California Rice

May 2, 2016

Ms. Ashley Peters, PE
Water Resource Control Engineer
Central Valley Regional Water Quality Control Board
11020 Sun Center Drive, Suite 200
Rancho Cordova, CA 95670

Dear Ms. Peters:

RE: Submittal of the Groundwater Trend Monitoring Workplan and Data Gap Assessment Plan per requirement of the California Regional Water Quality Control Board Central Valley Region, Order No. R5-2014-0032, Waste Discharge Requirements General Order for Sacramento Valley Rice Growers

The California Rice Commission (CRC) is a statutory organization representing the state's rice industry encompassing all rice growers, 40 millers, and approximately 500,000 acres (431,000 acres resulting from drought in 2015) of farmland. For purposes of managing water quality programs, the CRC represents rice growers as a commodity specific coalition in the Central Valley through Waste Discharge Requirements General Order R5-2014-0032 29 for Sacramento Valley Rice Growers (Rice WDR).

Please accept the Groundwater Trend Monitoring Workplan and Data Gap Assessment Plan final submittal. The data and information to develop the workplan are derived from public sources, and therefore the following statement is accurate:

> *"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel or represented Growers properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for knowingly submitting false information, including the possibility of fine and imprisonment for violations."*

Please contact me if you have any questions, need additional information, or more background materials. The CRC is a credible resource for information on the California rice industry.

Sincerely,

Roberta L. Firoved

Roberta L. Firoved
Industry Affairs Manager

Enclosure: Ground

F I N A L

Groundwater Trend Monitoring Workplan and Data Gap Assessment Plan

Prepared for

Central Valley Regional Water Quality Control Board

On Behalf of

California Rice Commission

March 2016

CH2M HILL
2485 Natomas Park Drive
Suite 600
Sacramento, CA 95833

Contents

Acronyms and Abbreviations

°C	degrees Celsius
µmhos/cm	micromhos per centimeter
µS/cm	microSiemen(s) per centimeter
amsl	above mean sea level
bgs	below ground surface
CASGEM	California Statewide Groundwater Elevation Monitoring
CRC	California Rice Commission
DO	dissolved oxygen
DWR	California Department of Water Resources
EC	electrical conductivity
ft	foot (feet)
GAR	Groundwater Assessment Report
GIS	geographic information system
GMAW	Groundwater Monitoring Advisory Workgroup
HVA	hydrogeologically vulnerable area
ID	identification
LTILRP	Long-term Irrigated Lands Regulatory Program
MCL	Maximum Contaminant Level
mg/L	milligram(s) per liter
MRP	Monitoring and Reporting Program
NAWQA	National Water Quality Assessment
NO_3	nitrate
NRCS	Natural Resource Conservation Service
PMW	Refers to Yuba County Water Agency Monitoring Wells
QAPP	Quality Assurance Project Plan
RWQCB	Central Valley Regional Water Quality Control Board
SSURGO	Soil Survey Geographic Database
SWRCB	California State Water Resources Control Board
TDS	total dissolved solids
USGS	U.S. Geological Survey
WDL	Water Data Library
YCWA	Yuba County Water Agency

SECTION 1

Introduction

The California Rice Commission (CRC) is a statutory organization representing approximately 2,500 rice farmers who farm approximately 550,000 acres of Sacramento Valley rice fields. The CRC is an approved Coalition Group under the Central Valley Regional Water Quality Control Board's (RWQCB) Irrigated Lands Regulatory Program *Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands*. A rice-specific Waste Discharge Requirements Order R5-2014-0032 (Order) was adopted in March 2014 (RWQCB 2014). The CRC's Monitoring and Reporting Program (MRP) corresponds to the Order and lists the reports required for submittal and approval to comply with the Order.

Per the Order, this document includes a Groundwater Trend Monitoring Workplan, described in Section 2, and a Data Gap Assessment Plan, provided in Section 3. The Data Gap Assessment Plan addresses the groundwater quality data gaps in Yuba County and the fringe areas and proposes elements to resolve the data gaps, as identified in Section 7.2.3 of the *Rice-Specific Groundwater Assessment Report* (GAR) (CRC 2013). Monitoring well reports are included in Appendix A, a groundwater quality assurance project plan (QAPP) is included in Appendix B, and the data gap analysis is provided in Appendix C.

SECTION 2

Groundwater Trend Monitoring Workplan

This section discusses groundwater quality trend monitoring under the CRC's MRP. Per the Order, this section describes the CRC's approach for trend monitoring, implementation, and data review, as well as presents the well characteristic details.

2.1 Background and Purpose

A GAR is required under the RWQCB's Long-term Irrigated Lands Regulatory Program (LTILRP), and CRC's rice-specific GAR (CRC 2013) was approved by the RWQCB in July 2013. The GAR provides a comprehensive groundwater quality analysis for areas farming rice and includes data from a network of 28 rice wells developed, maintained, and sampled by the U.S. Geological Survey (USGS). Because of the network's proximity to the rice fields and its representation of shallow groundwater, the USGS rice well network has been useful for assessing shallow groundwater quality underneath the rice fields.

In 1997, 28 rice wells were installed by the USGS. Since then, several of the wells have been destroyed or replaced and new wells have been installed to complement the original wells. Currently, 24 wells are active and used for water level monitoring and groundwater quality sampling. After two full network sampling events, the USGS used five network wells for trend monitoring as part of the USGS National Water Quality Assessment (NAWQA) Cycle II groundwater monitoring activities (from 2004 to 2014). Under the current monitoring program, now in Cycle III (2014 to 2024), water level monitoring is conducted bi-annually. In 2017, water quality monitoring will include the full network of active wells.

Based on the network's representation of shallow groundwater quality under the rice fields, a subsample of the USGS rice well network is used for rice-specific LTILRP MRP trend monitoring. The USGS has informally confirmed that the CRC may collaborate with the NAWQA team in Sacramento to obtain its sampling results and gain access to these wells for further sampling.

Figure 2-1 shows the current USGS rice well monitoring network.

2.2 Objectives

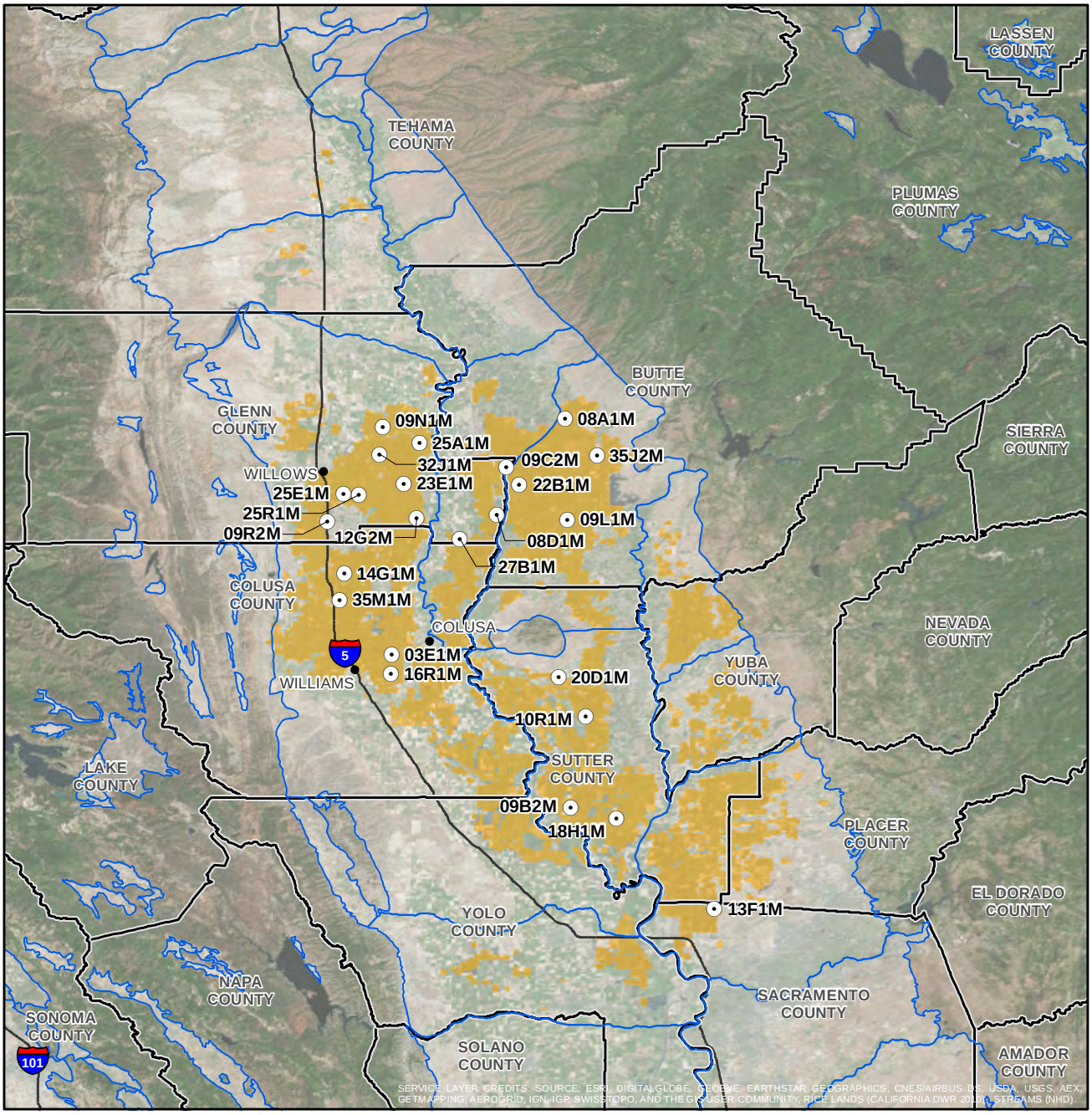
The objectives of Groundwater Quality Trend Monitoring Program are outlined in the MRP as follows:

- To determine current water quality conditions of groundwater relevant to rice operations.
- To develop long-term groundwater quality information that can be used to evaluate the regional effects (that is, not site-specific effects) of rice operations and its practices.

The Groundwater Monitoring Advisory Workgroup (GMAW) developed a list of seven questions to be answered through groundwater monitoring. Answers to each question were provided in Appendix I of the GAR (CRC 2013). However, trend monitoring was developed with the objective of corroborating and/or clarifying those answers, especially to the following GMAW questions:

1. *What are irrigated agriculture's impacts to the beneficial uses of groundwater and where has groundwater been degraded or polluted by irrigated agricultural operations (horizontal and vertical extent)?*

4. *What are the trends in groundwater quality beneath irrigated agricultural areas (getting better or worse) and how can we differentiate between ongoing impact, residual impact (vadose zone) or legacy contamination?*



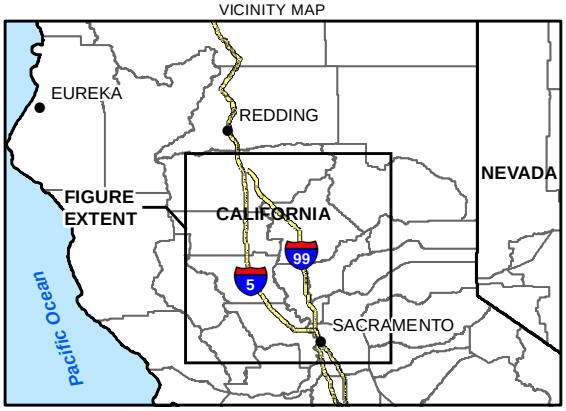
LEGEND

- ACTIVE USGS RICE MONITORING WELL
- COUNTY
- RICE LAND
- GROUNDWATER BASIN

NOTE:

DATA SOURCES: GROUNDWATER BASINS, RICE LANDS (CALIFORNIA DWR 2010); COUNTY (CAL FIRE) USGS RICE WELLS (USGS). HORIZONTAL DATUM IS NAD83.

VICINITY MAP



California Rice

0 20 40
Miles

N

FIGURE 2-1
Current USGS Rice Wells Monitoring Network
Groundwater Trend Monitoring Workplan
California Rice Commission

In addition, trend monitoring may help to answer GMAW Question 3 by further validating the answer provided in the GAR:

3. *To what extent can irrigated agriculture's impact on groundwater quality be differentiated from other potential sources of impact (e.g., nutrients from septic tanks or dairies)?*

Other methods such as isotope tracing and groundwater age determination may also be necessary to differentiate sources and fully answer GMAW Question 3. The MRP does not require these advance source methods because they are not necessary to determine compliance with the Order.

2.3 Approach

To reach the stated objectives for the Groundwater Quality Trend Monitoring Program, the CRC proposes the groundwater quality monitoring well network, sampling procedures, and data analysis presented in this Workplan. The active USGS monitoring wells being used for trend monitoring were specifically identified to yield data that can be compared with historical and future data to evaluate long-term shallow groundwater quality trends in areas where rice is farmed.

2.4 Implementation

The following subsections identify well detail information, sampling procedures, schedule, data analysis, and data reporting.

