards for drinking water.

5.4.3 Monitoring Frequency and Density

Regulation Requirements:

> **§354.34(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:
> 9) Amount of current and projected groundwater use.
> 10) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.
> 11) 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.
> 12) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

Frequency of water quality monitoring is performed at each municipal well according to state requirements. Testing frequency varies based on the system size and constituents of concern in the area. The density and frequency of monitoring for the ILRP is still being developed and will require approval from the Regional Water Quality Control Board. Rural domestic wells in the monitoring network will be tested once per year and compared to historical information.

5.4.4 Identification of Data Gaps

Regulation Requirements:

> **§354.38(b)** Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.
> **§354.38(c)** If the monitoring network contains data gaps, the Plan shall include a description of the following:
> 5) The location and reason for data gaps in the monitoring network.
> 6) Local issues and circumstances that limit or prevent monitoring.

The main issue with data on water quality in RCWD is the inconsistency at which it is measured. The most recent and comprehensive information on groundwater quality in the District is from a 2003 study. As discussed, the Groundwater Quality Monitoring Network is considered adequate in areas of urban use but is minimal for irrigated rural lands.

5.4.5 Plans to Fill Data Gaps

Regulation Requirements:

> **§354.38 (d)** Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

Beginning in 2020, the RCWDGSA will initiate sampling of the wells identified in the agricultural designation.

5.5 Land Subsidence Monitoring

Regulation Requirements:

> **§354.34(c)(5)** Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.

5.5.1 Monitoring Network Description

Based upon measurement by other agencies, land subsidence within the RCWDGSA is minimal. Most of subsidence in the San Joaquin Valley has and continues to happen west of the RCWDGSA over the axial trough of the valley, although minor subsidence has been documented in the extreme western portion of the RCWDGSA. Most significant subsidence in the trough of the Valley is underlain by the Corcoran Clay member of the Tulare Formation, the eastern extent of which is estimated 10 miles west of the RCWDGSA.

As discussed in Section 3.2.7 – Land Subsidence Conditions, measurement and monitoring for land subsidence is performed by a variety of agencies including USGS, DWR, USBR, USACE, University NAVSTAR (Navigation Satellite Timing and Ranging) Consortium (UNAVCO), and various private contractors. Interagency efforts between the USGS, USBR, the U.S. Coast and Geodetic Survey (now the National Geodetic Survey), and DWR resulted in an intensive series of investigations that identified and characterized subsidence in the San Joaquin Valley. NASA has also measured subsidence in the Central Valley and has maps on their websites that show the subsidence for a defined period. NASA obtains subsidence data by comparing satellite images of Earth's surface over time. For the last few years, InSAR observations from satellite and aircrafts have been used to produce the subsidence maps. More information can be found on their website:

https://www.nasa.gov/jpl/nasa-california-drought-causing-valley-land-to-sink

Subsidence Monitoring Programs. The land subsidence monitoring network for RCWDGSA moving forward will continue to utilize NASA InSAR data along with any other publicly available subsidence information. As mentioned above, some local agencies in the San Joaquin Valley monitor for land subsidence; however, the majority rely on monitoring performed by regional water agencies or the State and Federal government. The following programs are available for monitoring the RCWD area:

Continuous Global Positioning System Stations. Seven CGPS Stations are in the general vicinity of RCWDGSA area. The CPGS stations provide daily horizontal and vertical data at these locations, with records starting as early as 2004. The CGPS stations also show subsidence, or lack thereof, at locations near the RCWDGSA area. The Plate Boundary Observatory (PBO) and the Scripps Orbit and Permanent Array Center (SOPAC) upload and process the data from the network of CGPS stations and produce graphs depicting the horizontal and vertical change in a point's location through time. CGPS near RCWD are in Madera and Coarsegold with no stations located within the RCWDGSA boundary. Information on CGPS stations can be found at the following website:

https://www.unavco.org/instrumentation/networks/status/pbo

DWR Monitoring Network. DWR, along with other agencies, has monitored land subsidence in California for decades. DWR has been working with NASA to acquire and process InSAR data to measure land subsidence in portions of the Central Valley and other locations in California since 2007. More information can be found on their website:

https://ca.water.usgs.gov/projects/central-valley/land-subsidence-san-joaquin-valley.html

NASA Monitoring Network. NASA obtains subsidence data by comparing satellite images of Earth's surface over time. For the last few years, InSAR observations from satellite and aircrafts have been used to produce the subsidence maps. More information can be found on their website:

https://www.nasa.gov/jpl/nasa-california-drought-causing-valley-land-to-sink

San Joaquin River Restoration Program. Currently, USBR in conjunction with DWR, USGS, and USACE obtain subsidence data twice yearly and publish maps of the results in December and July as part of the SJRRP. The subsidence areas shown in these maps cover the RCWDGSA area. The USBR as part of the SJRRP has been monitoring subsidence along the river and bypass levees as part of the restoration effort. Maps of the subsidence in the area have been produced every July and December since 2012. More information can be found on their website:

http://www.restoresjr.net/monitoring-data/subsidence-monitoring/

USGS Monitoring Network. This subsidence monitoring network in the San Joaquin Valley was installed in the 1950s and consisted of 31 extensometers to quantify the subsidence occurring in the Valley. By the 1980s, the land subsidence monitoring efforts decreased. Since then, a new monitoring network has been developed. The new network includes refurbished extensometers from the old network, CGPS stations, and InSAR. More information can be found on their website:

https://ca.water.usgs.gov/land_subsidence/

5.5.2 Quantitative Values

Sustainable management criteria were not set for land subsidence in RCWD due to the lack of historical subsidence.

5.5.3 Review and Evaluation of Monitoring Network

Considering that subsidence in the area is very minimal, using data published from other agencies is sufficient for monitoring. If subsidence is realized in the area, then sustainable management criteria may be created, and a monitoring network formed.

5.5.3.1 Monitoring Frequency and Density

Regulation Requirements:

> **§354.34(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:
> 13) Amount of current and projected groundwater use.
> 14) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.
> 15) 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.
> 16) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

Land subsidence will be primarily monitored with agency and government land subsidence surveying programs. The subsidence monitoring network has adequate density to determine land subsidence in the RCWDGSA area. InSAR data will be used to monitor land subsidence in the RCWDGSA area since it provides complete coverage of the RCWDGSA area. This is considered adequate, especially since there is minimal subsidence in the GSA. NASA InSAR remote sensing data will be used to verify any observed subsidence and fill in gaps between the surveyed benchmarks, as of now it is unclear of the frequency of these programs.

5.5.3.2 Identification of Data Gaps

Regulation Requirements:

> **§354.38(b)** Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.
> **§354.38(c)** If the monitoring network contains data gaps, the Plan shall include a description of the following:
> 7) The location and reason for data gaps in the monitoring network.
> 8) Local issues and circumstances that limit or prevent monitoring.

Minimal data locations exist in and around the GSA, but the area is not experiencing significant subsidence.

5.5.3.3 Plans to Fill Data Gaps

Regulation Requirements:

> **§354.38(d)** Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

Should subsidence increase in the area, specific monitoring locations will be evaluated and added to the network as necessary. Several methods are available for measuring subsidence including surveying, extensometers, continuous global positioning system, light detection and ranging (LiDAR), and InSAR.

5.5.3.4 Site Selection

Regulation Requirements:

> **§354.34(g)** Each Plan shall describe the following information about the monitoring network:
> **(1)** Scientific rationale for the monitoring site selection process.

If additional monitoring locations are deemed necessary, the following scientific rationale will be used:

- Add sites to areas of higher subsidence in the RCWDGSA area.

- Add sites that can be easily surveyed and tied back to a nearby monument.
- Add sites where the ground surface is unlikely to be modified by future construction and will remain undisturbed.
- Add sites in areas where the geology and soil types present a greater potential for subsidence.

5.6 Interconnected Surface Water

Regulation Requirements:

§354.34(c)(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.

5.6.1 Monitoring Network Description

Sustainable management criteria for interconnected surface water do not apply due to the inconclusive nature that comes with a lack of available data. Currently, there is no evidence that active wells along the river are causing increased seepage loss or impacts to downstream beneficial uses and there are no known complaints of increased water required as a result of groundwater pumping.

There are several considerations in relating seepage to groundwater pumping such as volume of flows, timing of flows, climate, water quality, drought, antecedent moisture content, groundwater levels, etc. Increased seepage could be caused by many reasons other than increased groundwater pumping, including increased riparian pumping from rivers, change in operation, saturation, etc.

RCWDGSA will continue to review the near-river groundwater monitoring data by the San Joaquin River Restoration Program and will utilize the near-river monitoring well(s) in its own monitoring well network to verify that groundwater near-river gradients do not increase significantly. Updates will be included in subsequent GSP revisions as necessary.

5.6.2 Quantitative Values

Sustainable management criteria were not established for interconnected surface water and groundwater systems.

5.6.3 Review and Evaluation of Monitoring Network

The monitoring network consists of SJRRP monitoring piezometers and is considered adequate for evaluating the connectedness of the surface water and groundwater systems.

5.6.3.1 Monitoring Frequency and Density

Regulation Requirements:

§354.34(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:

17) Amount of current and projected groundwater use.
18) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.
19) 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.
20) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

Data gathering to be performed by the USBR under the SJRRP program.

5.6.3.2 Identification of Data Gaps

Regulation Requirements:

§354.38(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.
§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:

9) The location and reason for data gaps in the monitoring network.
10) Local issues and circumstances that limit or prevent monitoring.

Actual river seepage data is difficult to gather and, in most cases, must be estimated based on total losses and riparian diversions, which makes it difficult to correlate an increase in pumping to river seepage.

5.6.3.3 Plans to Fill Data Gaps

Regulation Requirements:

§354.38(d) Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

Monitor wells near the river and data published by the SJRRP.

5.6.3.4 Site Selection

Regulation Requirements:

§354.34(g) Each Plan shall describe the following information about the monitoring network:
(1) Scientific rationale for the monitoring site selection process.

If additional monitoring sites are deemed necessary in the future, the following criteria will be considered:

- Distance from river
- Feasibility of placing a shallow monitoring well

Regulation Requirements:

5.7 Seawater Intrusion Monitoring

Regulation Requirements:

> **§354.34(c)(3)** Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.

The GSA is approximately 100 miles from the ocean; therefore, seawater intrusion is not feasible. In addition, there are no saline water lakes in or near the GSA. As a result, seawater intrusion is not discussed hereafter in this chapter. Saline water intrusion from up-coning of deep saline groundwater is a potential problem, but has not been identified thus far, and will be monitored as part of general water quality monitoring (see following section). Further discussion of seawater intrusion is included in this GSP in Section 3.2.4.

5.8 Consistency with Data and Reporting Standards

Regulation Requirements:

> **§354.34(g)(2)** Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.

The data gathered through the monitoring networks is consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as **Appendix 5-A**.

- Data reporting units (Ex. Water volumes shall be reported in acre-feet, etc.)
- Monitoring site information (Ex. Site identification number, description of site location, etc.)
- Well attribute reporting (Ex. CASGEM well identification number, casing perforations, etc.)
- Map standards (Ex. Data layers, shapefiles, geodatabases shall be submitted in accordance with the procedures described in Article 4, etc.)
- Hydrograph requirements (Ex. Hydrographs shall use the same datum and scaling to the greatest extent practical, etc.)
- Groundwater and surface water models (Ex. The model shall include publicly available supporting documentation, etc.)

5.9 Monitoring Protocols

Regulation Requirements:

> **§354.34(i)** The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.

Groundwater level, groundwater quality, and land subsidence monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, December 2016b). The GSA may develop standard monitoring forms in the future if deemed necessary.

The following comments and exceptions to the BMP should be noted:

1. SGMA regulations require that groundwater levels be measured to the nearest 0.1 feet. The BMP suggests measurements to the nearest 0.01 feet; however, this is not practical for many measurement methods. In addition, this level of accuracy would have little value since groundwater contour maps typically have 10 or 20-foot intervals, and storage calculations are based on groundwater levels rounded to the nearest foot. The accuracy of groundwater level measurements will vary based on the well type and condition. For instance, if significant oil is found in an agricultural well, then readings to the nearest foot are achievable.
2. If used in a well suspected of contamination or if there are obvious signs of contamination (such as oil), well sounding equipment will be decontaminated after use.
3. Wells will be surveyed to a horizontal accuracy of 0.5 feet.
4. Unique well identifiers will be labeled on all public wells and on private wells if permission is granted.
5. The BMP states that measurements each spring and fall should be taken "preferably within a 1 to 2-week period." This is likely not feasible due to the large number of wells in the GSA, and a 4-week period will be granted for biannual monitoring.
6. If a vacuum or pressure release is observed, then water level measurements will be remeasured every five minutes until they have stabilized.
7. In the field, water level measurements will be compared to previous records. If there is a significant difference, then the measurement will be verified.
8. For water quality monitoring, field parameters for pH, electrical conductivity, and temperature will only be collected when required for the particular parameter being monitored. Determining if a well has been purged adequately may be ascertained by calculating a run time before sampling.

5.10 Representative Monitoring

Regulation Requirements:

§354.36 Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:
§354.36(a) Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.

DWR has referred to representative monitoring as utilizing one well to represent an entire GSA or Management Area. As discussed in Chapter 4, sustainability criteria are set at a subset of monitoring wells in the District. For groundwater elevation sustainability criteria, five wells were chosen to set goals by which the rest of the monitoring wells should be compared. These wells monitor three areas with separate hydrographs and general flow directions resulting from separate area constraints and characteristics. Groundwater conditions can vary substantially across the GSA. The area has a history of using multiple wells to monitor groundwater flow and gradient and will continue to use available water level data from multiple wells to assess groundwater conditions.

5.11 Data Storage and Reporting

Regulation Requirements:

§354.40 Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.

Monitoring programs are coordinated within the subbasin in each of the seven GSAs. It is planned that well location, construction, and level data will be shared amongst the different GSAs. In addition, the monitoring programs described in this Chapter were reviewed by the other GSAs, and they are generally consistent throughout the basin. Similarly, data reported to DWR will be collected and reported in a consistent format.

The rest of this section to be prepared later after the GSA has prepared a comprehensive Data Management System as part of the Madera Basin Coordinated Effort. .

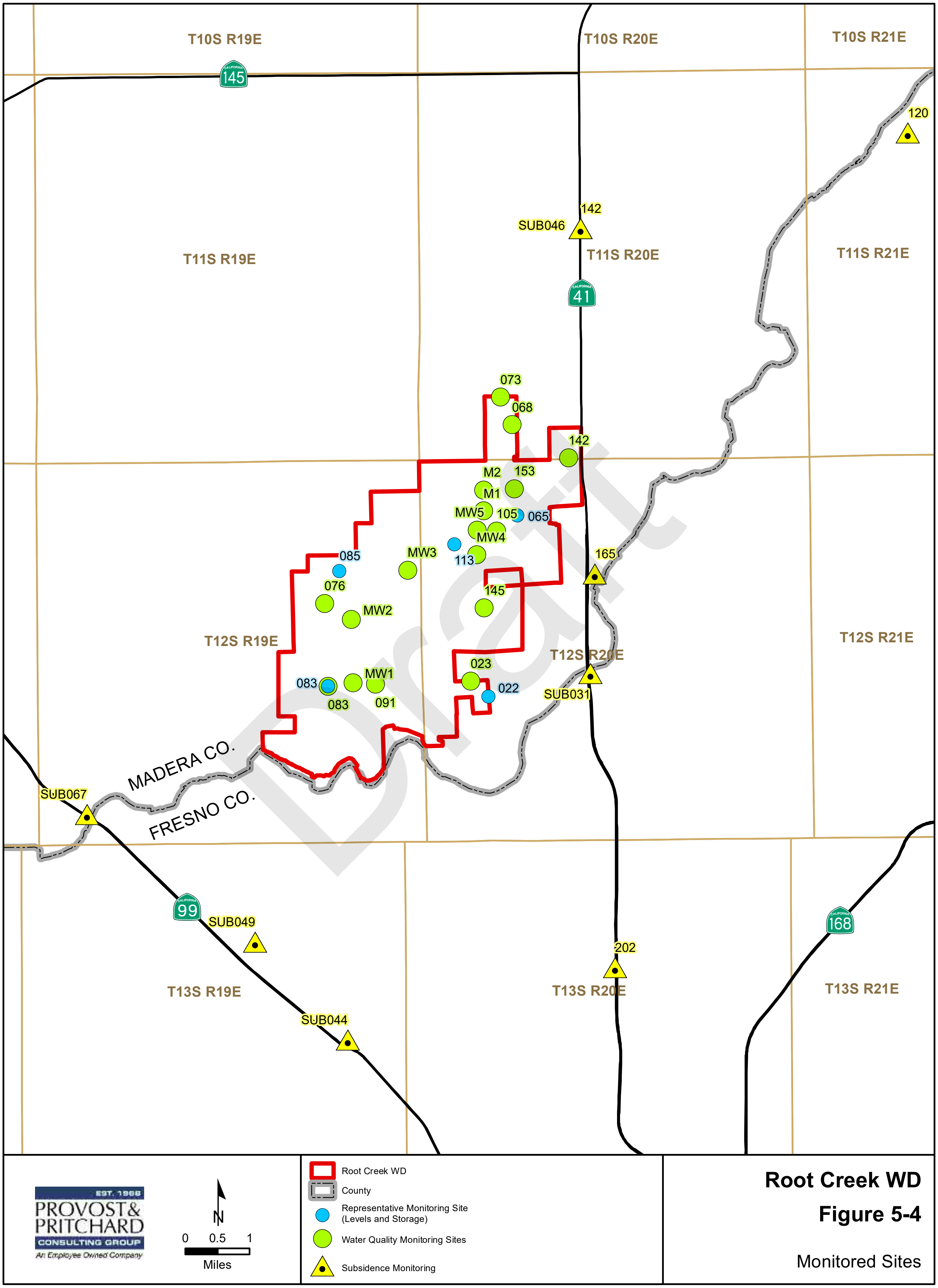
5.12 Monitoring Locations Map

Regulation Requirements:

§354.34(h) The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.

Figure 5-4 shows the monitoring site locations for groundwater levels, groundwater quality, land subsidence, and groundwater storage (same sites as the groundwater level monitoring). The groundwater quality monitor wells for the ILRP have not been confirmed by RWQCB yet, however the offsite locations near RCWDGSA are also shown. Land subsidence is also monitored close to and several miles outside of the border of the GSA.

Appendix 5-B includes a table of monitoring well attributes. (*This table requires expansion to include all wells in the network. This table only includes some of the wells, and is included an example of what the final table will look like*)



Root Creek WD

Figure 5-4

Monitored Sites

8/6/2019: G:\Root Creek WD-1249\Projects\124917002-GMP Update like GSP\GIS\Map\Report\Monitoring\monitored_wells.mxd

5.13 References

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Appendix 5-A Section 352.4 Standards

ARTICLE 3. Technical and Reporting Standards

§ 352. Introduction to Technical and Reporting Standards

This Article describes the monitoring protocols, standards for monitoring sites, and other technical elements related to the development or implementation of a Plan.

Note: Authority cited: Section 10733.2, Water Code.

Reference: Section 10733.2, Water Code.

§ 352.2. Monitoring Protocols

Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows:

(a) Monitoring protocols shall be developed according to best management practices.

(b) The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department, or may adopt similar monitoring protocols that will yield comparable data.

(c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.

Note: Authority cited: Section 10733.2, Water Code.

Reference: Sections 10727.2, 10728.2, 10729, and 10733.2, Water Code.

§ 352.4. Data and Reporting Standards

(a) The following reporting standards apply to all categories of information required of a Plan, unless otherwise indicated:

(1) Water volumes shall be reported in acre-feet.

(2) Surface water flow shall be reported in cubic feet per second and groundwater flow shall be reported in acre-feet per year.

(3) Field measurements of elevations of groundwater, surface water, and land surface shall be measured and reported in feet to an accuracy of at least 0.1 feet relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.

(4) Reference point elevations shall be measured and reported in feet to an accuracy of at least 0.5 feet, or the best available information, relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.

(5) Geographic locations shall be reported in GPS coordinates by latitude and longitude in decimal degree to five decimal places, to a minimum accuracy of 30 feet, relative to NAD83, or another national standard that is convertible to NAD83.

(b) Monitoring sites shall include the following information:

(1) A unique site identification number and narrative description of the site location.

(2) A description of the type of monitoring, type of measurement taken, and monitoring frequency.

(3) Location, elevation of the ground surface, and identification and description of the reference point.

(4) A description of the standards used to install the monitoring site. Sites that do not conform to best management practices shall be identified and the nature of the divergence from best management practices described.

(c) The following standards apply to wells:

(1) Wells used to monitor groundwater conditions shall be constructed according to applicable construction standards, and shall provide the following information in both tabular and geodatabase-compatible shapefile form:

(A) CASGEM well identification number. If a CASGEM well identification number has not been issued, appropriate well information shall be entered on forms made available by the Department, as described in Section 353.2.

(B) Well location, elevation of the ground surface and reference point, including a description of the reference point.

(C) A description of the well use, such as public supply, irrigation, domestic, monitoring, or other type of well, whether the well is active or inactive, and whether the well is a single, clustered, nested, or other type of well.

(D) Casing perforations, borehole depth, and total well depth.

(E) Well completion reports, if available, from which the names of private owners have been redacted.

(F) Geophysical logs, well construction diagrams, or other relevant information, if available.

(G) Identification of principal aquifers monitored.

(H) Other relevant well construction information, such as well capacity, casing diameter, or casing modifications, as available.

(2) If an Agency relies on wells that lack casing perforations, borehole depth, or total well depth information to monitor groundwater conditions as part of a Plan, the Agency shall describe a schedule for acquiring monitoring wells with the necessary information, or demonstrate to the Department that such information is not necessary to understand and manage groundwater in the basin.

(3) Well information used to develop the basin setting shall be maintained in the Agency's data management system.

(d) Maps submitted to the Department shall meet the following requirements:

(1) Data layers, shapefiles, geodatabases, and other information provided with each map, shall be submitted electronically to the Department in accordance with the procedures described in Article 4.

(2) Maps shall be clearly labeled and contain a level of detail to ensure that the map is informative and useful.

(3) The datum shall be clearly identified on the maps or in an associated legend.

(e) Hydrographs submitted to the Department shall meet the following requirements:

(1) Hydrographs shall be submitted electronically to the Department in accordance with the procedures described in Article 4.

(2) Hydrographs shall include a unique site identification number and the ground surface elevation for each site.

(3) Hydrographs shall use the same datum and scaling to the greatest extent practical.

(f) Groundwater and surface water models used for a Plan shall meet the following standards:

(1) The model shall include publicly available supporting documentation.

(2) The model shall be based on field or laboratory measurements, or equivalent methods that justify the selected values, and calibrated against site-specific field data.

(3) Groundwater and surface water models developed in support of a Plan after the effective date of these regulations shall consist of public domain open-source software.

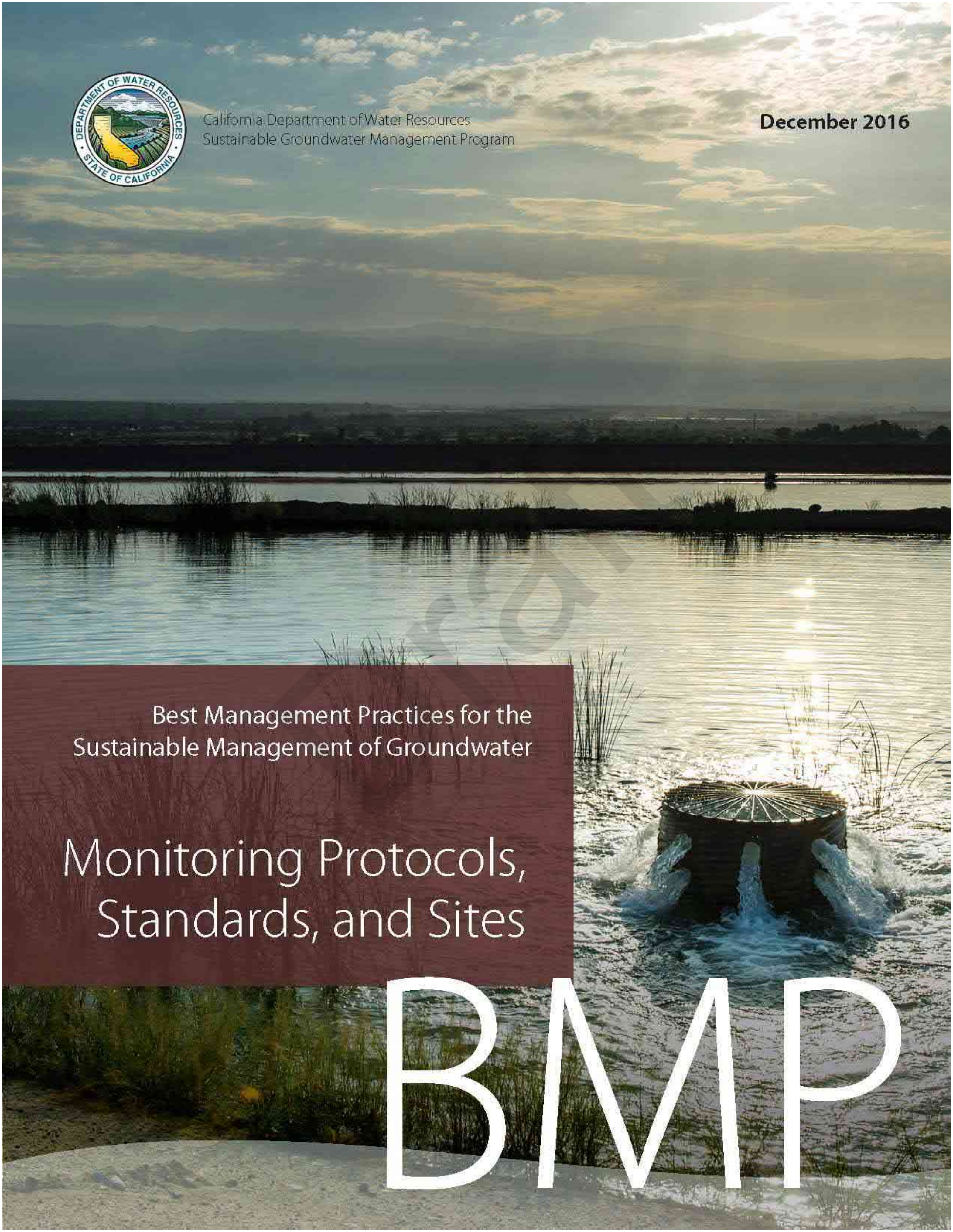
(g) The Department may request data input and output files used by the Agency, as necessary. The Department may independently evaluate the appropriateness of model results relied upon by the Agency, and use that evaluation in the Department's assessment of the Plan.