2.4.1 Monitoring Well Network

As outlined in the MRP, the CRC selected 20 of the active wells in the USGS monitoring network to be part of the trend monitoring network. These wells were chosen based on a detailed land use representation analysis that was performed for each of the 28 original USGS rice wells. The initial analysis is described in Appendix E-3 of the GAR (CRC 2013) and an updated summary is provided below. While most of the USGS rice wells are surrounded by land used to grow rice and, therefore, are representative of rice agriculture, a few of the wells are located closer to the edges of rice fields and might be influenced by other land uses.

2.4.1.1 USGS Rice Wells Trend Monitoring Network Rationale

The rationale for using certain USGS Rice Wells (Rice Wells) for the Trend Monitoring program is described with consideration of the pertinent features of each of the wells, including:

- Location relative to rice fields
- Other land uses besides rice farming surrounding the well, such as
  - Agricultural uses other than rice
  - Non-agricultural uses (e.g. riparian vegetation)
  - Urban and rural residential development

The relative location of each well on the groundwater flow path was assessed by reviewing regional groundwater contour maps and the regional locations of the wells (Figure 2-1). The nitrate concentrations as monitored and reported by the USGS for the wells were also summarized from the Rice-Specific GAR (CRC 2013). Appendix E-3 of the GAR showed aerial maps of each well location, which also provide a snapshot of the land uses within a few miles of each well. These characteristics were used to confirm that the Rice Wells adequately represent groundwater quality beneath rice fields. More recent imagery (2015) was reviewed to ensure consistency with the 2013 GAR mapping information. Table 2-1 provides a summary of the rationale and adequacy of the wells to represent rice farming influences.

Table 2-1. Groundwater Quality Trend Monitoring Well Identification Rationale

California Rice Commission Groundwater Trend Monitoring Workplan

DWR Well ID	Mapping ID	USGS Rice Well ID[a]	Location Relative to Rice Fields	Groundwater Quality[b]	Representation
012N003E18H001M	18H1M	2	Within and surrounded by rice	Nitrate <0.06 mg/L	Rice Farming
012N002E09B002M	09B2M	3	Within and surrounded by rice	Nitrate <5.97 mg/L	Rice Farming
014N002E10R001M	10R1M	6	Within and surrounded by rice to N and S. Agricultural fields and Yuba city to E and NE.	Nitrate <1 mg/L	Rice Farming and Other Land Uses
015N002W16R001M	16R1M	8	Within and surrounded by rice. Colusa NWR in close proximity.	Nitrate <1 mg/L	Rice Farming
015N002W03E001M	03E1M	9	Within and surrounded by rice. Delevan NWR in close proximity.	Nitrate <1 mg/L	Rice Farming
017N003W35M001M	35M1M	10	Within and surrounded by rice. Close to Coast Range on W. Delevan NWR to NE.	Nitrate <0.28 mg/L	Rice Farming
017N002W14G001M	14G1M	11	Within and surrounded by rice. Close to Coast Range on W. Delevan NWR to NE.	Nitrate <0.33 mg/L	Rice Farming
018N001W27B001M	27B1M	12	Bordered by rice on N and S. Other agriculture surrounding.	Nitrate <0.05 mg/L	Some rice farming, and other Land Uses
018N002E09L001M	09L1M	15	Within and bordered by rice on N and S. Sierra foothills and urban developments on E.	Nitrate <0.8 mg/L	Rice Farming
018N002W12G002M	12G2M	16	Within and surrounded by rice.	Nitrate <0.36 mg/L	Rice Farming
018N001E08D001M	08D1M	17	Within and mostly surrounded by rice.	Nitrate <0.08 mg/L	Rice Farming
019N003W25R001M	25R1M	18	Within and surrounded by rice. Sacramento NWR in close proximity.	Nitrate <0.85 mg/L	Rice Farming
019N003W25E001M	25E1M	19	Within and surrounded by rice. Sacramento NWR in close proximity.	Nitrate <0.3 mg/L	Rice Farming
019N001E22B001M	22B1M	21	Within and surrounded by rice.	Nitrate <1.83 mg/L	Rice Farming
019N002W23E001M	23E1M	22	Within and surrounded by rice	Nitrate <0.06 mg/L	Rice Farming
019N001E09C002M[c]	09C2M	23	Within and surrounded by rice.	Nitrate <0.21 mg/L	Rice Farming
020N002E35J002M[d,e]	35J2M	24	Within and surrounded by rice. Sierra foothills and urban developments on E.	Nitrate <2.4 mg/L	Rice Farming and Other Land Uses

Table 2-1. Groundwater Quality Trend Monitoring Well Identification Rationale

California Rice Commission Groundwater Trend Monitoring Workplan

DWR Well ID	Mapping ID	USGS Rice Well ID[a]	Location Relative to Rice Fields	Groundwater Quality[b]	Representation
020N002W32J001M	32J1M	25	Surrounded by rice.	Nitrate <3.82 mg/L	Rice Farming
020N002W25A001M	25A1M	26	Within and surrounded by rice to W. Sacramento River on E.	Nitrate <2.25 mg/L	Rice Farming and Other Land Uses
020N002E08A001M	08A1M	28	Within and surrounded by some rice. Sierra foothills to E.	Nitrate <1.84 mg/L	Rice Farming and Other Land Uses

[a] USGS Rice Wells from (USGS 2001).

[b] Groundwater quality sampling data by USGS between 1997 and 2010.

[c] Replacement for the original Rice Well 23; water quality is from old well, within close proximity to new well.

[d] Replacement for the original Rice Well 24; water quality is from old well, within close proximity to new well.

[e] New DWR Well ID for this replacement well is not currently available. Construction information in this report is updated to reflect the new well.

Notes:

N = North

S = South

E = East

W = West

NWR = National Wildlife Refuge

A few of the active USGS rice wells were not chosen for the trend monitoring network for the following reasons:

- Well is located in close proximity to other land uses, such as urban areas upgradient of the well, and therefore, is not entirely representative of rice agriculture (for example, Well 13F1M shown on Figure 2-1).
- Well 20D1M is located on the edge of rice fields in the northern Sutter Basin, close to the Sutter Buttes. A vast area of unused and other agricultural land to the north and urban development of Sutter to the northeast may influence this well's water quality. In addition, a well completed in similar soil conditions and more representative of agriculture is available to the south (Well 10R1M).
- Well 09N1M is located on the northern edge of the Glenn County rice fields and downgradient of other large agricultural land uses, such as dairies, which might influence the well's water quality. Two other wells are located south of this well that are more representative of rice agriculture.

2.4.1.2 Modifications to Trend Monitoring Network

The 20 USGS rice wells originally identified for the CRC's trend monitoring network are shown in Table 5 of the MRP. Since the selection of the 20 wells for this network, the USGS has made some changes to its valley-wide rice well network through regular maintenance of their well network. Two of the trend monitoring network wells are affected, as follows:

- Well 20 (019N001E20R001M; see MRP Table 5) was abandoned; as a replacement, formerly abandoned well 019N001E09C001M was re-drilled in 2006 at a site approximately 100 feet south of the old well. Therefore, the CRC proposes to use this well for the trend monitoring network to replace the original Well 20. This new well is numbered 019N001E09C002M and is shown as well 09C2M on Figure 2-2.
- Well 24 (020N002E35J002M; see MRP Table 5) has been re-drilled approximately 50 feet east of the old well location. This new well will replace the original Well 24 in the trend monitoring network (Mapping ID 35J2M).

Figure 2-2 shows the revised groundwater quality trend monitoring network in the context of rice land use extent. Further information on these wells is provided in the following sections.

2.4.1.3 Well Details

Table 2-2 provides basic information for each well in the trend monitoring network. Information on depth to water and well seals, along with other applicable and available well data, are provided in Appendix A.

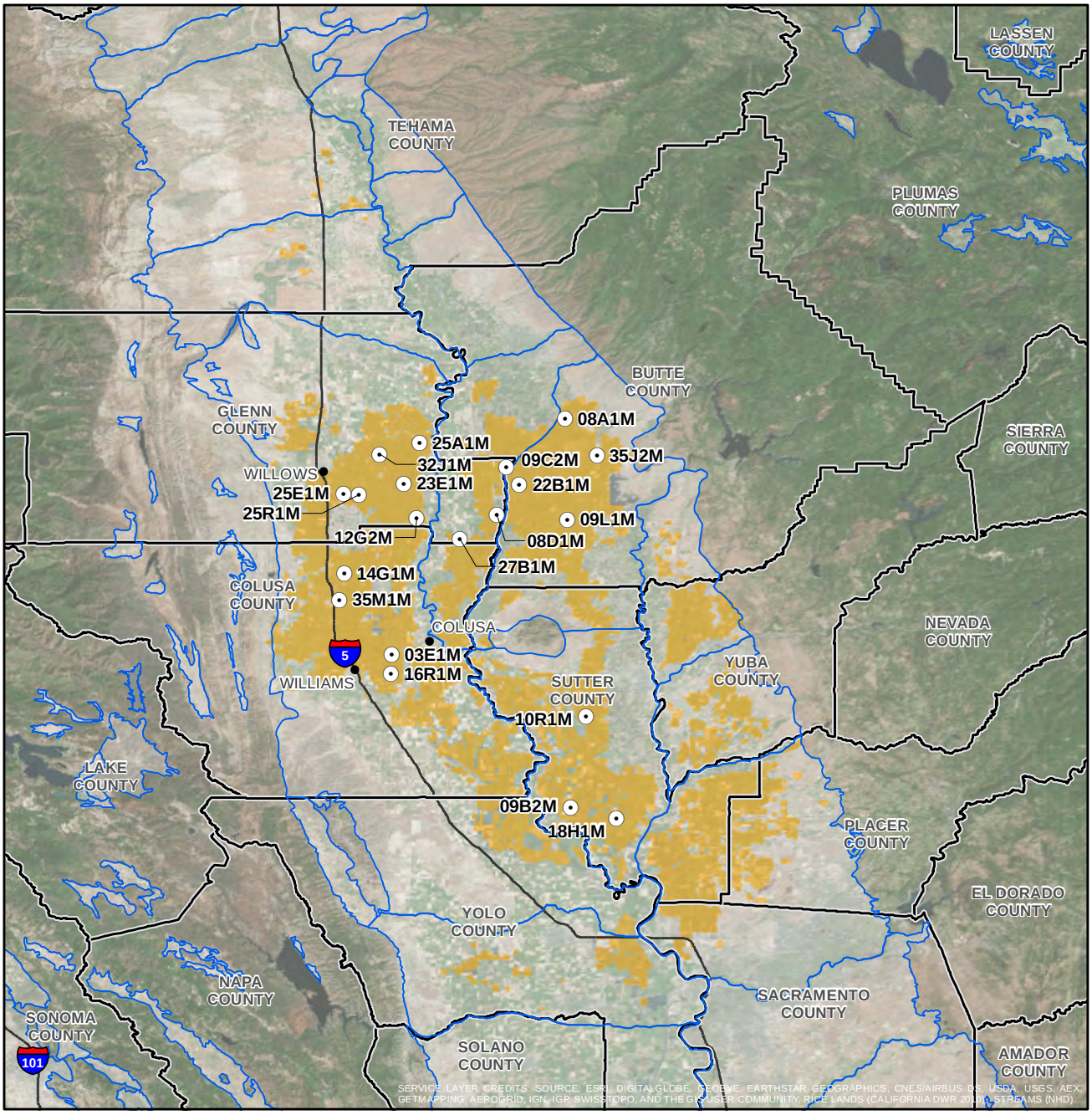
2.4.2 Sampling Procedures

Table 2-3 lists the monitoring parameters and units grouped according to the required monitoring frequency.

Quality assurance procedures for this trend monitoring workplan are written as a groundwater sampling supplement to the surface water *Quality Assurance Project Plan for California Rice Commission Water Quality Programs* (CRC 2015). The groundwater sampling supplement is attached to this Workplan in Appendix B.

2.4.3 Sampling Schedule

The GAR had originally identified seven USGS Rice Wells to be included in the rice-specific Trend Monitoring network (as described in Section 7.2 of the GAR [CRC 2013]). Through negotiation with RWQCB, a compromise was reached to monitor 20 wells (almost the entire active network of USGS Rice Wells) following a tiered sampling approach, as described below.



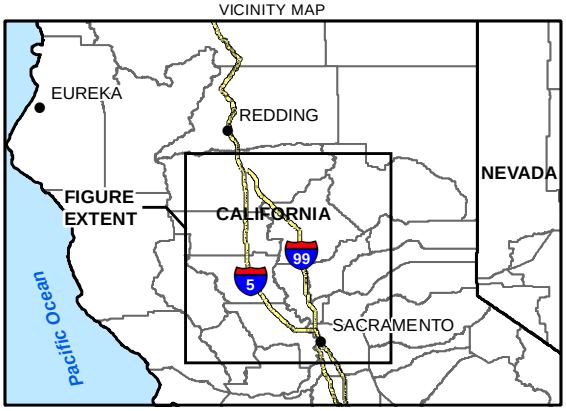
LEGEND

- TREND MONITORING WELL PER CRC MRP
- COUNTY
- RICE LAND
- GROUNDWATER BASIN

NOTE:

DATA SOURCES: GROUNDWATER BASINS, RICE LANDS (CALIFORNIA DWR 2010); COUNTY (CAL FIRE) USGS RICE WELLS (USGS). HORIZONTAL DATUM IS NAD83.