Note: Authority cited: Section 10733.2, Water Code.

Reference: Sections 10727.2, 10727.6, and 10733.2, Water Code.

Appendix 5-B Table of Monitoring Well Attributes

Appendix 5-C BMP Monitoring Protocols



California Department of Water Resources
Sustainable Groundwater Management Program

December 2016

Best Management Practices for the Sustainable Management of Groundwater

Monitoring Protocols, Standards, and Sites

BMP

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John Laird, Secretary for Natural Resources

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Groundwater Monitoring Protocols, Standards, and Sites Best Management Practice

1. Objective

The objective of this *Best Management Practice* (BMP) is to assist in the development of Monitoring Protocols. The California Department of Water Resources (the Department or DWR) has developed this document as part of the obligation in the Technical Assistance chapter (Chapter 7) of the Sustainable Groundwater Management Act (SGMA) to support the long-term sustainability of California's groundwater *basins*. Information provided in this BMP provides technical assistance to Groundwater Sustainability Agencies (GSAs) and other stakeholders to aid in the establishment of consistent data collection processes and procedures. In addition, this BMP can be used by GSAs to adopt a set of sampling and measuring procedures that will yield similar data regardless of the monitoring personnel. Finally, this BMP identifies available resources to support the development of monitoring protocols.

This BMP includes the following sections:

1. Objective. A brief description of how and where monitoring protocols are required under SGMA and the overall objective of this BMP.
2. Use and Limitations. A brief description of the use and limitations of this BMP.
3. Monitoring Protocol Fundamentals. A description of the general approach and background of groundwater monitoring protocols.
4. Relationship of Monitoring Protocols to other BMPs. A description of how this BMP is connected with other BMPS.
5. Technical Assistance. Technical content providing guidance for regulatory sections.
6. Key Definitions. Descriptions of definitions identified in the GSP Regulations or SGMA.
7. Related Materials. References and other materials that provide supporting information related to the development of Groundwater Monitoring Protocols.

2. USE AND LIMITATIONS

BMPs developed by the Department provide technical guidance to GSAs and other stakeholders. Practices described in these BMPs do not replace the GSP Regulations, nor do they create new requirements or obligations for GSAs or other stakeholders. In addition, using this BMP to develop a GSP does not equate to an approval determination by the Department. All references to GSP Regulations relate to Title 23 of the California Code of Regulations (CCR), Division 2, Chapter 1.5, and Subchapter 2. All references to SGMA relate to California Water Code sections in Division 6, Part 2.74.

3. MONITORING PROTOCOL FUNDAMENTALS

Establishing data collection protocols that are based on best available scientific methods is essential. Protocols that can be applied consistently across all basins will likely yield comparable data. Consistency of data collection methods reduces uncertainty in the comparison of data and facilitates more accurate communication within basins as well as between basins.

Basic minimum technical standards of accuracy lead to quality data that will better support implementation of GSPs.

4. RELATIONSHIP OF MONITORING PROTOCOL TO OTHER BMPS

Groundwater monitoring is a fundamental component of SGMA, as each GSP must include a sufficient network of data that demonstrates measured progress toward the achievement of the sustainability goal for each basin. For this reason, a standard set of protocols need to be developed and utilized.

It is important that data is developed in a manner consistent with the basin setting, planning, and projects/management actions steps identified on **Figure 1** and the GSP Regulations. The inclusion of monitoring protocols in the GSP Regulations also emphasizes the importance of quality empirical data to support GSPs and provide comparable information from basin to basin.

Figure 1 provides a logical progression for the development of a GSP and illustrates how monitoring protocols are linked to other related BMPs. This figure also shows the context of the BMPs as they relate to various steps to sustainability as outlined in the GSP Regulations. The monitoring protocol BMP is part of the Monitoring step identified in **Figure 1**.

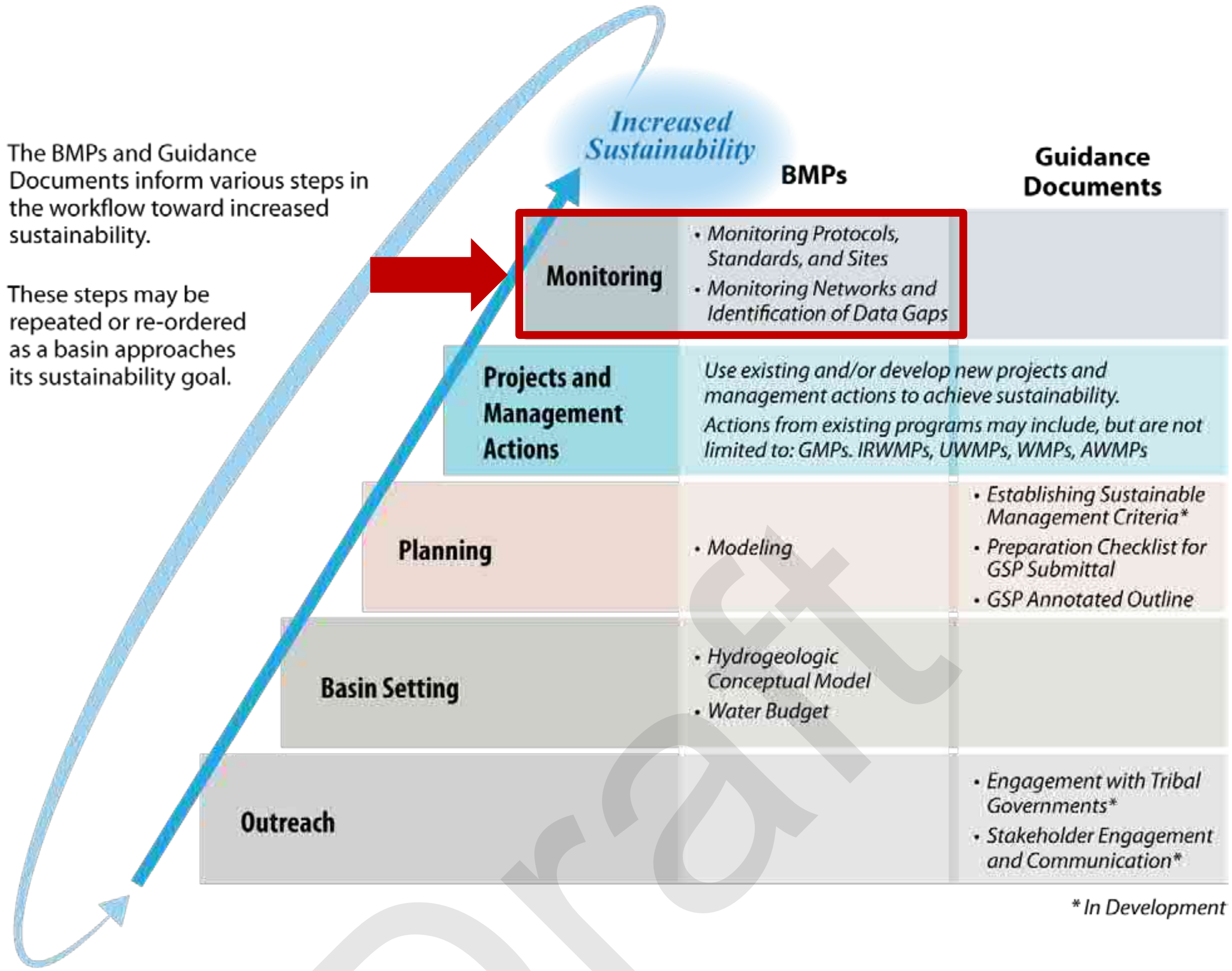

Figure 1 – Logical Progression of Basin Activities Needed to Increase Basin Sustainability

5. TECHNICAL ASSISTANCE

23 CCR §352.2. Monitoring Protocols. Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows:
(a) Monitoring protocols shall be developed according to best management practices.
(b) The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department, or may adopt similar monitoring protocols that will yield comparable data.
(c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.

The GSP Regulations specifically call out the need to utilize protocols identified in this BMP, or develop similar protocols. The following technical protocols provide guidance based upon existing professional standards and are commonly adopted in various groundwater-related programs. They provide clear techniques that yield quality data for use in the various components of the GSP. They can be further elaborated on by individual GSAs in the form of standard operating procedures which reflect specific local requirements and conditions. While many methodologies are suggested in this BMP, it should be understood that qualified professional judgment should be used to meet the specific monitoring needs.

The following BMPs may be incorporated into a GSP's monitoring protocols section for collecting groundwater elevation data. A GSP that adopts protocols that deviate from these BMPs must demonstrate that they will yield comparable data.

PROTOCOLS FOR ESTABLISHING A MONITORING PROGRAM

The protocol for establishment of a monitoring program should be evaluated in conjunction with the *Monitoring Network and Identification of Data Gaps* BMP and other BMPs. Monitoring protocols must take into consideration the *Hydrogeologic Conceptual Model, Water Budget, and Modeling* BMPs when considering the data needs to meet GSP objectives and the sustainability goal.

It is suggested that each GSP incorporate the Data Quality Objective (DQO) process following the U.S. EPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006). Although strict adherence to this method is not required, it does provide a robust approach to consider and assures that data is collected with a specific purpose in mind, and efforts for monitoring are as efficient as possible to achieve the objectives of the GSP and compliance with the GSP Regulations.

The DQO process presents a method that can be applied directly to the sustainability criteria quantitative requirements through the following steps.

1. State the problem – Define sustainability indicators and planning considerations of the GSP and sustainability goal.
2. Identify the goal – Describe the quantitative measurable objectives and minimum thresholds for each of the sustainability indicators.
3. Identify the inputs – Describe the data necessary to evaluate the sustainability indicators and other GSP requirements (i.e. water budget).
4. Define the boundaries of the study – This is commonly the extent of the Bulletin 118 groundwater basin or subbasin, unless multiple GSPs are prepared for a given basin. In that case, evaluation of the coordination plan and specifically how the monitoring will be comparable and meet the sustainability goals for the entire basin.
5. Develop an analytical approach – Determine how the quantitative sustainability indicators will be evaluated (i.e. are special analytical methods required that have specific data needs).
6. Specify performance or acceptance criteria – Determine what quality the data must have to achieve the objective and provide some assurance that the analysis is accurate and reliable.
7. Develop a plan for obtaining data – Once the objectives are known determine how these data should be collected. Existing data sources should be used to the greatest extent possible.

These steps of the DQO process should be used to guide GSAs to develop the most efficient monitoring process to meet the measurable objectives of the GSP and the sustainability goal. The DQO process is an iterative process and should be evaluated regularly to improve monitoring efficiencies and meet changing planning and project needs. Following the DQO process, GSAs should also include a data quality control and quality assurance plan to guide the collection of data.