VICINITY MAP



California Rice

0 20 40
Miles

N

FIGURE 2-2
CRC Trend Monitoring Wells
Groundwater Trend Monitoring Workplan
California Rice Commission

The USGS is scheduled to monitor its entire rice well network in the summer of 2017 and will collect samples for water quality analysis. Based on the USGS sampling schedule, the CRC proposes to adjust the trend monitoring sampling schedule accordingly. Because rice fields have been shown to pose no negative impacts to groundwater quality and all rice lands were classified as low vulnerability (CRC 2013), the groundwater quality from the USGS rice wells will be monitored starting in 2017. The CRC will coordinate with the USGS to obtain the sampling data in the same manner as it did during the development of the GAR (CRC 2013).

Table 2-4 shows the proposed monitoring schedule for Group A and B parameters, as listed in the MRP. All monitoring wells and parameters will be monitored by the USGS in the summer of 2017. Per MRP requirements, after the initial monitoring year, monitoring shall be conducted on a rotating basis, with half of the monitoring wells monitored during the second year (2018) and the other half monitored during the next year (2019). Group B parameters will be monitored in the first year (2017), then once every 5 years. This rotating monitoring schedule will continue unless modified by the RWQCB Executive Officer. After the third monitoring year, the CRC may ask the Executive Officer to approve a reduction in groundwater monitoring.

Sampling will occur during the month of August, during the peak rice growing season and before the fields are drained, to assess the influence of rice field flooding on groundwater levels and potential nutrient migration to the water table.

2.4.4 Data Analysis and Reporting

Data from each well will be compiled into an electronic database, which includes applicable historical data, and analyzed for statistically significant trends for the major parameters such as nitrate and salinity indicators.

Groundwater sampling results will be included in the annual monitoring report submitted to the RWQCB by December 31 each year, as well as in electronic data submittals, per the requirements of the MRP. The following information will be provided as part of the monitoring data submittal and analysis in the annual report:

- Map of the sampled wells (such as Figure 2-2 of this report)
- Tabulation of the analytical data for each well
- Time concentration charts (chemographs) that include any available historical sampling data provided by the USGS

Sampling data will be compared to historical data for initial trend analysis which will include the time concentration charts. The annual sampling data will be kept in a database for further trend analysis.

At the end of the 3-year rotating cycle, a statistical trend analysis, such as the Mann-Kendall trend analysis, will be performed as a statistical approach to determine if water quality parameters are increasing, decreasing, or stable. This analysis will help establish whether monitoring needs to be continued at the rice wells, or whether the data are sufficient to validate the GAR analysis (CRC 2013) and conclude that rice fields do not pose a threat to shallow groundwater quality.

The Mann-Kendall method is commonly used to assess trends in groundwater quality over time. It is a non-parametric (for example, does not assume a distribution in the data) test for identifying trends in time-series data. The test compares the relative magnitudes of sample data rather than the data values themselves. The concentrations are evaluated as an ordered time series by location where each concentration is compared with all subsequent data for each constituent. The initial value of the Mann-Kendall statistic, S, is assumed to be 0 (that is, no trend). If a concentration from a later sampling event is higher than a concentration from an earlier sampling event, S is incremented by 1. Conversely, if the concentration from a later sampling event is lower than a concentration sampled earlier, S is

decremented by 1. The final value of S is equal to the net result of all such increments and decrements. In addition to S, a confidence factor was estimated for each time series.

The Mann-Kendall results can be categorized for a given well as follows:

- **Probable increase:** A time series with a positive S value and a confidence factor between 60 and 90 percent.
- **Increase:** A time series with a positive S value and a confidence factor greater than or equal to 90 percent.
- **Probable decrease:** A time series with a negative S value and a confidence factor between 60 and 90 percent.
- **Decrease:** A time series with a negative S value and a confidence factor greater than or equal to 90 percent.
- **No trend:** A time series with no statistically evident increase or decrease.

Historical data are available for all rice wells, and with the additional 3 years of sampling specified under this Workplan, sufficient data will be available for a statistical trend analysis.

Table 2-2. Groundwater Quality Trend Monitoring Wells
California Rice Commission Groundwater Trend Monitoring Workplan

DWR State Well Number	Mapping ID	Latitude	Longitude	Well Depth (ft bgs)	Top and Bottom Perforation Depths (ft bgs)	Subbasin	County
012N003E18H001M	18H1M	38°53'12.90"N	121°40'21.88"W	50	40 to 45	Sutter	Sutter
012N002E09B002M	09B2M	38°54'30.56"N	121°45'18.24"W	29	19 to 25	Sutter	Sutter
014N002E10R001M	10R1M	39°04'15.43"N	121°43'39.14"W	44	34 to 39	Sutter	Sutter
015N002W16R001M	16R1M	39°08'54.05"N	122°04'45.38"W	35	25 to 30	Colusa	Colusa
015N002W03E001M	03E1M	39°10'59.40"N	122°04'41.10"W	35	25 to 30	Colusa	Colusa
017N003W35M001M	35M1M	39°16'54.46"N	122°10'18.83"W	35	25 to 30	Colusa	Colusa
017N002W14G001M	14G1M	39°19'46.34"N	122°9'48.82"W	35	25 to 30	Colusa	Colusa
018N001W27B001M	27B1M	39°23'27.50"N	121°57'19.11"W	33.5	23.5 to 28.5	West Butte	Glenn
018N002E09L001M	09L1M	39°25'35.40"N	121°45'41.96"W	35	25 to 30	East Butte	Butte
018N002W12G002M	12G2M	39°25'44.41"N	122°01'56.53"W	35	25 to 30	Colusa	Glenn
018N001E08D001M	08D1M	39°26'05.43"N	121°53'18.16"W	38.5	28.5 to 33.5	West Butte	Glenn
019N003W25R001M	25R1M	39°28'14.87"N	122°08'12.71"W	38.5	28.5 to 33.5	Colusa	Glenn
019N003W25E001M	25E1M	39°28'22.76"N	122°09'51.42"W	35	25 to 30	Colusa	Glenn
019N001E22B001M	22B1M	39°29'24.94"N	121°50'51.37"W	35	25 to 30	East Butte	Butte
019N002W23E001M	23E1M	39°29'29.75"N	122°03'21.01"W	35.5	25.5 to 30.5	Colusa	Glenn
019N001E09C002M	09C2M	39°31'18.1"N	121°52'14.1"W	45	35 to 40	West Butte	Glenn

Table 2-2. Groundwater Quality Trend Monitoring Wells
California Rice Commission Groundwater Trend Monitoring Workplan

DWR State Well Number	Mapping ID	Latitude	Longitude	Well Depth (ft bgs)	Top and Bottom Perforation Depths (ft bgs)	Subbasin	County
020N002E35J002M[a]	35J2M	39°32'29.6"N	121°42'27.1"W	35	25 to 30	East Butte	Butte
020N002W32J001M	32J1M	39°32'34.52"N	122°05'56.82"W	35	25 to 30	Colusa	Glenn
020N002W25A001M	25A1M	39°33'52.51"N	122°01'39.34"W	35	25 to 30	Colusa	Glenn
020N002E08A001M	08A1M	39°36'29.27"N	121°45'56.86"W	35	25 to 30	East Butte	Butte

[a] New DWR Well ID for this replacement well is not currently available. Construction information in this report is updated to reflect the new well.

Notes:

DWR = California Department of Water Resources

ft bgs = foot (feet) below ground surface

ID = identification

Table 2-3. Groundwater Monitoring Parameters
California Rice Commission Groundwater Trend Monitoring Workplan

	Field Measurement	Laboratory Measurement
Group A (annual)		
Conductivity (at 25°C) (µmhos/cm)	✓	
pH (standard units)	✓	
Dissolved oxygen (DO) (mg/L)	✓	
Temperature (°C)	✓	
Total dissolved solids (TDS) (mg/L)		✓
Nitrate + nitrite as nitrogen (mg/L)		✓
Total ammonia as nitrogen (mg/L)		✓
Group B (initially, then once every 5 years)		
Anions (carbonate, bicarbonate, chloride, and sulfate)		✓
Cations (boron, calcium, sodium, magnesium, and potassium)		✓

Notes:

°C = degrees Celsius

µmhos/cm = micromhos per centimeter

mg/L = milligram(s) per liter

Table 2-4. Proposed Groundwater Sampling Schedule (sampling will occur in August)
California Rice Commission Groundwater Trend Monitoring Workplan

DWR Well ID	2017 [a]	2018	2019 [b]	2020	2021	2022
012N003E18H001M	A, B	A		A		A, B
012N002E09B002M	A, B	A		A		A, B
014N002E10R001M	A, B	A		A		A, B
018N001E08D001M	A, B	A		A		A, B
019N001E22B001M	A, B	A		A		A, B
019N001E09C002M	A, B	A		A		A, B
020N002E35J002M[c]	A, B	A		A		A, B
018N001W27B001M	A, B	A		A		A, B
018N002E09L001M	A, B	A		A		A, B
020N002E08A001M	A, B	A		A		A, B
015N002W16R001M	A, B		A		A	A, B
019N003W25R001M	A, B		A		A	A, B
019N003W25E001M	A, B		A		A	A, B
015N002W03E001M	A, B		A		A	A, B
019N002W23E001M	A, B		A		A	A, B
017N003W35M001M	A, B		A		A	A, B
017N002W14G001M	A, B		A		A	A, B
020N002W32J001M	A, B		A		A	A, B
020N002W25A001M	A, B		A		A	A, B
018N002W12G002M	A, B		A		A	A, B

[a] USGS is scheduled to sample the entire rice wells network for water quality constituents.

[b] The 2019 Annual Monitoring Report will determine if a reduction in sampling will be proposed to the Executive Officer.

[c] New DWR Well ID for this replacement well is not currently available. Construction information in this report is updated to reflect the new well.

Notes:

A = field parameters, total ammonia, nitrate-nitrite, and total dissolved solids.
B = anions and cations; see Table 2-3.
DWR = California Department of Water Resources

SECTION 3

Groundwater Quality Data Gap Assessment Plan

3.1 Background

Data gaps where limited or no groundwater quality data were available to make final conclusions on groundwater vulnerability were identified in the GAR (CRC 2013). Figure 3-1 shows the data gap areas as defined in the GAR. Yuba County was identified as a data gap because of the following interrelated factors (see GAR Section 6.5 [CRC 2013]):

- High proportion of Yuba County rice acreage farmed on moderately well-drained soil, as classified by Natural Resources Conservation Service.
- Lack of a substantial number of USGS rice wells located throughout the Yuba County area in the moderately well-drained and well-drained soil classes.
- Lack of USGS rice wells in Yuba County.

In addition, smaller data gaps were identified in the valley fringe areas of northern Glenn, eastern Sutter, and Placer counties where well-drained and moderately well-drained soil occur, similar to the Yuba County area.

The following sections identify the objectives, approach, and proposed analysis for addressing data gaps for groundwater quality in areas growing rice. The results of this analysis are provided in Appendix C.

3.2 Objectives

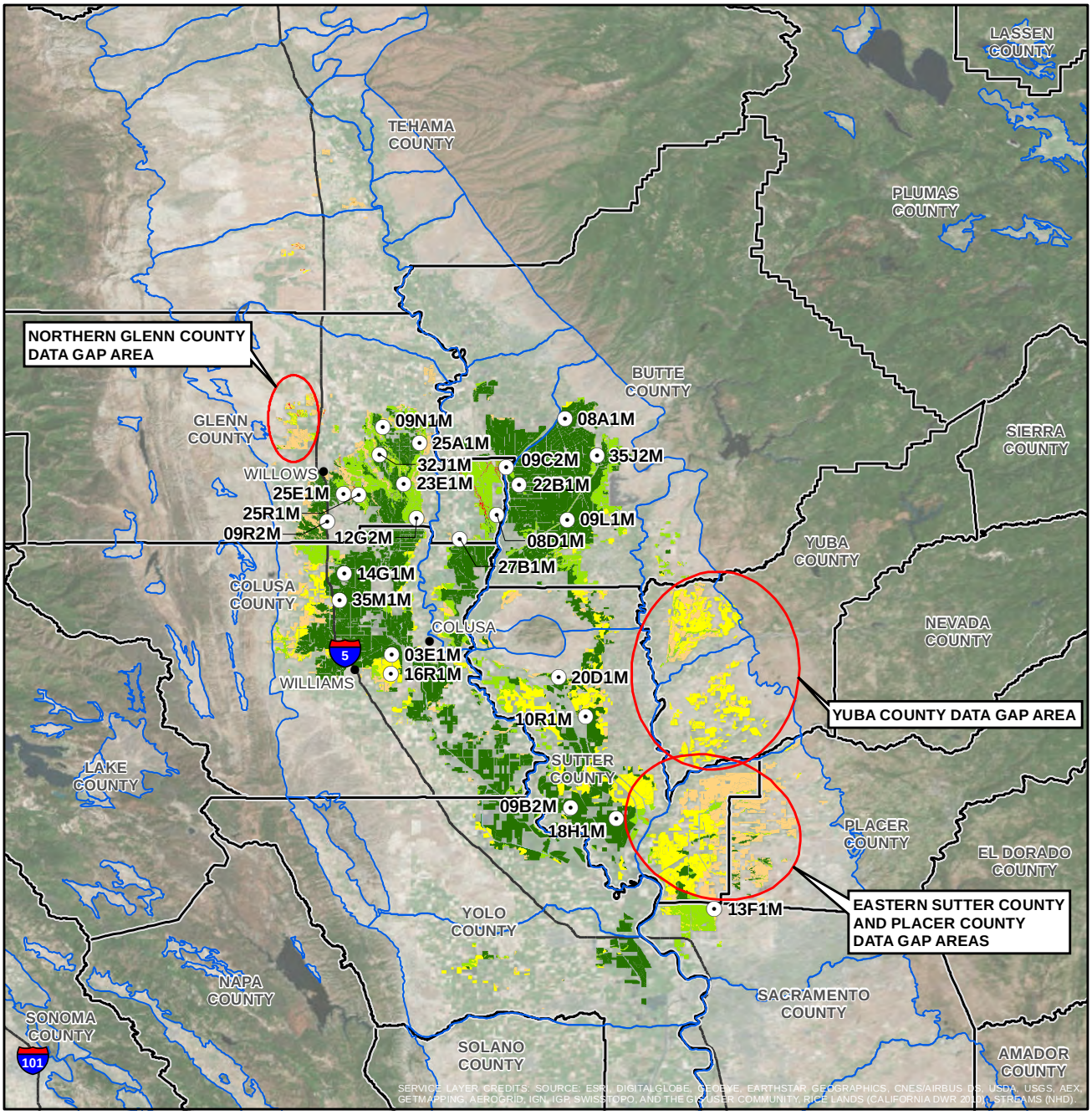
The objectives of the data gap analysis are outlined in the GAR (CRC 2013) and are summarized as follows:

- Perform additional groundwater quality data collection and analysis to characterize groundwater quality in terms of rice-specific vulnerability in Yuba County and fringe area groundwater.
- Determine whether there are impacted groundwater quality areas in the Yuba County and fringe data gap areas that are reasonably attributed to rice agriculture.
- Determine whether additional root zone studies or groundwater quality monitoring are needed to characterize the vulnerability of data gap area groundwater to rice agriculture.

3.3 Data Gap Analysis Approach

To achieve the data gap objectives, the CRC proposed the following approach, as described in Section 7.2.3 of the GAR (CRC 2013):

1. Determine if additional groundwater quality data (such as Yuba County or California Department of Water Resources [DWR]) are available to characterize rice-specific vulnerability.
2. Provide an overview of current and historical non-USGS groundwater quality data in the area, if available.
3. Perform an inventory of existing groundwater wells such as those maintained by Yuba County or DWR to locate dedicated shallow monitoring wells in Yuba County that could be used for a monitoring effort as part of the LTILRP.



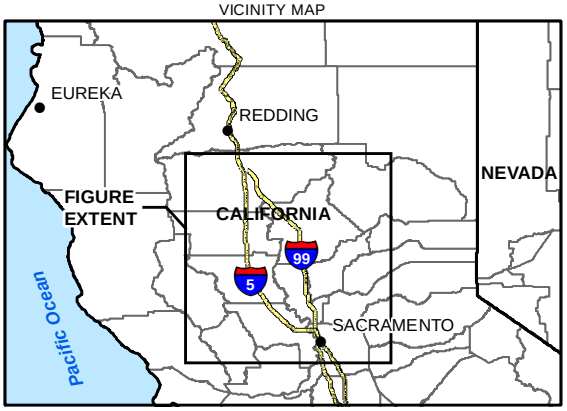
LEGEND

- ACTIVE USGS RICE MONITORING WELL
- COUNTY
- GROUNDWATER BASIN

NRCS DRAINAGE CLASS WITHIN RICE LANDS

- POORLY DRAINED
- SOMEWHAT POORLY DRAINED
- MODERATELY WELL DRAINED
- WELL DRAINED
- SOMEWHAT EXCESSIVELY DRAINED
- EXCESSIVELY DRAINED
- WATER

VICINITY MAP



NOTE:

DATA SOURCES: GROUNDWATER BASINS, RICE LANDS (CALIFORNIA DWR 2010); COUNTY (CAL FIRE) USGS RICE WELLS (USGS). NRCS SOILS (USDA; CH2M). HORIZONTAL DATUM IS NAD83.

California Rice

0 20 40
Miles

N

FIGURE 3-1
Data Gap Areas
Groundwater Trend Monitoring Workplan
California Rice Commission

4. Review Yuba County groundwater quality reports and groundwater management plans.
5. Coordinate with Yuba County Water Agency (YCWA) and DWR to obtain additional groundwater quality data.
6. Identify appropriate water quality information and perform additional water quality analysis, with mapping and graphing of results, similar to those presented in Section 5 of the GAR (CRC 2013).
7. Assess the applicability of the additional data to the rice-specific evaluation:
    a. Determine if existing groundwater wells are located in or directly downgradient of rice fields and whether sufficient background (upgradient) water quality data are available for comparison with downgradient groundwater quality.
    b. Determine if other land uses in Yuba County adjacent to rice fields might influence the quality of groundwater underlying the rice fields.
8. Perform additional geographic information system (GIS) soil mapping and evaluation to assess the similarity of the subbasin soil characteristics to similar drainage classes in other counties, including northern Glenn County and eastern Sutter and Placer counties, and confirm the applicability of the Yuba County analysis to the fringe areas. Evaluate duripan and other soil characteristics.
9. Identify whether additional root zone studies or implementation of groundwater quality monitoring are needed, such as:
    a. Perform additional nitrate studies in the coarser soil.
    b. Determine if representative or trend monitoring is indicated, and identify appropriate shallow monitoring wells to be used for monitoring, as needed.
    c. Identify constituents and frequency of recommended monitoring.

3.4 Proposed Elements to Resolve the Data Gaps

This section reviews the proposed data sources and analysis methods to achieve resolution of the data gaps. Two major data sources were identified in the GAR (CRC 2013) to support further analysis:

- Groundwater quality data in Yuba County
- Refined review of soil data collected in the fringe areas and a comparison with soil data collected in Yuba County to correlate groundwater quality data with fringe areas vulnerability designations

3.4.1 Yuba County Well Data Review

Two main types of well networks are currently sampled for groundwater quality in Yuba County:

- **YCWA monitoring wells**: YCWA maintains dedicated water level monitoring wells that were installed with assistance from DWR. Eight monitoring wells were installed in 2006, with two of them developed as multiple-completion monitoring wells (they have separate depth intervals with multiple screens so samples can be collected at multiple intervals within the same well). Six more wells were constructed in 2011, with one multi-completion well. During well development, samples were collected and analyzed for basic water quality constituents. Well information and sampling data are reported in the Data Gap Analysis (Appendix C). Additional water quality information is provided in the Yuba County Groundwater Management Plan (YCWA, 2010) and annual monitoring reports.
- **DWR-sampled wells**: DWR samples its own wells for water quality throughout the Sacramento Valley. Ten of these wells, located in Yuba County, have been sampled every other year for a variety of groundwater constituents for the past decade. Usually, five wells are sampled in odd-numbered

years, and another five are sampled in even-numbered years. Sampling results are available on the online Water Data Library (WDL) and are reported in the Data Gap Analysis (Appendix C). In addition, historical sampling data from the 1960s through the 1980s provide groundwater quality trend information.

A detailed review of these data sets and groundwater quality data will be used to determine the vulnerability of groundwater quality underlying rice fields in Yuba County. The data will be reviewed against maximum contaminant limits and plotted for trend analysis, and maximum values will be mapped in relation to rice fields to determine the groundwater quality in the proximity of rice fields.

3.4.2 Fringe Areas Soil Data Analysis

In some fringe areas of the rice fields, no additional readily accessible monitoring wells were identified; therefore, a detailed soil analysis will be performed in these areas to identify similarities in drainage patterns to the Yuba County area and determine the existence of any soil layers that restrict flow. If the fringe areas have soil characteristics similar the Yuba County area, the results from Yuba County sampling and analysis will be correlated to the fringe areas.

GIS mapping of detailed Natural Resources Conservation Service Soil Survey Geographic (SSURGO) data sets will be performed to evaluate depth to duripan, the location of other restrictive layers, and other soil characteristics. Mapping similar to that performed for Yuba County and included in Section 6.5 and Appendix H of the GAR (CRC 2013) will be performed.

3.5 Data Gap Analysis and Reporting

The data gap analysis was completed concurrently with this Workplan. Results of the analysis are reported in Appendix C.

3.6 Data Gap Analysis Summary and Trend Monitoring Conclusions

Conclusions of the data gap analysis verify that the analysis satisfies the objectives stated in the GAR (CRC 2013). The primary conclusion is that the groundwater quality in the Yuba County groundwater basin shows low levels of nitrate and salinity and thus, this area can also be considered low vulnerability, like the rest of the rice areas in the Sacramento Valley. In addition, the fringe areas soil analysis showed that the soils have similar characteristics to the soils in the Yuba County area (specifically well drained surficial soils with water-restricting features in the subsoil), and therefore, the monitoring results in the Yuba County rice growing areas can be applied to these other smaller fringe areas. The rice-specific conceptual site model developed and described in the GAR (CRC 2013) identified specific applications, such as:

Areas with similar soils, hydrogeology, and crop management practices could be reasonably concluded to have the same low risk as areas that have been found to be low vulnerability due to high quality groundwater.

This correlative approach between the rice farming areas is based on the fact that the generally large, contiguous rice acreages in the Sacramento Valley are farmed continuously in rice with similar and consistent rice-farming practices.

Six of the DWR monitoring wells in Yuba County were identified as additional wells that will be included as part of the CRC Groundwater Quality Trend Monitoring Network for data review purposes. DWR monitors these wells every other year and the results will be incorporated into the review and analysis of the USGS Rice Wells sampling results. Information on these DWR wells and the schedule and

constituents sampled are provided in Tables C-7 and C-8 of Appendix C. The CRC will not monitor the DWR wells, but will use the data from DWR in its analysis.

The results of ongoing Yuba County DWR water quality monitoring and trend monitoring of USGS rice wells will be evaluated in the Annual Monitoring Report after each sampling season for a complete review of groundwater quality in the rice growing areas of the Sacramento Valley.

SECTION 4

References

Central Valley Regional Water Quality Control Board (RWQCB). 2014. Order No. R5-2014-0032 Waste Discharge Requirements General Order for Sacramento Valley Rice Growers. March 2014.

California Rice Commission (CRC). 2013. *Final Rice-Specific Groundwater Assessment Report.* Prepared for the Central Valley Regional Water Quality Control Board on behalf of the California Rice Commission. Prepared by CH2M HILL and PlanTierra. July.

California Rice Commission (CRC). 2015. *Quality Assurance Project Plan for California Rice Commission Water Quality Programs*. Draft Version 3.0. April.

Yuba County Water Agency (YCWA). 2010. *Groundwater Management Plan.* December.

USGS (U.S. Geological Survey). 2001. *Shallow Ground-Water Quality Beneath Rice Areas in the Sacramento Valley, California, 1997*. Water-Resources Investigations Report 01-4000. National Water-Quality Assessment Program. Sacramento, CA.