Many monitoring programs already exist as part of ongoing groundwater management or other programs. To the extent possible, the use of existing monitoring data and programs should be utilized to meet the needs for characterization, historical record documentation, and continued monitoring for the SGMA program. However, an evaluation of the existing monitoring data should be performed to assure the data being collected meets the DQOs, regulatory requirements, and data collection protocol described in this BMP. While this BMP provides guidance for collection of various regulatory based requirements, there is flexibility among the various methodologies available to meet the DQOs based upon professional judgment (local conditions or project needs).

At a minimum, for each monitoring site, the following information or procedure should be collected and documented:

- Long-term access agreements. Access agreements should include year-round site access to allow for increased monitoring frequency.
- A unique identifier that includes a general written description of the site location, date established, access instructions and point of contact (if necessary), type of information to be collected, latitude, longitude, and elevation. Each monitoring location should also track all modifications to the site in a modification log.

PROTOCOLS FOR MEASURING GROUNDWATER LEVELS

This section presents considerations for the methodology of collection of groundwater level data such that it meets the requirements of the GSP Regulations and the DQOs of the specific GSP. Groundwater levels are a fundamental measure of the status of groundwater conditions within a basin. In many cases, relationships of the sustainability indicators may be able to be correlated with groundwater levels. The quality of this data must consider the specific aquifer being monitored and the methodology for collecting these levels.

The following considerations for groundwater level measuring protocols should ensure the following:

- Groundwater level data are taken from the correct location, well ID, and screen interval depth
- Groundwater level data are accurate and reproducible
- Groundwater level data represent conditions that inform appropriate basin management DQOs
- All salient information is recorded to correct, if necessary, and compare data
- Data are handled in a way that ensures data integrity

General Well Monitoring Information

The following presents considerations for collection of water level data that include regulatory required components as well as those which are recommended.

- Groundwater elevation data will form the basis of basin-wide water-table and piezometric maps, and should approximate conditions at a discrete period in time. Therefore, all groundwater levels in a basin should be collected within as short a time as possible, preferably within a 1 to 2 week period.
- Depth to groundwater must be measured relative to an established Reference Point (RP) on the well casing. The RP is usually identified with a permanent marker, paint spot, or a notch in the lip of the well casing. By convention in open casing monitoring wells, the RP reference point is located on the north side of the well casing. If no mark is apparent, the person performing the measurement should measure the depth to groundwater from the north side of the top of the well casing.
- The elevation of the RP of each well must be surveyed to the North American Vertical Datum of 1988 (NAVD88), or a local datum that can be converted to NAVD88. The elevation of the RP must be accurate to within 0.5 foot. It is preferable for the RP elevation to be accurate to 0.1 foot or less. Survey grade global navigation satellite system (GNSS) global positioning system (GPS) equipment can achieve similar vertical accuracy when corrected. Guidance for use of GPS can be found at USGS http://water.usgs.gov/osw/gps/. Hand-held GPS units likely will not produce reliable vertical elevation measurement accurate enough for the casing elevation consistent with the DQOs and regulatory requirements.
- The sampler should remove the appropriate cap, lid, or plug that covers the monitoring access point listening for pressure release. If a release is observed, the measurement should follow a period of time to allow the water level to equilibrate.
- Depth to groundwater must be measured to an accuracy of 0.1 foot below the RP. It is preferable to measure depth to groundwater to an accuracy of 0.01 foot. Air lines and acoustic sounders may not provide the required accuracy of 0.1 foot.
- The water level meter should be decontaminated after measuring each well.

Where existing wells do not meet the base standard as described in the GSP Regulations or the considerations provided above, new monitoring wells may need to be constructed to meet the DQOs of the GSP. The design, installation, and documentation of new monitoring wells must consider the following:

- Construction consistent with California Well Standards as described in Bulletins 74-81 and 74-90, and local permitting agency standards of practice.
- Logging of borehole cuttings under the supervision of a California Professional Geologist and described consistent with the Unified Soil Classification System methods according to ASTM standard D2487-11.
- Written criteria for logging of borehole cuttings for comparison to known geologic formations, principal aquifers and aquitards/aquicludes, or specific marker beds to aid in consistent stratigraphic correlation within and across basins.
- Geophysical surveys of boreholes to aid in consistency of logging practices. Methodologies should include resistivity, spontaneous potential, spectral gamma, or other methods as appropriate for the conditions. Selection of geophysical methods should be based upon the opinion of a professional geologist or professional engineer, and address the DQOs for the specific borehole and characterization needs.
- Prepare and submit State well completion reports according to the requirements of §13752. Well completion report documentation should include geophysical logs, detailed geologic log, and formation identification as attachments. An example well completion as-built log is illustrated in **Figure 2.** DWR well completion reports can be filed directly at the Online System for Well Completion Reports (OSWCR) http://water.ca.gov/oswcr/index.cfm.

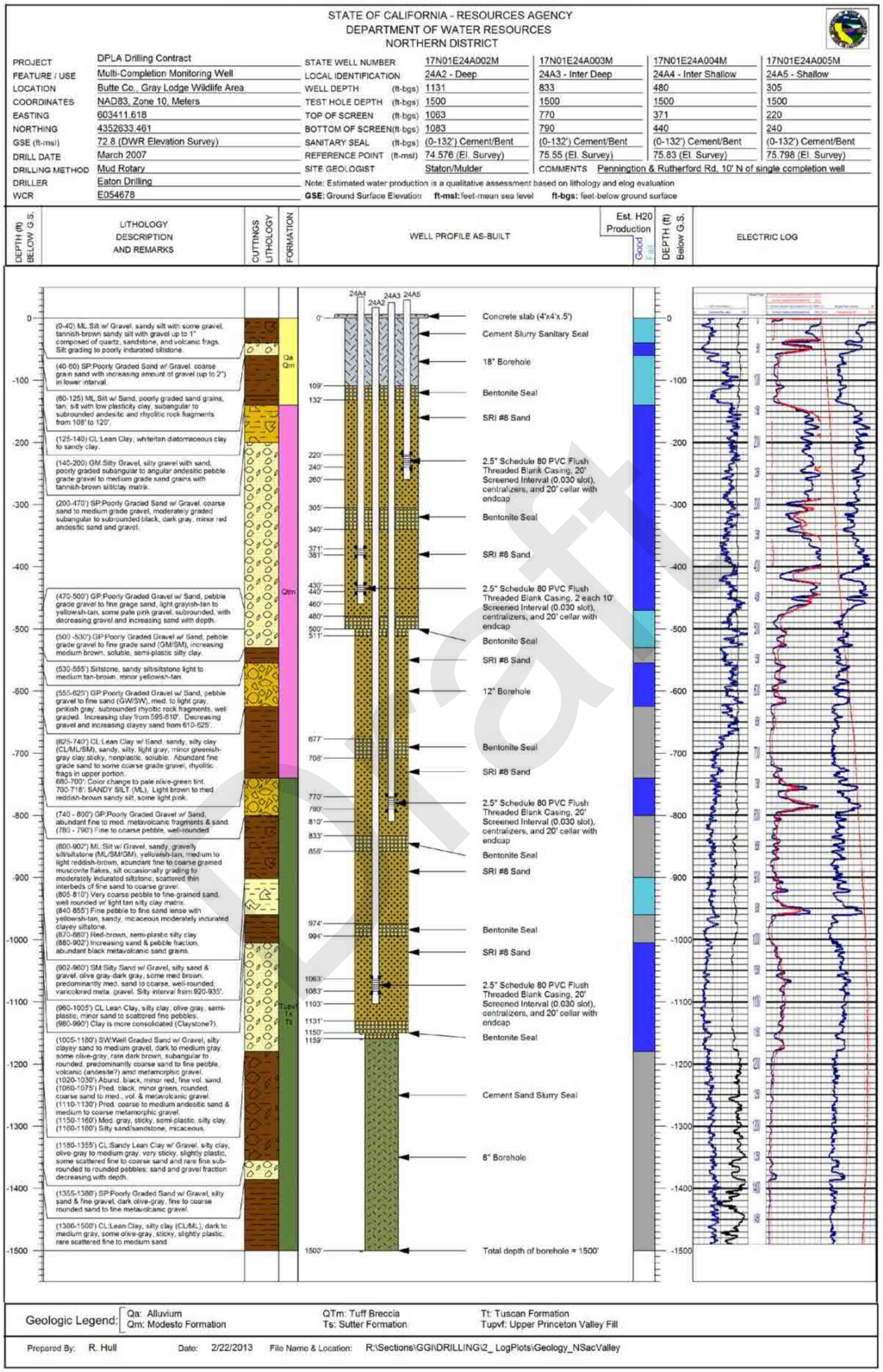

Figure 2 – Example As-Built Multi-Completion Monitoring Well Log

Measuring Groundwater Levels

Well construction, anticipated groundwater level, groundwater level measuring equipment, field conditions, and well operations should be considered prior collection of the groundwater level measurement. The USGS *Groundwater Technical Procedures* (Cunningham and Schalk, 2011) provide a thorough set of procedures which can be used to establish specific Standard Operating Procedures (SOPs) for a local agency. **Figure 3** illustrates a typical groundwater level measuring event and simultaneous pressure transducer download.

Figure 3 – Collection of Water Level Measurement and Pressure Transducer Download

The following points provide a general approach for collecting groundwater level measurements:

- Measure depth to water in the well using procedures appropriate for the measuring device. Equipment must be operated and maintained in accordance with manufacturer's instructions. Groundwater levels should be measured to the nearest 0.01 foot relative to the RP.
- For measuring wells that are under pressure, allow a period of time for the groundwater levels to stabilize. In these cases, multiple measurements should be collected to ensure the well has reached equilibrium such that no significant changes in water level are observed. Every effort should be made to ensure that a representative stable depth to groundwater is recorded. If a well does not stabilize, the quality of the value should be appropriately qualified as a

questionable measurement. In the event that a well is artesian, site specific procedures should be developed to collect accurate information and be protective of safety conditions associated with a pressurized well. In many cases, an extension pipe may be adequate to stabilize head in the well. Record the dimension of the extension and document measurements and configuration.

- The sampler should calculate the groundwater elevation as:

$$GWE = RPE - DTW$$

Where:

GWE = Groundwater Elevation
RPE = Reference Point Elevation
DTW = Depth to Water

The sampler must ensure that all measurements are in consistent units of feet, tenths of feet, and hundredths of feet. Measurements and RPEs should not be recorded in feet and inches.

Recording Groundwater Levels

- The sampler should record the well identifier, date, time (24-hour format), RPE, height of RP above or below ground surface, DTW, GWE, and comments regarding any factors that may influence the depth to water readings such as weather, nearby irrigation, flooding, potential for tidal influence, or well condition. If there is a questionable measurement or the measurement cannot be obtained, it should be noted. An example of a field sheet with the required information is shown in **Figure 4**. It includes questionable measurement and no measurement codes that should be noted. This field sheet is provided as an example. Standardized field forms should be used for all data collection. The aforementioned USGS *Groundwater Technical Procedures* offers a number of example forms.
- The sampler should replace any well caps or plugs, and lock any well buildings or covers.
- All data should be entered into the GSA data management system (DMS) as soon as possible. Care should be taken to avoid data entry mistakes and the entries should be checked by a second person for compliance with the DQOs.

STATE OF CALIFORNA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WELL DATA

STATE WELL NUMBER	COUNTY	REFERENCE POINT ELEV.	MEASURING AGENCY
			DWR

NO MEASUREMENT	QUESTIONABLE MEASUREMENT
0. Measurement discontinued	0. Caved or deepened
1. Pumping	1. Pumping
2. Pump house locked	2. Nearby pump operating
3. Tape hung up	3. Casing leaky or wet
4. Can't get tape in casing	4. Pumped recently
5. Unable to locate well	5. Air or pressure gauge measurement
6. Well has been destroyed	6. Other
7. Special	7. Recharge operation at or nearby well
8. Casing leaky or wet	8. Oil in casing
9. Temporarily inaccessible	

DATE	N M	Q M	TAPE AT RP	TAPE AT WS	RP to WS	OBSR VR	COMMENTS

DWR 1213

Figure 4 – Example of Water Level Well Data Field Collection Form

Pressure Transducers

Groundwater levels and/or calculated groundwater elevations may be recorded using pressure transducers equipped with data loggers installed in monitoring wells. When installing pressure transducers, care must be exercised to ensure that the data recorded by the transducers is confirmed with hand measurements.

The following general protocols must be followed when installing a pressure transducer in a monitoring well:

- The sampler must use an electronic sounder or chalked steel tape and follow the protocols listed above to measure the groundwater level and calculate the groundwater elevation in the monitoring well to properly program and reference the installation. It is recommended that transducers record measured groundwater level to conserve data capacity; groundwater elevations can be calculated at a later time after downloading.
- The sampler must note the well identifier, the associated transducer serial number, transducer range, transducer accuracy, and cable serial number.
- Transducers must be able to record groundwater levels with an accuracy of at least 0.1 foot. Professional judgment should be exercised to ensure that the data being collected is meeting the DQO and that the instrument is capable. Consideration of the battery life, data storage capacity, range of groundwater level fluctuations, and natural pressure drift of the transducers should be included in the evaluation.
- The sampler must note whether the pressure transducer uses a vented or non-vented cable for barometric compensation. Vented cables are preferred, but non-vented units provide accurate data if properly corrected for natural barometric pressure changes. This requires the consistent logging of barometric pressures to coincide with measurement intervals.
- Follow manufacturer specifications for installation, calibration, data logging intervals, battery life, correction procedure (if non-vented cables used), and anticipated life expectancy to assure that DQOs are being met for the GSP.
- Secure the cable to the well head with a well dock or another reliable method. Mark the cable at the elevation of the reference point with tape or an indelible marker. This will allow estimates of future cable slippage.
- The transducer data should periodically be checked against hand measured groundwater levels to monitor electronic drift or cable movement. This should happen during routine site visits, at least annually or as necessary to maintain data integrity.

- The data should be downloaded as necessary to ensure no data is lost and entered into the basin's DMS following the QA/QC program established for the GSP. Data collected with non-vented data logger cables should be corrected for atmospheric barometric pressure changes, as appropriate. After the sampler is confident that the transducer data have been safely downloaded and stored, the data should be deleted from the data logger to ensure that adequate data logger memory remains.

PROTOCOLS FOR SAMPLING GROUNDWATER QUALITY

The following protocols can be incorporated into a GSP's monitoring protocols for collecting groundwater quality data. More detailed sampling procedures and protocols are included in the standards and guidance documents listed at the end of this BMP. A GSP that adopts protocols that deviate from these BMPs must demonstrate that the adopted protocols will yield comparable data.

In general, the use of existing water quality data within the basin should be done to the greatest extent possible if it achieves the DQOs for the GSP. In some cases it may be necessary to collect additional water quality data to support monitoring programs or evaluate specific projects. The USGS *National Field Manual for the Collection of Water Quality Data* (Wilde, 2005) should be used to guide the collection of reliable data. **Figure 5** illustrates a typical groundwater quality sampling setup.

Figure 5 – Typical Groundwater Quality Sampling Event

All analyses should be performed by a laboratory certified under the State Environmental Laboratory Accreditation Program. The specific analytical methods are beyond the scope of this BMP, but should be commiserate with other programs evaluating water quality within the basin for comparative purposes.

Groundwater quality sampling protocols should ensure that:

- Groundwater quality data are taken from the correct location
- Groundwater quality data are accurate and reproducible
- Groundwater quality data represent conditions that inform appropriate basin management and are consistent with the DQOs
- All salient information is recorded to normalize, if necessary, and compare data
- Data are handled in a way that ensures data integrity

The following points are general guidance in addition to the techniques presented in the previously mentioned USGS *National Field Manual for the Collection of Water Quality Data.*

Standardized protocols include the following:

- Prior to sampling, the sampler must contact the laboratory to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements.
- Each well used for groundwater quality monitoring must have a unique identifier. This identifier must appear on the well housing or the well casing to avoid confusion.
- In the case of wells with dedicated pumps, samples should be collected at or near the wellhead. Samples should not be collected from storage tanks, at the end of long pipe runs, or after any water treatment.
- The sampler should clean the sampling port and/or sampling equipment and the sampling port and/or sampling equipment must be free of any contaminants. The sampler must decontaminate sampling equipment between sampling locations or wells to avoid cross-contamination between samples.
- The groundwater elevation in the well should be measured following appropriate protocols described above in the groundwater level measuring protocols.
- For any well not equipped with low-flow or passive sampling equipment, an adequate volume of water should be purged from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. Purging three well casing volumes is generally

considered adequate. Professional judgment should be used to determine the proper configuration of the sampling equipment with respect to well construction such that a representative ambient groundwater sample is collected. If pumping causes a well to be evacuated (go dry), document the condition and allow well to recover to within 90% of original level prior to sampling. Professional judgment should be exercised as to whether the sample will meet the DQOs and adjusted as necessary.

- Field parameters of pH, electrical conductivity, and temperature should be collected for each sample. Field parameters should be evaluated during the purging of the well and should stabilize prior to sampling. Measurements of pH should only be measured in the field, lab pH analysis are typically unachievable due to short hold times. Other parameters, such as oxidation-reduction potential (ORP), dissolved oxygen (DO) (in situ measurements preferable), or turbidity, may also be useful for meeting DQOs of GSP and assessing purge conditions. All field instruments should be calibrated daily and evaluated for drift throughout the day.
- Sample containers should be labeled prior to sample collection. The sample label must include: sample ID (often well ID), sample date and time, sample personnel, sample location, preservative used, and analytes and analytical method.
- Samples should be collected under laminar flow conditions. This may require reducing pumping rates prior to sample collection.
- Samples should be collected according to appropriate standards such as those listed in the *Standard Methods for the Examination of Water and Wastewater*, USGS *National Field Manual for the Collection of Water Quality Data,* or other appropriate guidance. The specific sample collection procedure should reflect the type of analysis to be performed and DQOs.
- All samples requiring preservation must be preserved as soon as practically possible, ideally at the time of sample collection. Ensure that samples are appropriately filtered as recommended for the specific analyte. Entrained solids can be dissolved by preservative leading to inconsistent results of dissolve analytes. Specifically, samples to be analyzed for metals should be field-filtered prior to preservation; do not collect an unfiltered sample in a preserved container.
- Samples should be chilled and maintained at 4 °C to prevent degradation of the sample. The laboratory's Quality Assurance Management Plan should detail appropriate chilling and shipping requirements.

- Samples must be shipped under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.
- Instruct the laboratory to use reporting limits that are equal to or less than the applicable DQOs or regional water quality objectives/screening levels.

Special protocols for low-flow sampling equipment

In addition to the protocols listed above, sampling using low-flow sample equipment should adopt the following protocols derived from EPA's *Low-flow (minimal drawdown) ground-water sampling procedures* (Puls and Barcelona, 1996). These protocols apply to low-flow sampling equipment that generally pumps between 0.1 and 0.5 liters per minute. These protocols are not intended for bailers.

Special protocols for passive sampling equipment

In addition to the protocols listed above, passive diffusion samplers should follow protocols set forth in USGS Fact Sheet 088-00.

PROTOCOLS FOR MONITORING SEAWATER INTRUSION

Monitoring seawater intrusion requires analysis of the chloride concentrations within groundwater of each principal aquifer subject to seawater intrusion. While no significant standardized approach exists, the methodologies described above for degraded water quality can be applied for the collection of groundwater samples. In addition to the protocol described above, the following protocols should be followed:

- Water quality samples should be collected and analyzed at least semi-annually. Samples will be analyzed for dissolved chloride at a minimum. It may be beneficial to include analyses of iodide and bromide to aid in determination of salinity source. More frequent sampling may be necessary to meet DQOs of GSP. The development of surrogate measures of chloride concentration may facilitate cost-effective means to monitor more frequently to observe the range of conditions and variability of the flow dynamics controlling seawater intrusion.
- Groundwater levels will be collected at a frequency adequate to characterize changes in head in the vicinity of the leading edge of degraded water quality in each principal aquifer. Frequency may need to be increased in areas of known preferential pathways, groundwater pumping, or efficacy evaluation of mitigation projects.
- The use of geophysical surveys, electrical resistivity, or other methods may provide for identification of preferential pathways and optimize monitoring well placement and evaluation of the seawater intrusion front. Professional judgment

should be exercised to determine the appropriate methodology and whether the DQOs for the GSP would be met.

PROTOCOLS FOR MEASURING STREAMFLOW

Monitoring of streamflow is necessary for incorporation into water budget analysis and for use in evaluation of stream depletions associated with groundwater extractions. The use of existing monitoring locations should be incorporated to the greatest extent possible. Many of these streamflow monitoring locations currently follow the protocol described below.

Establishment of new streamflow discharge sites should consider the existing network and the objectives of the new location. Professional judgment should be used to determine the appropriate permitting that may be necessary for the installation of any monitoring locations along surface water bodies. Regular frequent access will be necessary to these sites for the development of ratings curves and maintenance of equipment.

To establish a new streamflow monitoring station special consideration must be made in the field to select an appropriate location for measuring discharge. Once a site is selected, development of a relationship of stream stage to discharge will be necessary to provide continuous estimates of streamflow. Several measurements of discharge at a variety of stream stages will be necessary to develop the ratings curve correlating stage to discharge. The use of Acoustic Doppler Current Profilers (ADCPs) can provide accurate estimates of discharge in the correct settings. Professional judgment must be exercised to determine the appropriate methodology. Following development of the ratings curve a simple stilling well and pressure transducer with data logger can be used to evaluate stage on a frequent basis. A simple stilling well and staff gage is illustrated in **Figure 6**.

Streamflow measurements should be collected, analyzed, and reported in accordance with the procedures outlined in USGS Water Supply Paper 2175, *Volume 1. – Measurement of Stage Discharge* and *Volume 2. – Computation of Discharge.* This methodology is currently being used by both the USGS and DWR for existing streamflow monitoring throughout the State.

Figure 6 – Simple Stilling Well and Staff Gage Setup

PROTOCOLS FOR MEASURING SUBSIDENCE

Evaluating and monitoring inelastic land subsidence can utilize multiple data sources to evaluate the specific conditions and associated causes. To the extent possible, the use of existing data should be utilized. Subsidence can be estimated from numerous techniques, they include: level surveying tied to known stable benchmarks or benchmarks located outside the area being studied for possible subsidence; installing and tracking changes in borehole extensometers; obtaining data from continuous GPS (CGPS) locations, static GPS surveys or Real-Time-Kinematic (RTK) surveys; or analyzing Interferometric Synthetic Aperture Radar (InSAR) data. No standard procedures exist for collecting data from the potential subsidence monitoring approaches. However, an approach may include:

- Identification of land subsidence conditions.
    - Evaluate existing regional long-term leveling surveys of regional infrastructure, i.e. roadways, railroads, canals, and levees.
    - Inspect existing county and State well records where collapse has been noted for well repairs or replacement.
    - Determine if significant fine-grained layers are present such that the potential for collapse of the units could occur should there be significant depressurization of the aquifer system.

- Inspect geologic logs and the hydrogeologic conceptual model to aid in identification of specific units of concern.
- Collect regional remote-sensing information such as InSAR, commonly provided by USGS and NASA. Data availability is currently limited, but future resources are being developed.

- Monitor regions of suspected subsidence where potential exists.
  - Establish CGPS network to evaluate changes in land surface elevation.
  - Establish leveling surveys transects to observe changes in land surface elevation.
  - Establish extensometer network to observe land subsidence. An example of a typical extensometer design is illustrated in **Figure 7**. There are a variety of extensometer designs and they should be selected based on the specific DQOs.

Various standards and guidance documents for collecting data include:

- Leveling surveys must follow surveying standards set out in the California Department of Transportation's Caltrans Surveys Manual.
- GPS surveys must follow surveying standards set out in the California Department of Transportation's Caltrans Surveys Manual.
- USGS has been performing subsidence surveys within several areas of California. These studies are sound examples for appropriate methods and should be utilized to the extent possible and where available:
  - http://ca.water.usgs.gov/land_subsidence/california-subsidence-measuring.html
- Instruments installed in borehole extensometers must follow the manufacturer's instructions for installation, care, and calibration.
- Availability of InSAR data is improving and will increase as programs are developed. This method requires expertise in analysis of the raw data and will likely be made available as an interpretative report for specific regions.