Appendix A
USGS Rice Wells Details and Driller Logs

Table A-1. Rice Groundwater Quality Trend Monitoring Well Details

DWR Well ID	Mapping ID	USGS State Well ID	Latitude	Longitude	Year Built	County	Average Depth to Water Level[a] (ft bls)	Well depth (ft bls)	Top and Bottom Perforation Depths (ft bgs)	Bottom of Seal (fbls)	Well Seal Material Type
012N003E18H001M	18H1M	385314121401701	38°53'12.90"	121°40'21.88"	1997	Sutter	3.3	50	40 to 45	35	Bentonite
012N002E09B002M	09B2M	385431121451401	38°54'30.56"	121°45'18.24"	1997	Sutter	3.4	29	19 to 25	18	Bentonite
014N002E10R001M	10R1M	390416121433601	39°04'16"	121°43'36"	1997	Sutter	2.1	44	34 to 39	29[b]	Bentonite
015N002W16R001M	16R1M	390856122044301	39°08'54.05"	122°04'45.38"	1997	Colusa	3.6	35	25 to 30	20	Bentonite
015N002W03E001M	03E1M	391059122043601	39°10'59.40"	122°04'41.10"	1997	Colusa	5.9	35	25 to 30	20	Bentonite
017N003W35M001M	35M1M	391653122101401	39°16'54.46"	122°10'18.83"	1997	Colusa	2.0	35	25 to 30	20	Bentonite
017N002W14G001M	14G1M	391947122094501	39°19'46.34"	122°09'48.82"	1997	Colusa	3.4	35	25 to 30	20	Bentonite
018N001W27B001M	27B1M	392328121571501	39°23'27.50"	121°57'19.11"	1997	Glenn	3.8	33.5	23.5 to 28.5	20	Bentonite
018N002E09L001M	09L1M	392542121452501	39°25'35.40"	121°45'41.96"	1999	Butte	4.5	35	25 to 30	18	Bentonite
018N002W12G002M	12G2M	392545122015201	39°25'44.41"	122°01'56.53"	1997	Glenn	5.6	35	25 to 30	20	Bentonite
018N001E08D001M	08D1M	392604121531801	39°26'05.43"	121°53'18.16"	1997	Glenn	4.1	38.5	28.5 to 33.5	23.5	Bentonite
019N003W25R001M	25R1M	392810122080901	39°28'14.87"	122°08'12.71"	1997	Glenn	4.5	38.5	28.5 to 33.5	20	Bentonite
019N003W25E001M	25E1M	392824122091401	39°28'22.76"	122°09'51.42"	1997	Glenn	2.4	35	25 to 30	20	Bentonite
019N001E22B001M	22B1M	392924121504801	39°29'24.94"	121°50'51.37"	1997	Butte	3.0	35	25 to 30	20	Bentonite
019N002W23E001M	23E1M	392931122031701	39°29'29.75"	122°03'21.01"	1998	Glenn	2.1	35.5	25.5 to 30.5	20.5[b]	Bentonite
019N001E09C002M	09C2M	393118121521401	39°31'18.1"	121°52'14.1"	2006	Glenn	-	45	35 to 40	30	Bentonite
020N002E35J002M[c]	35J2M	393230121422201	39°32'29.6"	121°42'27.1"	2013	Butte	4.8	24.2	19.2 to 24.2	14.2[b]	Bentonite
020N002W32J001M	32J1M	393235122055301	39°32'34.52"	122°05'56.82"	1997	Glenn	2.4	35	25 to 30	20	Bentonite
020N002W25A001M	25A1M	393353122013501	39°33'52.51"	122°01'39.34"	1997	Glenn	1.7	35	25 to 30	20	Bentonite
020N002E08A001M	08A1M	393630121455401	39°36'29.27"	121°45'56.86"	2006	Butte	6.0	35	25 to 30	21	Bentonite

[a] Water level averages are for the period of record for each well

[b] Inferred from verbal confirmation of USGS

[c] New DWR Well ID for this replacement well is not currently available. Construction information in this report is updated to reflect the new well.

Source: USGS, 2015. All data in this Appendix provided by USGS; personal communication.

Drilling Log

DWR Well ID: 012N003E18H001M

Siteid 385314121407M01 State Well No. 12N3E18H1 SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study

DRILLING LOG

State CA County Sutter Well Name (OTID) [redacted]

7.5' QUAD Sutter Causeway Altitude 22 ft. Location

Land Owner [redacted] Contact Person & # [redacted]

Driller Render Drilling Method Auger, Hollow Stem, Type of Rig CME Bit size 8 in.

Date Work Began 5/30/97 Date Work Ended 5/30/97 Borehole Diameter 8 in. Depth of Borehole 50 ft.

7:43

depth	graphic lithology	grain size, % gravel: cobble	gravel: pebble	gravel: granule	sand: very coarse	sand: coarse	sand: medium	sand: fine	sand: very fine	silt	clay	cuttings	core	Descriptions (color, sorting, grain texture, lithology; drilling comments, date, weather)	well construction
0											X			dark brown stiff clay - almost no sand	
5											X			slightly lighter - very few sand grains (f spar?)	
10														Color change 13 ft - blue gray clay - more sand - very fine - soft clay	
15														blue gray clay - silty; minor sand - very fine - arkosic?	
20														21.5 - drilling got soft 23 - drilling hard again same blue gray clay	
25														very wet sloppy clay - coiling around flights - stiff clay more gray - some very fine sand	
30														drilling very hard at 30 ft 32 ft drilling very soft some stiff clay coiling around flights - very wet sloppy gray clay	
35														same - drilling soft then hard - interbedded 38 - soft drilling	

Recorded By BJM Dawson Date 5/30/97 Sheet 1 of 2

Siteid 385314121401701 State Well No. 12N3E18H1 SACR NAWQA Rice Land-use Study

[redacted]

Drilling Log Continued

depth	graphic lithology	grain size, % gravel: cobble	pebble	granule	sand: very coarse	coarse	medium	fine	very fine	silt	clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
50														48- drilling hard again same, darker stiff clay sloppy lighter gray clay with some sand gray water brought up on flights STOPPED TD-50'	

8.43

Recorded By BJM Dawson Date 5/30/97 Sheet 2 of 2

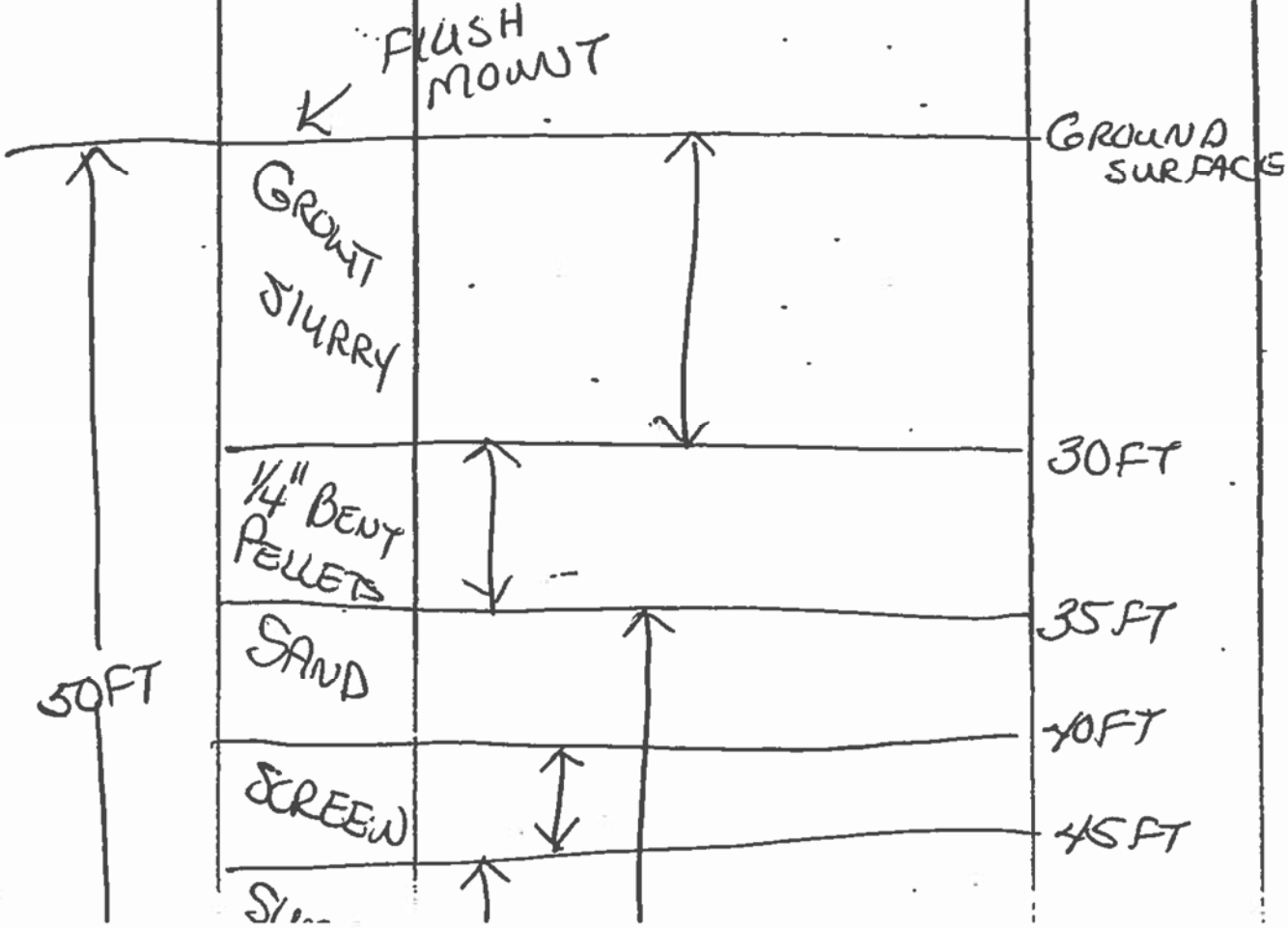
DRILLER: DAVE 3 GEOLOGIST: BARBRA DATE: 5-30-97

LOCATION: 12N3E 18H DAWSON DRILLING SYSTEM: 4¼ Hollow Stem Augers/Knockout Plate

SITE: [redacted]

DRILL HOLE: #1

DEPTH:	ROTATION PSI	PUMP PSI	DESCRIPTION OF MATERIAL	RECOVERY	W. CON.
			SUMP	5FT.	
			.020 SCREEN	5FT.	
			BLANK PVC	40FT.	
			#2/12 SAND	6 BAGS	
			¼" BENT PELLETS	2 PAILS	
			GROUT	6½ BAGS	



Drilling Log

DWR Well ID: 012N002E09B002M

Siteid 385431121451401 State Well No. 12N/2E-9B2 SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study

DRILLING LOG

State CA County Sutter Well Name (OTID) [redacted]

7.5' QUAD Kirkville Altitude 22 ft. Location

Land Owner [redacted] Contact Person & # [redacted]

Driller Dave Rader (Central Region) Drilling Method Auger, Hollow Stem Type of Rig CME Bit size 8 5/8 in.

Date Work Began 7/14/97 Date Work Ended 7/14/97 Borehole Diameter 8 5/8 in. Depth of Borehole 29 ft.

depth (ft)	graphic lithology	grain size, % gravel: cobble, pebble, granule	sand: very coarse, coarse, medium, fine, very fine	silt	clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology, drilling comments, date, weather	well construction
2					X			1st dirt - very dark Brown clay with some sand and pebbles. The sand & pebbles are moist 1ft from the surface	Well cap
4					X				
6					X			The clay is moist with some silt <5% medium brown color	20' Blank; Grout Seal
8					X				
10					X			The clay has more moisture, brown; 1-2mm particles that may be cemented clay.	
12					X				
14					X				10' Blank
16					X			very wet muddy clay, very sticky, more silt content,	
18					X			<10% sand upto 2mm <1% silt	Pellets; Sand pack
20					X				
22					X			Heaving sands mostly 1mm - 1cm in size, feldspar, quartz & lithic frag. poorly sorted, unconsolidated, very fine angular - subangular	5' screen
24					X				
26					X			grey if in water	5' blank; Heaving Sands
28					X				
29					X				

Recorded By D. Kremer Date 7/14/97 Sheet 1 of 1

DRILLER: DAVE

GEOLOGIST: BARBARA DAWSON

26

DATE: 7-14-97

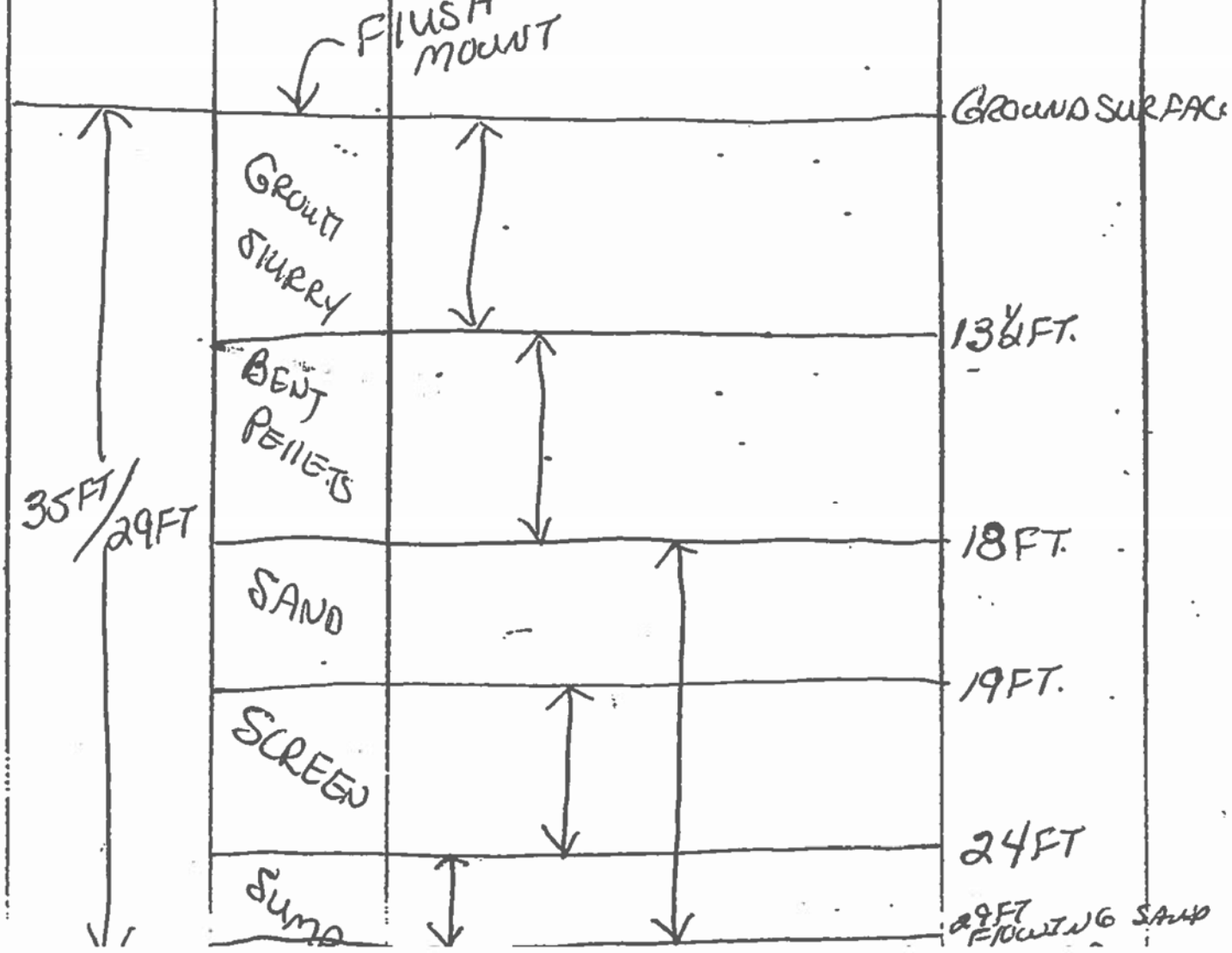
LOCATION: 12N2E9A

SITE: [redacted]