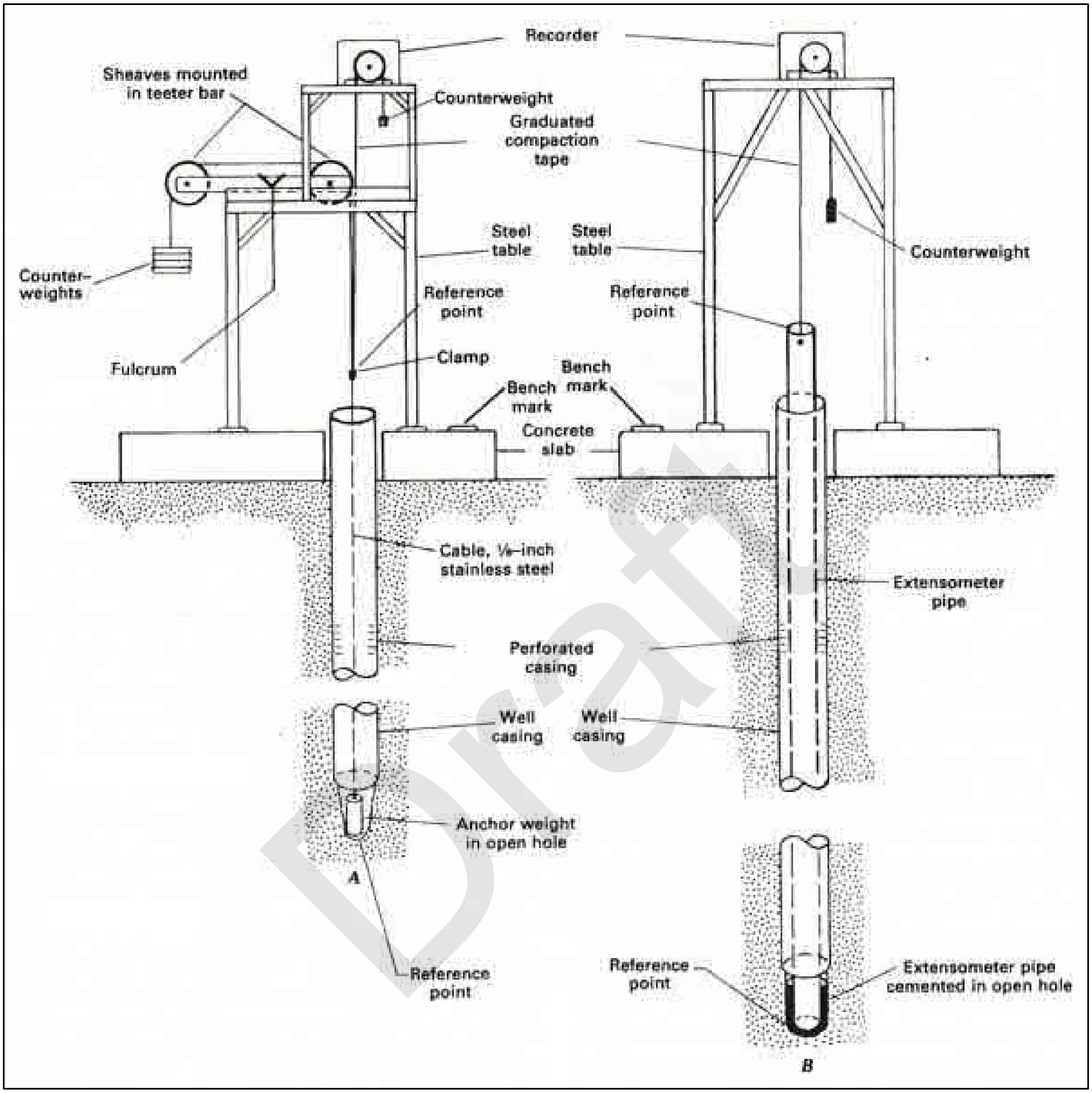

Figure 7 – Simplified Extensometer Diagram

6. KEY DEFINITIONS

The key definitions and sections related to Groundwater Monitoring Protocols, Standards, and Sites outlined in applicable SGMA code and regulations are provided below for reference.

Groundwater Sustainability Plan Regulations (California Code of Regulations §351)

- §351(h) "Best available science" refers to the use of sufficient and credible information and data, specific to the decision being made and the time frame available for making that decision, that is consistent with scientific and engineering professional standards of practice.
- §351(i) "Best management practice" refers to a practice, or combination of practices, that are designed to achieve sustainable groundwater management and have been determined to be technologically and economically effective, practicable, and based on best available science.

Monitoring Protocols Reference

§352.2. Monitoring Protocols

Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows:

(a) Monitoring protocols shall be developed according to best management practices.

(b) The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department, or may adopt similar monitoring protocols that will yield comparable data.

(c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.

SGMA Reference

§10727.2. Required Plan Elements

(f) Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin. The monitoring protocols shall be designed to generate information that promotes efficient and effective groundwater management.

7. Related Materials

CASE STUDIES

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ONLINE RESOURCES

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Measuring Land Subsidence web page. U.S. Geological Survey. http://ca.water.usgs.gov/land_subsidence/california-subsidence-measuring.html

USGS Global Positioning Application and Practice web page. U.S. Geological Survey. http://water.usgs.gov/osw/gps/

6 Projects and Management Actions

Regulation Requirements:

§ 354.44. Projects and Management Actions

(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. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:

(A) A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.

(B) The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.

(2) If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.

(3) A summary of the permitting and regulatory process required for each project and management action.

(4) The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.

(5) An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.

(6) An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.

(7) A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.

(8) A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.

(9) A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.

(c) Projects and management actions shall be supported by best available information and best available science.

(d) An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.

6.1 Introduction

The RCWDGSA plans to adopt the use of projects to meet sustainability goals. Projects are discussed in the next section. In addition to the projects, numerous programs and management actions can be developed and utilized to help attain the GSA's sustainability goals. A listing of overall types of projects and management actions are summarized below:

Table 6-1 Projects and Programs for Mitigating Groundwater Overdraft

Type	Activity	Description
Conjunctive Use	Intentional Recharge	Dedicates land to allow for the intentional recharge of surface water
	On Farm Field Flooding	Allows for the temporary use of field for intentional recharge while not dedicating the land to this purpose
Surface Water	Import additional surface water supplies	Importation of surface water supplies reduces the amount of groundwater pumping
	Increase Conveyance Capacity	Importation of surface water supplies reduces the amount of groundwater pumping
	Fully Utilize surface water allocations	Importation of surface water supplies reduces the amount of groundwater pumping
	Surface water pricing	Importation of surface water supplies reduces the amount of groundwater pumping
Agricultural Land Conversion	Development of Riverstone	Municipal land use associated with water conservation reduces the unit water demand
Groundwater Use	Groundwater Metering	Metering may encourage a reduction in pumping
	Groundwater Pumping Fees	Imposition of fees may encourage a reduction in pumping
Water Conservation	Use of Recycled water	Use of recycled water supplies would result in a reduction of groundwater pumping
Public Education	Outreach to stakeholders	Education of the community may have a resultant change in use patterns

The first three activities are considered projects while the remaining activities are considered management actions.

Description of the circumstance and criteria for initiating projects or management actions:

From historical information documented in Chapter 3, it can be shown that presently there is a historic general lowering of groundwater levels by about 3.5 feet per year. Thus, overdraft is occurring, and the GSA is implementing projects to correct the overdraft. RWCDGSA plans to continue to import surface water supplies through the recently constructed In-Lieu pipeline annually. The RCWDGSA will continue to monitor groundwater level changes annually as the project continues to operate. Groundwater level response will be averaged over a five-year period to gauge effectiveness of the project.

Process to notify the public and local agencies:

The District has initiated a web site and has initiated outreach to its constituency through mailers and meetings. The web site and the homeowner's association will be the instrument to keep the public aware of current conditions and success in managing the groundwater resources.

What if Overdraft Continues to Occur:

With the proactive approach of the District, it is envisioned that the GSA will be successful in developing the projects needed to offset the overdraft. Should this not be realized, then the addition of additional projects and management actions would be considered.

Permitting:

The projects will need to be permitted. The District is not unfamiliar with this process having recently permitted and constructed the In-Lieu pipeline project. Generally, the permitting process involves review of the project site for environmental and cultural concerns, preparation of environmental documents to comply with California Environmental Quality Act and with the Air Resources' and Regional Water Quality Control Board's requirements and approvals. Since most of the areas planned for this development are currently cultivated to farming, it is thought that this process should be relatively straightforward.

Status of each Action:

The summary of the actions listed above are included in the table below:

Table 6-2 Status of Projects and Management Actions

Type	Activity	Status
Conjunctive Use	Intentional Recharge	Planning
	On Farm Field Flooding	Implemented
Surface Water	Import additional surface water supplies	Based upon future evaluation
	Increase Conveyance Capacity	Based upon future evaluation
	Fully Utilize surface water allocations	In progress
	Surface water pricing	Implemented
Agricultural Land Conversion	Development of Riverstone	Being Implemented
Groundwater Use	Groundwater Metering	Implemented
	Groundwater Pumping Fees	Implemented
Water Conservation	Use of Recycled water	Based Upon future evaluation
Public Education	Outreach to stakeholders	In progess

Explanation of Benefits:

The projects will allow greater ability to utilize surface water supplies and incorporation of the management actions should allow flexibility and documentation of groundwater use. With the continuation of the projects and actions, additional supplies will be imported and groundwater pumping should decrease. Inclusion of additional recharge capability will allow surface water to be diverted and recharged in the winter months when availability from storm runoff would occur. If the rain/snowmelt patterns change and more surface water is available outside the normal crop irrigation demand season, these facilities will allow the district to take advantage of the timing of the surface water availability and may make even more surface water available for recharge.

How the projects will be accomplished: (or Accomplishment of the Projects)

The projects will be accomplished using the same method and process that the District has been using the past five to seven years. District staff have relationships with its growers, as well as the relating agencies.

Legal Authority:

The RCWD has the legal authority to buy, sell, and enter into contracts for purchase of property as well as construction contracts.

Cost:

See explanation below in **Table 6-2** and **Table 6-3** and in the explanation in chapter 7.

Management:

The activities of the RCWDGSA will be handled by the staff of the RWCD. It is envisioned that the RCWDGSA duties and responsibilities will be carried out by the RCWD. The RCWD has a manager and field staff that will carry out the activities of the GSA.

The projects that are currently being considered are shown on **Table 6-1.** They have not been prioritized.

Table 6-3 Status of Projects and Management Actions

Type	Activity	Project
Conjunctive Use	Intentional Recharge	Root Creek Parkway Ponds
		80 Acre dedicated basin
Surface Water	Increase Conveyance Capacity	Expansion of Irrigation System
Water Conservation	Use of Recycled water	Development of Reuse facilities

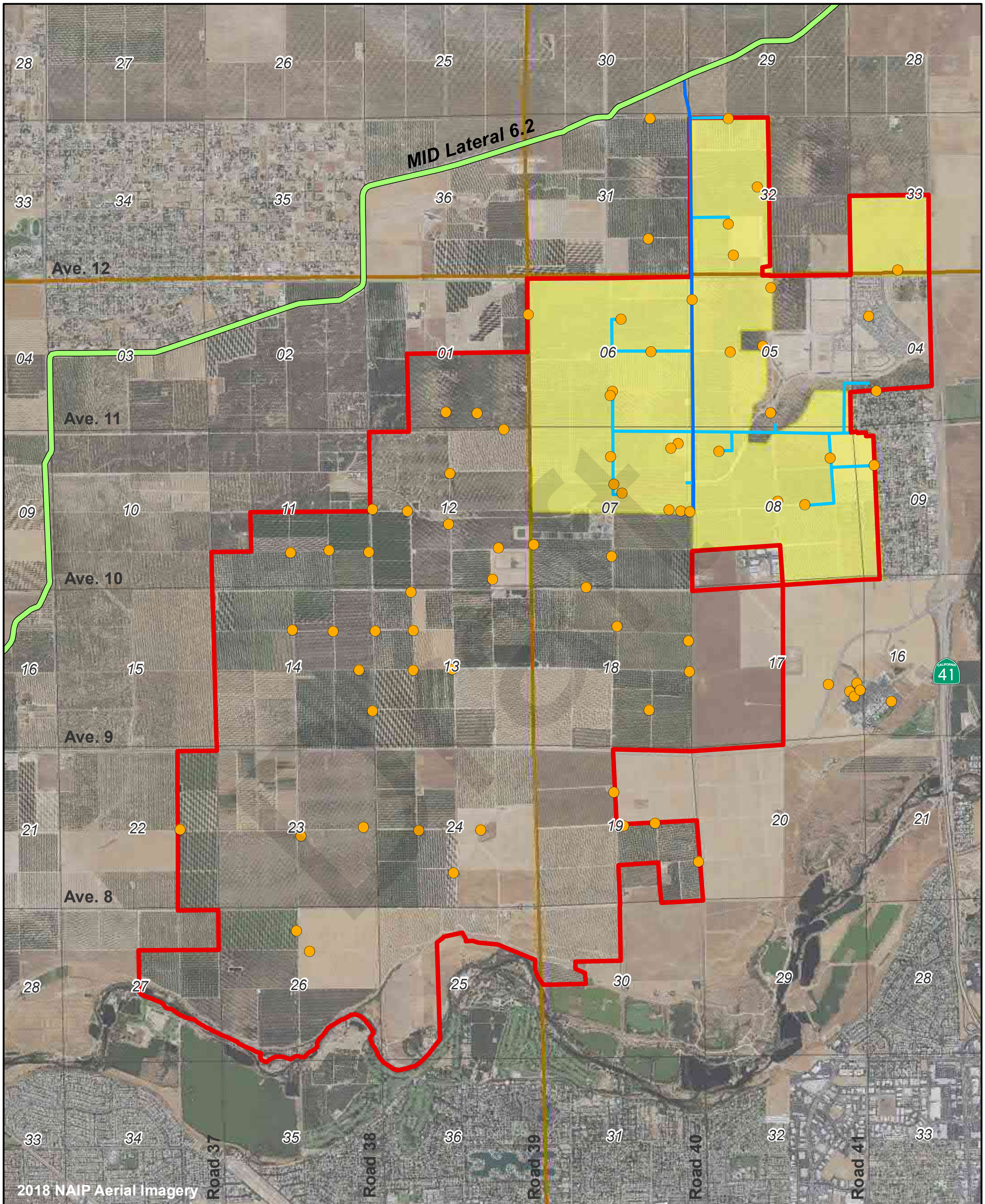
6.2 Expansion of the In-Lieu Pipeline

6.2.1 Project Description

RCWD has access to surface water supplies through three main contracts. These contracts are with MID, USBR, and Wonderful, as discussed in Section 3.3.2. The contract with USBR is for Section 215 water, or flood flows, off of the San Joaquin River and is the most economical source of surface supplies but is highly variable and unreliable due to its dependence on climatic conditions. Furthermore, Section 215 water typically does not occur during peak irrigation season, limiting its use within the RCWD system that relies on delivery of surface supplies to offset groundwater pumping. The contract with MID states that RCWD has the right to purchase Class II water from MID when it exceeds their demand, which generally occurs in wet years and usually during the spring months when irrigation demands are less. It is also recognized that with the enactment of SGMA, MID will look for more opportunities to recharge surface water supplies, which could limit availability to RCWD. Lastly, the contract with Wonderful guarantees a firm supply of up to 7,000 AF/year but comes with a high cost. Most of these contracts were secured around 2006, but prior to 2014, RCWD did not have the infrastructure for importing surface supplies they had secured in their contracts.

In 2014, RCWD received a grant to help pay for a turnout and pipeline from MID Lateral 6.2 to bring the surface water supplies into the north side of the District. The purpose of the pipeline is to mitigate groundwater overdraft by using surface water, when available, in place of groundwater use on approximately 2,500 acres of agricultural land in the RCWD service area. Facilities include a 48-inch diameter main line that runs south for about 2.7 miles and has approximately 5 miles of laterals, connecting to 15 wells (Provost & Pritchard, 2014). The existing system tries to maximize the ability to meet irrigation demands in the summer months of May, June, July and August with the limitations imposed by the contractual obligations with the contract with MID. In other words, the conveyance capacity limitations restrict the potential use of the system to about 6,000 af in these summer months when it is anticipated that the irrigation demands for this same time period would approximate 7,500 af.

A map of the facilities and the current RCWD service area can be seen in **Figure 6-1**. The design maximum capacity of the system is approximately 50 cfs.



Well
Existing Service Area
Root Creek WD
MID Lat. 6.2
Existing Conveyance Pipeline
Existing Lateral

0 0.25 0.5
Miles

PROVOST & PRITCHARD CONSULTING GROUP
EST. 1968
An Employee Owned Company

Root Creek WD

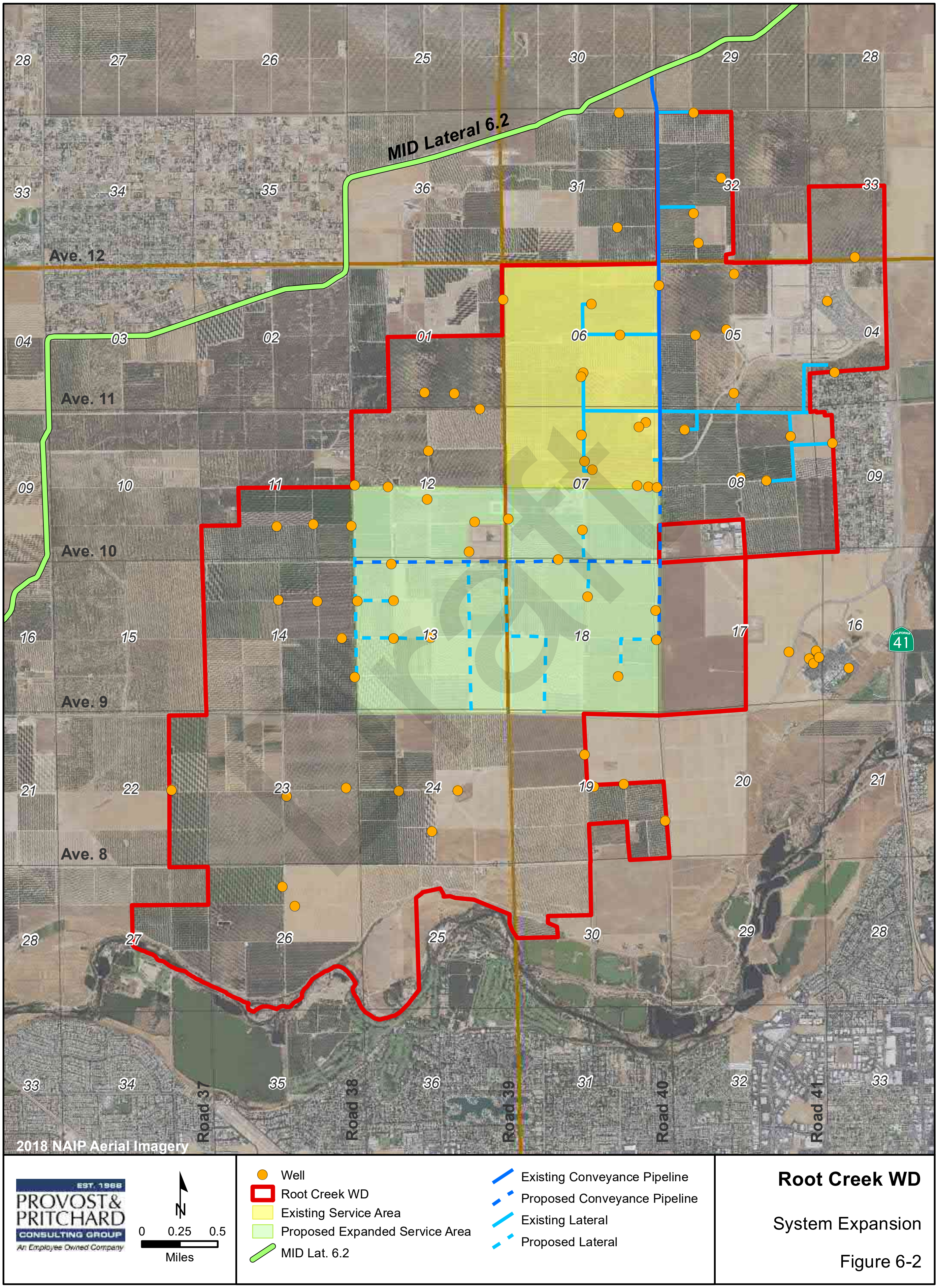
Existing Distribution System

Figure 6-1

8/1/2019: G:\Root Creek WD GSA-2843\284318001-GSP\GIS\Map\RCWD_Distribution_existing.mxd

With the development of the Riverstone community in the northeast corner of the District, approximately 1,200 acres of agricultural land that is presently within the agricultural service area will be converted to municipal use. As land is developed to municipal uses, additional agricultural land within the RCWD service area is planned to receive surface water. A map showing the potential master plan of the agricultural system is shown on **Figure 6-2**.

The mainline pipe extension will continue to be a 48-inch diameter reinforced concrete pipeline with gravity flow. The lateral lines will be 12-inch PVC pipe connecting to approximately 20 well sites. With the expansion, the total service area to agricultural lands will be approximately 3,000 acres, creating an opportunity to serve an agricultural demand of about 10,400 AF annually. However, due to contractual agreements with MID over the use of Lateral 6.2, the maximum conveyance during prime irrigation months could be the limiting factor rather than crop demand.



Root Creek WD

System Expansion

Figure 6-2

8/1/2019: G:\Root Creek WD GSA-2843\284318001-GSP\GIS\Map\system_expansion.mxd

6.2.2 Project Benefits

The general benefit of this project is the continued ability to supply farmers with surface water to directly replace groundwater pumping, thus decreasing overall groundwater overdraft. By mitigating groundwater overdraft, increased pumping costs and diminishing water quality may be avoided. The volume of surface water that may be realized on an annual average basis was estimated by creating a surface water simulation based on historical data, shown in **Table 6-4**. Information on volume of flood water released can be found as far back as 1966. By choosing a 23-year period that is close to representing a typical hydrologic period, the data can be projected into the future. In this case, the years 1965-1988 were used to estimate future hydrology. In months where Section 215 water is available, it is assumed that either the full agricultural demand will be met, or the maximum conveyance of the system will be used depending on the limiting factor. It is also assumed that in years when there is no flood release, or otherwise dry years, MID will not have excess Class II water available for sale, and thus the only surface supply available will be from the contract with Wonderful. The surface water supply simulation suggests that RCWD may be able to bring in approximately 5,231 AF on an average annual basis using the existing and proposed system as a whole.

6.2.3 Measurable Objectives

The main objective of this project is to expand the service area of irrigated lands that utilize the Root Creek In-Lieu Groundwater Recharge pipeline in the north side of the district, thus increasing its capacity to accept surface water. It is anticipated that the project will provide the District with the ability to bring in an additional 1,831 AF on an average annual basis.

6.2.4 Circumstances for Implementation

Groundwater level change are most significant in the northern part of the District. Decreased pumping or in-lieu recharge) located in this area are expected to have the most significant benefit if practiced in this same area. In order to stabilize groundwater levels and achieve the sustainability goal of this Plan, this project would have the most significant contribution. Thus, this project has been determined as high priority by the board members of RCWDGSA and will be implemented when the necessary funding is obtained. No other circumstances are necessary for implementation.

Table 6-4 Surface Water Supply Simulation Based on Extended Pipeline System

Calendar Year	Percent Water Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
	Project Limitations	Conveyance max 3,069 AF	Conveyance max 2,772 AF	Conveyance max 3,069 AF	Conveyance max 2,970 AF	Conveyance max 1,535 AF	Ag Demand 1,912 AF	Ag Demand 2,097 AF	Ag Demand 1,852 AF	Conveyance max 2,970 AF	Conveyance max 3,069 AF	Conveyance max 2,970 AF	Conveyance max 3,069 AF	
		Ag Demand 0 AF	Ag Demand 0 AF	Ag Demand 305 AF	Ag Demand 890 AF	Ag Demand 1,491 AF	Conveyance max 1,485 AF	Conveyance max 1,535 AF	Conveyance max 1,535 AF	Ag Demand 1,230 AF	Ag Demand 573 AF	Ag Demand 81 AF	Ag Demand 0 AF	
2017	63	0	0	0	0	0	0	900	900	0	0	0	0	1,800
2018	71	0	0	0	0	0	0	900	900	0	0	0	0	1,800
2019	176	0	0	305	890	1,491	1,485	1,535	1,535	1,230	573	81	0	9,125
2020	47	0	0	0	0	0	0	900	900	0	0	0	0	1,800
2021	220	0	0	305	890	1,491	1,485	1,535	1,535	1,230	573	81	0	9,125
2022	79	0	0	0	0	0	0	900	900	0	0	0	0	1,800
2023	77	0	0	0	0	0	0	900	900	0	0	0	0	1,800
2024	57	0	0	0	0	0	0	900	900	0	0	0	0	1,800
2025	112	0	0	305	890	1,491	1,485	1,535	1,535	1,230	573	81	0	9,125
2026	119	0	0	305	890	1,491	1,485	1,535	1,535	1,230	573	81	0	9,125
2027	98	0	0	305	840	1,491	1,485	1,535	1,535	1,230	573	81	0	9,075
2028	34	0	0	0	0	0	0	900	900	0	0	0	0	1,800
2029	20	0	0	0	0	0	0	900	900	0	0	0	0	1,800
2030	185	0	0	305	890	1,491	1,485	1,535	1,535	1,230	573	81	0	9,125
2031	100	0	0	305	840	1,491	1,485	1,535	1,535	1,230	573	81	0	9,075
2032	162	0	0	305	890	1,491	1,485	1,535	1,535	1,230	573	81	0	9,125
2033	58	0	0	0	0	0	0	0	0	0	0	0	0	0
2034	181	0	0	305	890	1,491	1,485	1,535	1,535	1,230	573	81	0	9,125
2035	253	0	0	305	890	1,491	1,485	1,535	1,535	1,230	573	81	0	9,125
2036	111	0	0	305	840	1,491	1,485	1,535	1,535	1,230	573	81	0	9,075
2037	70	0	0	0	0	0	0	0	0	0	0	0	0	0
2038	151	0	0	305	890	1,491	1,485	1,535	1,535	1,230	573	81	0	9,125
2039	42	0	0	0	0	0	0	0	0	0	0	0	0	0
2040	47	0	0	0	0	0	0	900	900	0	0	0	0	1,800
Averages	**106**	0	0	153	439	746	743	1,105	1,105	615	287	41	0	**5,231**

*Note: Blue cells indicate Section 215 water, yellow cells indicate MID water, orange cells indicate Wonderful water

6.2.5 Permitting and Regulatory Process

The following agencies have the following requirements for projects to be completed in the District.