DRILL HOLE: #1

DRILLING SYST: 4¼ Hollow Stem Augers/Knockout Plate

DEPTH:	ROTATION PSI	PUMP PSI	DESCRIPTION OF MATERIAL	RECOVERY	U CON
FLOWING SAND, LOCKED CASING IN HAD TO PULL BROKE LOOSE, BOTTOM OF CASING AT 29', HAD 12' OF NATURAL FILL, THAT CAME-UP. POUR SAND TO 9'.			SUMP; .020 SCREEN; BLANK AUG; #2/12 SAND; ¼" BENT PELLETS; GROUT;	5FT. 5FT. 25FT. 1¾ BAGS & PAILS 2½ BAGS	



MOUNT SOPRIS INSTRUMENT COMPANY,INC.
17301 WEST COLFAX AVENUE SUITE 255
GOLDEN CO 80401 USA
PHONE (303)279-3211 FAX: (303)279-2730

LOGGING REPORT

On Site ~10:05
Off Site
talked to [redacted]

Depth 29 Screen 19-25

Date 1/21/98 Page 1 of 1

Engineer(s) B Dawson

Truck Suburban

Well # [redacted] Project/Permit # SACR RiceLU Client Weathor - Mostly light fluffy clouds Clear Cool ground wet

Location CA Sutter B2 9 12N 2E Elevation 22 Depth Ref Landsurface Witness

State County Qtr. Sec. Sec. Twp. Ran

Drilling Contractor USGS CR Drill Type Auger

Run No.	Tools	Speed Ft/Min	Time Start / Stop	Depth Bot. Log / Top Log	Depth Error	Digital File Name / Digital Interval	Remarks/Comments	Fluid Level
1	Model SN / Module SN	N12	1030 / 1033	22.6 / 3.7		[redacted]	PROBE = PGA 1000 Natural Gamma Starting Depth = 3.71	E tape 1.05 m 3.44 ft
2	Model SN / Module SN	N12	1042 / 1044	20.7 / 4.8			PROBE = PGA 1000 Conductivity 0-1000 Starting Depth = 4.85	
	Model SN / Module SN							
	Model SN / Module SN							
	Model SN / Module SN							
	Model SN / Module SN							

Drilling Log

DWR Well ID: 014N002E10R001M

Siteid 390411612143601 State Well No. 14N2E10R SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study
DRILLING LOG

State CA County Sutter Well Name (OTID) [redacted] 14N2E10R

7.5' QUAD Gilsizer Slough Altitude 36 ft. Location

Land Owner [redacted] Contact Person & #

Driller Rehder Drilling Method Auger, Hollow Stem Type of Rig CME Bit size 8 in.

Date Work Began 5/31/97 Date Work Ended 5/31/97 Borehole Diameter 8 in. Depth of Borehole 44 ft.

depth	graphic lithology	grain size, % gravel: cobble, pebble, granule	sand: very coarse, coarse, medium, fine, very fine	silt	clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
7:00a								dark brown, soft clay, organic, almost no sand	
5								8 or 9 ft - change to wet clay-sand - light brown	
10								same - sand med grain arkosic drilling soft, then hard-	
15								same, interbedded	
20								20 ft - drilling soft again then hard	
25								some stiff clay - light greyish brown - very little sand	
30								25-27 very soft, 27- hard again drilling hard - stiff sandy clay sand fine	
35								35 - drilling very hard 35.5 - drilling very soft	34
								39 - drilling very hard	39
								35-39 - light brown soupy clay sand sand - fine - black grains, lithic fspar? grains	
40								drilling very hard 39-44 very stiff light brown clay coiled around flights -	
8:05a 44								STOPPED very little sand	44

Recorded By BJM Dawson Date 5/31/97 Sheet 1 of 1

Drilling Log

DWR Well ID: 015N002W16R001M

Siteid 390854122044101 State Well No. 15N 2W 16R SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study

DRILLING LOG

State CA County Colusa Well Name (OTID) [redacted]

7.5' QUAD Colusa Altitude 55 ft. Location

Land Owner [redacted] Contact Person & # [redacted]

Driller Rehder Drilling Method Auger, Hollow Stem Type of Rig CME Bit size 8 in.

Date Work Began 6/16/97 Date Work Ended 6/16/97 Borehole Diameter 8 in. Depth of Borehole ft.

11

11:57 a

12:20

depth	graphic lithology	Descriptions color, sorting, grain texture, lithology drilling comments, date, weather	well construction
5		stiff red brown clay - some coiling - some sand	cement surface seal
10		slightly lighter brown - clay - more coiling - stiff "modeling" type clay - very little sand	Bentonite grout
15		slightly yellower brown - not as cohesive more silty? still easily molded when pressed - bits up around flights	Pellets + collapsed
20		15 to 15.5 feet - drilling hard - then soft to 18.5 - no return except clay balls as in 10-15 ft	
25		some wet runny clay fine sand (dark grains) soft from 15-23' then a little harder	sand pack
30		clayey sandy water return 25-28.5 - very soft drilling - harder at 28.5	
35		31-33.5 very soft	
		STOPPED DRILLING - 35' TD	

Recorded By BJM Dawson Date 6/16/97 Sheet 1 of 1

6/16/97

[redacted]

ONSITE 11:14a -
Lunch - Start Setup 11:45a

Started Drilling 11:51a
Stopped Drilling ~12:20p

Knockplate won't knockout

Start Sandpack 12:48
- Sand heaving into augers
sand to 20 ft

pellets finished 2:15p
some formation collapse -
pellets to 13 ft

390854122044101
15N2W16R

DRILLER: DAVE 2D

GEOLOGISTS: BARBARA DAWSON

DATE: 6-16-9

LOCATION:

SITE: [redacted]

DRILL HOLE: #2

DRILLING SYSTEM: 4¼ Hollow STEM AUGC
KNOCK-OUT PLATE

DEPTH:	ROTATION PSI	PUMP PSI	DESCRIPTION OF MATERIAL	RECOVERY	W. CON
			SUMP:	5 FT.	
			.020 SCREEN:	5 FT.	
			BLANK RUC:	25 FT.	
			#2/12 SAND:	4¾ BAGS	
			¼ BENT PELLETS:	2 PAILS	
			GROUT:	2¾ BAGS	

FLUSH MOUNT

GROUND SURFACE

GROUT SLURRY

13 FT.

1½' SLUFF WHEN ADDING PELLETS

BENT PELLETS

19FT

20 FT

1' SLUFF BEFORE ADDING PELLETS

35FT.

SAND

SCREEN

SUMP

Drilling Log

DWR Well ID: 015N002W03E001M

Siteid 391059122043601 State Well No. 15N2W3E1 SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study

DRILLING LOG

State CA County Colusa Well Name (OTI

7.5' QUAD Colusa Altitude 4

Date Work Began 6/16/97 Date Work Ended 6/16/97 Borehole Diameter 8 in. Depth of Borehole 35 ft.

6:55a

depth	graphic lithology	Descriptions color, sorting, grain texture, lithology drilling comments, date, weather	well construction
5		Mod brown clayey gravel- rounded up to 5 cm; clay has very little sand	bentonite grout
10		clay stiff - coiling around flights - easy to mold - very little sand	
15		clay lumping - not coiling so much around auger - color slightly more orange brown - still very little sand (dark med size grain) drilling tighter at 13 feet	
20		clay forming balls as it comes up augers no return - 20-22 drilling - sand? then interbeds - some may have had some gravel - hard drilling 24-24.5 - the soft	pellets
25		clay much wetter - sticky lighter brown stiff - coiling around auger almost no sand in clay 29ft - hard drilling	sand pack
30		some muddy runny sand return up flights very fine sand mostly light mousse clay like thick soup interbeds from 30-35	
35		STOPPED DRILLING - 35 TD	

cement surface seal

15

20

25

30

35

7:30a

Recorded By BJM Dawson Date 6/16/97 Sheet 1 of 1

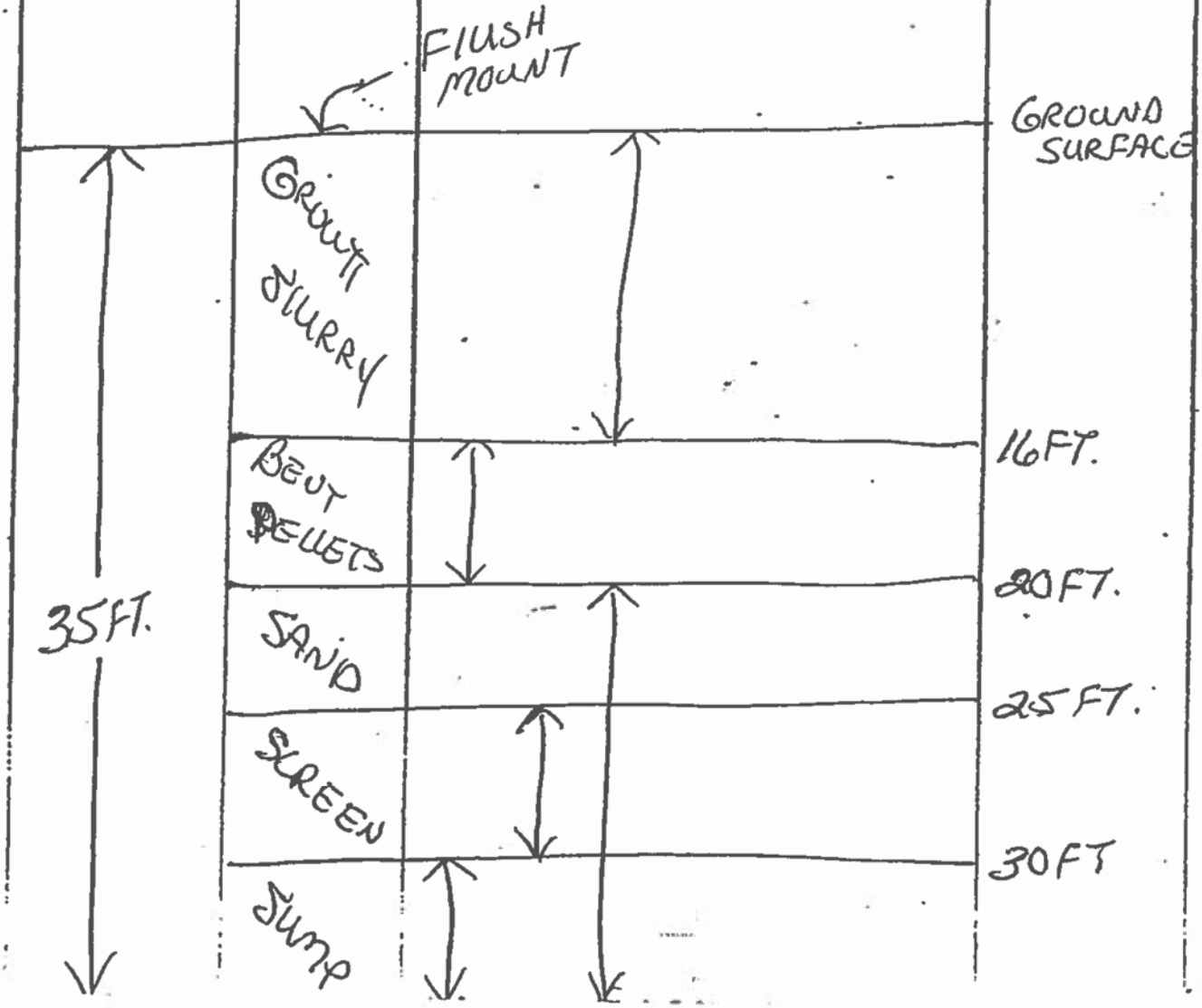
: DAVE

TOWN: 15N 2W 3E

AUGERS/KNOCK-OUT PLATE

WELL HOLE: #1

DEPTH:	ROTATION PSI	PUMP PSI	DESCRIPTION OF MATERIAL	RECOVERY	M. CON.
			SUMP:	5 FT.	
			.020 SCREEN:	5 FT.	
			BLANK PVC:	25 FT.	
			#2/12 SAND:	5 3/4 BAGS	
			1/4 BENT PELLETS:	2 PAILS	
			GROUT	3 BAGS	



Drilling Log

DWR Well ID: 017N003W35M001M

Siteid 391653122101401 State Well No. 17N/3W-35M1 SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study

Grout Inspected by: Rolf Frankenbach (916) 458-0398

DRILLING LOG

State CA County Colusa Well Name (OTID) [redacted]

7.5' QUAD Maxwell Altitude 74 ft. Location [redacted]

Land Owner [redacted] Contact Person & # [redacted]

Central Region USGS

Driller Dave Rader Drilling Method Auger, Hollow Stem Type of Rig CME Bit size 8 5/8 in.