- *State Water Resources Control Board, Stormwater Pollution Prevention Plan (SWPPP)* - for construction that disturbs more than five acres
- *Madera County, Encroachment Permit* – for the crossing of County Road rights-of-way.
- *San Joaquin Valley Air Pollution Control District (SJVAPCD)* – for preparation of a Dust Control Plan for construction with disturbs a surface area of 5 acres or more
- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval

6.2.6 Project Schedule

This project is still in its conceptual phase and will need to continue through the design process before bidding for construction can be accomplished. The design process may take up to 10 months, and the permitting and construction process should take no longer than one year.

6.2.7 Legal Authority

RCWD has the legal authority to raise funds through the use of groundwater pumping fees, special assessment fees on all properties within its borders, and by applying for State and Federal grants. RCWD also reserves the right to operate and maintain public utilities, including the surface water supply line. Agreements with landowners will need to be made for right-of-way during construction.

6.2.8 Project Cost Estimate

A preliminary engineer's opinion of probable construction costs has been completed based on similar projects and level of design and is shown in **Table 6-5**. The total cost of the project is estimated at about $7.7 million. Assuming a 5% interest rate loan, annualized over a 30-year period, the annual repayment cost is expected to be about $500,000 (**Table 6-6**). Construction costs include a 25 percent contingency due to the current level of design for the project.

Table 6-5 Summary of Probable Construction Costs for Extension of In-Lieu Pipeline

Project Section	Length (Feet)	Cost Estimate
Pipe Segment A (48" dia.)	5,280	$2,201,000
Pipe Segment B (48" dia.)	10,560	$3,765,000
Laterals (12" dia.)	26,160	$1,757,000
	Total:	**$7,723,000**

Table 6-6 Summary of Cost per AF

Extension of Root Creek In-Lieu Pipeline Project			
Total Capital Cost	Capital Repayment	Annual Yield AF	Capital Cost Per AF
$ 7,723,000	$ 502,000	1,831	$ 274

The tables shown above do not include price of water in the estimations. Using the surface supply simulation from **Table 6-4** and contractual costs, the average annual cost of surface water supplies may be around $310 per AF.

6.2.9 Management of groundwater extractions and recharge

The project will include flow meters to monitor in lieu recharge on a yearly basis.

6.3 Intentional Recharge Projects

6.3.1 Project Description

RCWD has three different intentional recharge projects that have been developed since the formation of the district. These consist of the following:

- Recharge in the unused Wastewater Treatment Plant Disposal ponds along Avenue 10
- Recharge along Root Creek with the use of control structures to pond water
- Recharge in intentional recharge basins on property owned outside of the District. (80 acres in Sec 16 T12S R19E)

RCWD has access to surface water supplies through three main contracts as discussed in the previous sections. RCWD recognizes that more opportunities exist for diversion of additional surface supplies during January through March, when irrigation demands are lower. This would result in the development of intentional recharge projects that would intentionally recharge water in the winter months with later extractions in the summer months. The three projects in this section fall into this category and based upon soil conditions and land availability could amount to a total of about 150 acres. If percolation rates of 0.5 feet/day could be achieved, then an upper limit of about 75 AF/day could be realized. Assuming the projects could be operated for 30 days every other year, then an additional supply of about 1,050 AF/year could be generated.

6.3.2 Project Benefits

The general benefits these projects would bring to the District is the opportunity to recharge surface water supplies when hydrologic events make supplies available and when irrigation demands are low. Recharging water when demand is low will help to offset the drawdown from pumping later on and will decrease overall overdraft. By mitigating groundwater overdraft, increased pumping costs may be avoided. The volume of surface water that may be realized on an annual average basis was estimated in the project description.

6.3.3 Measurable Objectives

The main objective of these projects is to allow for the opportunity to recharge surface supplies during winter season when irrigation demands are low. The objective would be validated by the measurement of surface water supplies delivered and recharged in these facilities. At this time the objective is 400 af/yr of supplies developed using this method. Activities will continue to identify and develop if this method proves economically and technically viable.

6.3.4 Circumstances for Implementation

The district will continue developing information to support implementation of these projects. Site specific investigations will be made, and applications will be submitted to State Fish and Wildlife regarding these intentional recharge programs to gain applicable permits.

6.3.5 Permitting and Regulatory Process

The following agencies have the following requirements for projects to be completed in the district.

- *California State Fish and Wildlife* – Review and application to the agency to modify and/or construct facilities in Root Creek
- *State Water Resources Control Board, Stormwater Pollution Prevention Plan (SWPPP)* - for construction that disturbs more than five acres
- *Madera County, Encroachment Permit* – for the crossing of County Road right-of-ways
- *San Joaquin Valley Air Pollution Control District (SJVAPCD)* – for preparation of a Dust Control Plan for construction with disturbs a surface area of 5 acres or more
- *California Environmental Quality Act (CEQA)* – compliance with CEQA for project approval

6.3.6 Project Schedule

This project is still in its conceptual phase and will need to continue through the design process before bidding for construction can be accomplished. The design process may take up to 10 months, and the permitting and construction process should take longer than one year.

6.3.7 Legal Authority

RCWD has the legal authority to raise funds through the use of groundwater pumping fees, special assessment fees on all properties within its borders, and by applying to state and federal grants. RCWD also reserves the right to operate and maintain public utilities, including the surface water supply line. Agreements with landowners will need to be made for right-of-way during construction.

6.3.8 Project Cost Estimate

A preliminary engineer's opinion of probable construction costs for each of the projects has been completed based on similar projects and level of design and is shown in **Table 6-7.** The total cost of the projects is estimated at about $6.3 million. Assuming a 5% interest rate loan, annualized over a 30-year period, the annual repayment cost is expected to be about $400,000 (**Table 6-7**). Construction costs include a 25 percent contingency due to the current level of design for the project.

Table 6-7 Summary of Probable Construction Costs for Extension of In-Lieu Pipeline

Project	Estimated Recharge Potential	Cost Estimate
WWTP Avenue 10	300	$2,000,000
Root Creek Control Structures	150	$ 300,000
Out of District 80 acres	600	$4,000,000
Total:	**1,050**	**$6,300,000**

Table 6-8 Summary of Cost per AF

Extension of Root Creek In-Lieu Pipeline Project				
Project	Total Capital Cost	Capital Repayment	Annual Yield AF	Capital Cost Per AF
WWTP Ave 10	$ 2,000,000	$130 ,000	300	$ 433
Root Creek Structures	$ 300,000	$19,500	150	$130
Out of District 80 acres	$4,000,000	$260,000	600	$433

The tables shown above do not include price of water in the estimations.

6.3.9 Management of Groundwater Extractions and Recharge

The project will include flow meters to monitor recharge volumes to the projects.

6.4 Management Actions

GSAs have a variety of tools which can be used to achieve sustainable groundwater management. The projects previously identified in this chapter primarily focus on the capture and use of surface water supplies within the GSA. Alternatively, there are other management actions which primarily focus on the reduction of groundwater demand and increase of data collection including education and outreach, regulatory policies, incentive-based programs, and enforcement actions.

The legal authority and basis for management actions are outlined in SGMA and related provisions. SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Chapters 5, 8, and 9 respectively. These GSA authorities include adopting regulations, regulating groundwater extractions, imposing fees, monitoring, enforcing programs, and more. Though the law grants the GSA these powers, the pursuit and implementation of the projects and management actions is the GSA's responsibility. The GSA may enforce their legal authority to the extent necessary to achieve sustainable groundwater management for all beneficial users within the GSA.

The RCWD adopted a number of programs prior to the enactment of SGMA and continues to advance policies related to the use and sustainable management of groundwater. These management actions are identified in Table 6-1.

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7 Plan Implementation

As identified and discussed previously, the RCWDGSA has continued to monitor the groundwater resources of the District. The RCWD has developed a groundwater management program under previous legislation and has measured groundwater since its formation and has gathered records of water levels in wells that predate the formation of the District. With the establishment of the RCWDGSA, this is a new agency that is working cooperatively with RCWD and will continue to monitor and now manage the groundwater resources of the region. The plan is being implemented under the existing authorities of both agencies and hopefully through coordinated activities with County of Madera GSA the groundwater resources of the region will now be managed.

7.1 Estimate of GSP Costs

Developing new water resources is not cheap. The RCWDGSA is fortunate in location to have access to surface water facilities that allow for cost effective facilities to be constructed from surface water systems, as well as having access to surface water supplies. Many are not so fortunate in the San Joaquin Valley. The following table lists the historic, anticipated costs for development of the GSP as well as planned implementation of projects.

Table 7-1.1 Root Creek Water District GSP Past Costs

Root Creek Water District GSP Costs			
Item	**Description**	**Cost**	**Result**
1	Groundwater Monitoring and testing	$400,000	Complete
2	Planning and Organizational	$2,100,000	Complete
	District Formation		
	Planning		
	Operations		
	Contractual and Permitting		
	Facilities	$5,300,000	Complete
	Surface Water Supplies	$4,531,000	Complete
	Total	**$12,331,000**	

Table 7-2 Root Creek Water District GSP Present and Estimated Future Costs

Root Creek Water District GSP Estimated Costs			
Item	**Description**	**Cost**	**Result**
1	GSA Formation	$10,000	Complete
2	Regional Coordination	$100,000	In progress
3	GSP Plan	$400,000	In progress
4	Projects		
	Pipeline	$7,723,000	Planned
	Recharge	$500,000	Planned
5	Management Actions		Complete
	Total Capital	**$8,733,000**	

Table 7-3 Root Creek Water District GSP Present and Estimated AnnualCosts

Root Creek Water District GSP Estimated Costs		
Item	Item	Item
1	Monitoring	$45,000
2	Planning and Organizational	$20,000
3	Surface Water Supplies	$2,500,000
	Total	**$2,565,000**

Of note, the annual surface water purchases are anticipated to be the single most significant cost component of the plan.

7.2 Identify Funding Alternatives

The Madera Subbasin has qualified for funding for developing and pursuing planning for the development and writing of the GSP. RCWDGSA has been a part of this effort and the RCWDGSA is grateful. Hopefully, Proposition 1 grant funding will be available to offset some of the capital improvement costs. Because Proposition 3 did not pass in this last election, there is some doubt that there will be grant or low interest loan money available to help offset some of the costs.

7.3 Schedule for Implementation

As stated, it is the plan of RCWDGSA and RCWD to use the existing agricultural conveyance and delivery system to annually divert surface water supplies. Combined with the conversion of agricultural land to municipal uses as well as recharge and recycling wastewater, the combined efforts are expected to result in a sustainable groundwater condition beneath the district. All other projects and management actions would be employed should these activities fail to result in the intended result or be added so as to decrease the cost of the activity. These programs were initiated with the approval by the County of Madera with the approval of the Specific Plan for what was then known as Gateway Village and has become known as Riverstone. With the acquisition of surface water supplies, the construction of the in lieu pipeline in 2014, the passage of the Proposition 218 election in 2016, the RCWD and the RCWDGSA are well on their way to implementing the projects, actions and financial plan for sustainability.

7.4 Data Management system

The existing system will continue to be utilized. In cooperation with the neighboring GSAs and the Madera Subbasin, the expectation is that over time the system will be modified to allow easier sharing of data within the region.

7.5 Annual Reporting

The RCWDGSA will report annually the result of operations as well as the result of groundwater level and storage changes.

7.6 Periodic Evaluations

During the course of normal operations, RCWD staff will continue to review its policies on surface water use and delivery, as well as operations so as to respond to questions and management goals. RCWD staff will also cooperate with neighboring GSAs in meeting the objectives set forth herein.