Date Work Began 6/3/97 Date Work Ended 6/3/97 Borehole Diameter 8 5/8 in. Depth of Borehole 35 ft.

* indicates change - cement 6/6/97 & install monument cover

depth	graphic lithology	grain size, % gravel: cobble, pebble, granule	grain size, % sand: very coarse, coarse, medium, fine, very fine	grain size, % silt	grain size, % clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
1.5' 5 min								dark brown, moist, ribbon stays together ~0.3 mm < 5%; cannot see many grains mostly clay w/some silt; silty clay 0-3.5	
3.5'								cuttings from 2nd auger flight brown, slightly yw-orange ~5% 0.5-1mm more clay than previous sample still some silt; clay seems tightly packed/hard ribbons hold together, less moist 7' water; easy to drill through	
2nd									
8.5'									
3rd								11'-13' hard zone of clay	
								13'. soft again, lots of H_2O coming up w/cuttings	
13.5'									
4th								13.5-18.5' cuttings very wet, lt brown more sand ~25% 0.4-2mm more silt than clay, won't ribbon sandy silt w/some clay	
18.5'								18.5-23.5 cuttings very wet same material some clay interbeds <4"	
5 1/2									
23.5'									
6"									
28.5'									

13'

Recorded By J. Shelton Date 6/3/97 Sheet 1 of 3

Siteid 391653122101401 State Well No. 17N/3W-35K SACR NAWQA Rice Land-use Study

Drilling Log Continued

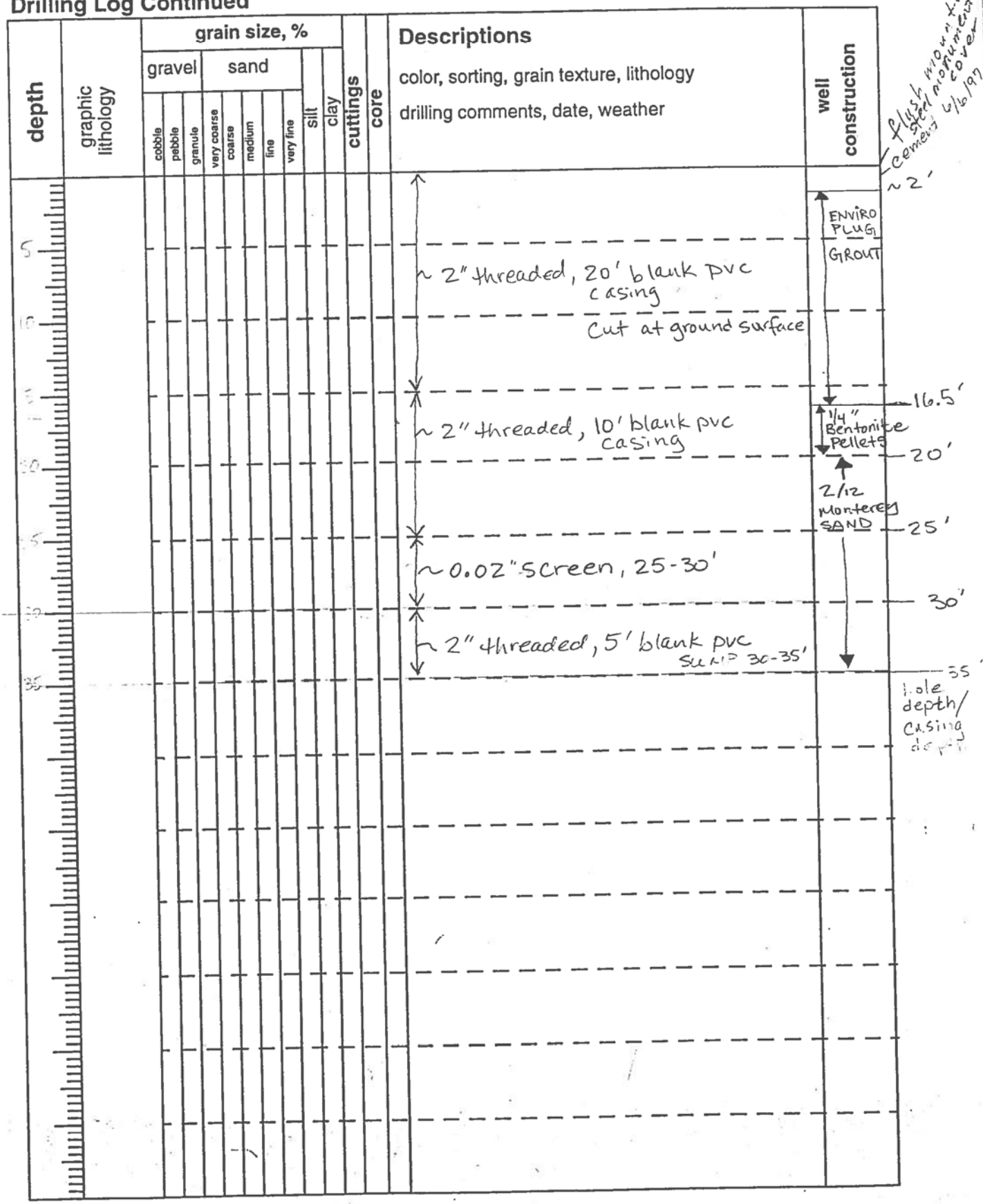
depth	graphic lithology	grain size, %										cuttings	core	Descriptions color, sorting, grain texture, lithology drilling comments, date, weather	well construction
		gravel			sand										
		cobble	pebble	granule	very coarse	coarse	medium	fine	very fine	silt	clay				
28.5'															
30	*													30' hit hardest material so far tightly packed clay	
32														7" auger flight will drill to 33.5' can use 2' extender to push the extra 1.5' in order to get at least a 20' grout seal	
33.5															
34															

7" flight

Recorded By J. Shelton Date 6/3/97 Sheet 2 of 3

Siteid 391653122101401 State Well No. 7N/2W-35K SACR NAWQA Rice Land-use Study

Drilling Log Continued



Recorded By J. Shelton Date 6/3/97 Sheet 3 of 3

391653122101401

DRILLER: DAVE & GEOLOGIST: BARBARA DAWSON DATE: 6-3-97

LOCATION: 17N3W35 ~~KM~~

SITE: [redacted]

DRILL HOLE: #1

DRILLING SYSTEM: 4¼ Hollow STEM AUGERS / KNOCK-OUT PLATE

DEPTH:	ROTATION PSI	PUMP PSI	DESCRIPTION OF MATERIAL	RECOVERY	U CON
			SUMP	5 FT.	
			.020 SCREEN	5 FT.	
			BLANK PVC	25 FT.	
			#2/12 SAND	6 BAGS	
			¼" BENT PELLETS	2 PAILS	
			GROUT	3½ BAGS	
			FLUSH MOUNT		
			GROUND SURFACE		
			GROUT SLURRY	16½ FT.	
			BENT PELLETS	20 FT.	
35 FT.			SAND	25 FT.	
			SCREEN	30 FT.	
			Sump		

Drilling Log

DWR Well ID: 017N002W14G001M

Siteid 391947122094501 State Well No. 17N/2W-14G1 SACR NAWQA Rice Land-use Study

17N/2W-14G1

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study

[redacted]

DRILLING LOG

State CA County Colusa Well Name (OTID) [redacted]

7.5' QUAD Maxwell Altitude 80 ft. Location

Land Owner [redacted]

Central Region USGS
Driller Dave Rader Drilling Method Auger, Hollow Stem Type of Rig CME Bit size 8 5/8 in.

Date Work Began 6/3/97 Date Work Ended 6/3/97 Borehole Diameter 8 5/8 in. Depth of Borehole 35 ft.

- cement 6/6/97

depth	graphic lithology	grain size, % gravel: cobble, pebble, granule	sand: very coarse, coarse, medium, fine, very fine	silt	clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
1st flight								0-3' Brown; dry; gritty; won't form a ribbon; mostly silt w/ some sand 1/3-1/2 mm (avg. 0.4mm) poorly sorted; sandy silt/silty	[redacted]
3.5'								3' WET; EASY TO DRILL THROUGH light brown to yellowish orange; smooth texture; makes a ribbon; more clay than previous sample from cuttings; very poorly sorted; mostly silt; sand is finer ~0.3mm; sandy silt w/ more clay	[redacted]
2nd flight									
8.5'								8.5-13.5' same as above except more wet and sticky; slightly more clay; - some clay interbeds less than 0.5 ft thick	
3rd flight									
13.5'									
4th								14' hard to drill through - more hard packed clay; slightly darker brown and not as orangish silty clay w/some fine sand	
18.5'								18' soft/easy to drill through again without applying pressure; more sandy silt w/ clay	
5th									
23.5'								23'-23.2' hard to drill through; small clay interbed less than 0.5 ft	
6th								23.2' soft material again	
28.5'								27'-27.5' hard; clay interbed 27.5- soft material - less clay clayey silt w/ fine sand	

Recorded By J. Shelton Date 6/3/97 Sheet 1 of 3

Siteid 391947122094501 State Well No. 17N/2W-14G1 SACR NAWQA Rice Land-use Study

Drilling Log Continued

depth	graphic lithology	grain size, % gravel: cobble	gravel: pebble	gravel: granule	sand: very coarse	sand: coarse	sand: medium	sand: fine	sand: very fine	silt	clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
30														light brown, slightly velvety clayey silt w/ some fine sand	
32														32' very hard - tightly packed clays; brown	
34														35'	
36															
38															
40															

7th flight

33.5'

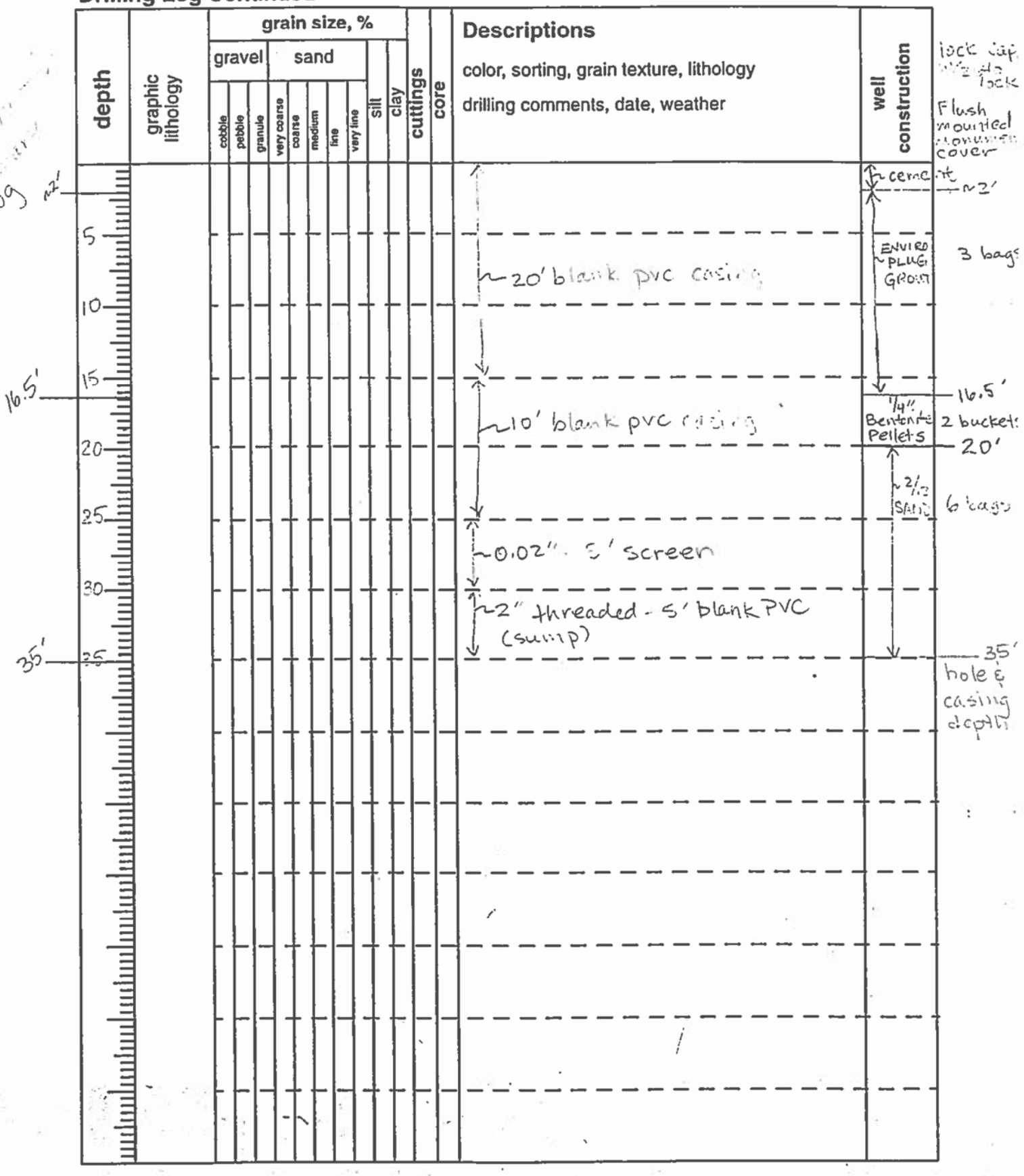
2 ft extender

35'

Recorded By J. Shelton Date 6/3/97 Sheet 2 of 3

Siteid 391947122094501 State Well No. 17N/2W-14G1 SACR NAWQA Rice Land-use Study

Drilling Log Continued



Recorded By J. Shelton Date 6/3/97 Sheet 3 of 3

DRILLER: DAVE 9

GEOLOGIST: BARBARA DAWSON

391947122094501
17N 2W 14 G 1

DATE: 6-3-97

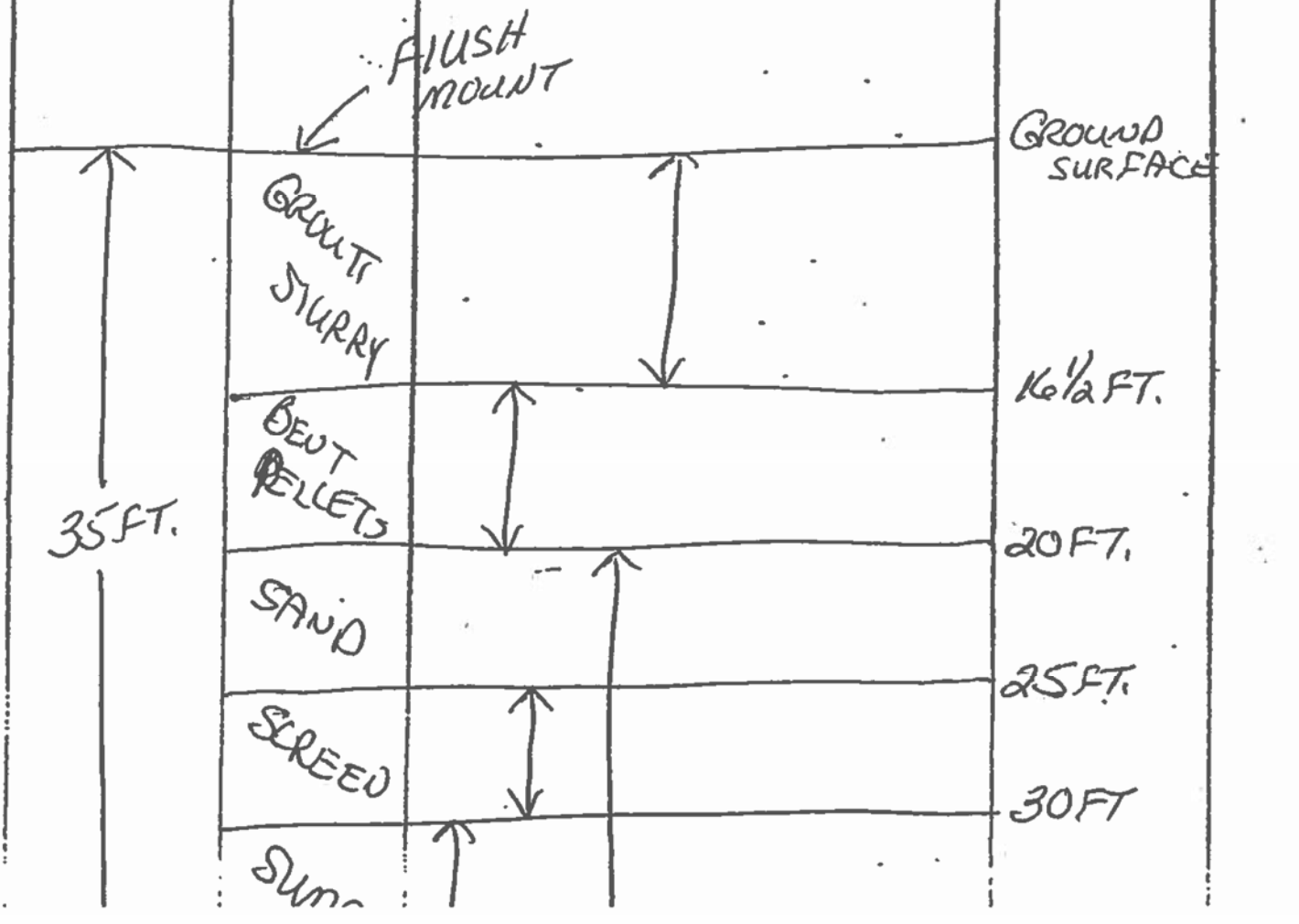
LOCATION: 17N2W14G

SITE: [redacted]

DRILL HOLE: #1

DRILLING SYSTEM: 4¼ Hollow STEM AUGERS/KNOCK OUT PLATE

DEPTH:	ROTATION PSI	PUMP PSI	DESCRIPTION OF MATERIAL	RECOVERY	CON
			SUMP	5FT.	
			.020 SCREEN	5FT.	
			BLANK PVC	25FT.	
			#2/12 SAND	6 BAGS	
			¼" BENT PELLETS	2 PAILS	
			GROUT	3 BAGS	



Drilling Log

DWR Well ID: 018N001W27B001M

[redacted]

Siteid 392328121571501 State Well No. 18N/1W-22 SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study

DRILLING LOG

State CA County Glenn Well Name (OTID) [redacted]

7.5' QUAD [redacted] Altitude _____ ft. Locatio [redacted]

Land Owner [redacted] Contact Person & # [redacted]

Driller _____ Drilling Method Auger, Hollow Stem Type of Rig CME Bit size 8 5/8 in.

Date Work Began 7/11/97 Date Work Ended 7/11/97 Borehole Diameter 8 5/8 in. Depth of Borehole 35 ft.

depth	graphic lithology	grain size, % gravel: cobble	gravel: pebble	gravel: granule	sand: very coarse	sand: coarse	sand: medium	sand: fine	sand: very fine	silt	clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
2														0-1' dry, brown silty sand, < 1/3 - 1/2 mm 1-3' moist, slightly orangish - brown sandy clay, ribbons well, easy to drill through - soft	
4														3-3.5' moist, orange-brown silty clay very hard to drill through - tight 3.5-7.5' wet, brown sandy clay, not as hard to drill - soft	
6															
8														7.5' very wet cuttings, orange-brown to light brown silty sand, very soft - easy to drill through ?9' approx. water table	
10														10' No cuttings, lots of water coming up flights	
12														11.5' hard to drill - clay, no cuttings 12-15' interbeds of silty sand & sandy clay, no cuttings water coming up flights	
14															
16														15-19' real tight - hard to drill - clay, no cuttings	
18														19-20' tighter - harder to drill than previous very little cuttings coming up w/ water	
20														20' Rig is making a lot of noise GRAVELS IN SILTY SAND pebbles in silty sand	
22														22' same - rig not making as much noise but can still feel gravels from vibrations in pipe very soft - drilling w/ no pressure	
24														~25' sample from auger flights	

Recorded By J. Shelton Date 7/11/97 Sheet 1 of 2

Siteid _____ State Well No. 18N/1W-22 SACR NAWQA Rice Land-use Study

Drilling Log Continued

depth	graphic lithology	grain size, % gravel: cobble, pebble, granule	grain size, % sand: very coarse, coarse, medium, fine, very fine	grain size, % silt	grain size, % clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
28									
30								30' coarse gravel - Rig is making a lot of noise	
31								31' back to pebbles in silty sand	
32									
34									
35									

Recorded By J. Shelton Date 7/11/17 Sheet 2 of 2

DRILLER: DAVE

LOCATION: 18N 1W 22

SITE: [redacted]

DRILL HOLE: #1

GEOLOGIST: BARBARA DAWSON

24

DATE: 7-11-97

DRILLING SYSTEM: 4¼ Hollow STEM AUGER KNOCKOUT PLATE

DEPTH:	ROTATION PSI	PUMP PSI	DESCRIPTION OF MATERIAL	RECOVERY	% CORE
			SUMP:	5 FT.	
			.020 SCREEN:	5 FT.	
			BLANK PIPE:	25 FT.	
			#2/12 SAND:	2 BAGS	
			¼" BENT PELLETS:	2 PAILS	
			GROUT:	2½ BAGS	
			FLUSH MOUNT		
			GROUND SURFACE		
			GROUT SLURRY		
			BENT PELLETS		
			SAND	20 FT	
35 FT			SCREEN	23½ FT	
			SUMP	28½ FT.	
				33½ FT	
			SILICA	FLOWING SAND	

Drilling Log

DWR Well ID: 018N002E09L001M

Siteid 392542121452501 State Well No. 18N/2E-9F1 SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study
DRILLING LOG

State CA County Butte Well Name (OTID) [redacted]

7.5' QUAD Biggs Altitude 86[illegible] ft. Locati[redacted]

Land Owner [redacted] Contact Person & # [redacted]

Driller _____ Drilling Method Auger, Hollow Stem Type of Rig CME Bit size 8 5/8 in.

Date Work Began 6/13/97 Date Work Ended 6/13/97 Borehole Diameter 8 5/8 in. Depth of Borehole 35 ft.

depth	graphic lithology	grain size, % gravel: cobble, pebble, granule	grain size, % sand: very coarse, coarse, medium, fine, very fine	grain size, % silt	grain size, % clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology, drilling comments, date, weather	well construction
2								0-3.5' dark grey-dark brown, dry, silty clay with some very fine sand, a few plant roots in 1st foot	CEMENT 1'
4								3.5-6' same as above, [illegible] moist	Bentonite Slurry
6								6-8.5' light brown-yellowish orange, wet, sandy silt with a little clay, sand ranges from 1/3-1mm,	
8								average size is 1/2 mm, very easy to dri[illegible] through, very soft	
10								8.5-12' light brown-yellowish orange, wet, sandy silt, still soft & easy to drill through	
12								12' yellowish orange silty sand with GRAVEL, Rig is making a grinding noise, gravel not coming up in cuttings	
14								13-23.5' yellowish orange silty sand with gravel, Sand is more coarse - avg size is 1mm,	14' Note: SAND/ Gravel at 14' in auger flig
16								ranges from 1/3-2mm, lots of water coming up but still	
18								not seeing gravel in cuttings - see description of gravel	18'? Bottom Bentonit seal
20								at 23.5-28.5 cuttings - gravel probably more coar with depth	flowing sands 2/12 SAND & natural gravel pack
22								23.5-28.5' yellowish orange, wet, silty sand with fine to coarse gravel, gravels in cuttings now, gravel sizes range	
24								from 5-30mm, avg size is 20mm,	
26								sub angular - well rounded, few pcs are quartz & few are reddish brown, most are grayish black	25-30' SCREEN IN SAND & gravel pack 25'

2" sch 40 threaded PVC w/ lock cap under flush mount monument cover grout

28

Recorded By J. Shelton Date 6/13/97 Sheet 1 of 2

Siteid [redacted] State Well No. 18N/2E-9 SACR NAWQA Rice Land-use Study

Drilling Log Continued

28

depth	graphic lithology	grain size, % gravel: cobble	pebble	granule	sand: very coarse	coarse	medium	fine	very fine	silt	clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
30														28.5-31' silty sand with coarse gravel, gravel ranges from 15-55mm, mostly 35-55 mm sub rounded-well rounded, most pcs are grey/black, some quartz, few are reddish brown or greenish brown; 31' Silty sand with some clay, Rig is starting to move slow	SAND PACK; gravel pack; 25-30' SCREEN; 29'; 30'; 5' sump with bottom plug in 2 1/2
32															
34														32-35' sandy clay, rig is moving slow, sand ranges from 1/2-2mm, lt brown to yellowish orange	SAND PACK
35															35' hole/casing depth

Recorded By J. Shelton Date 6/13/97 Sheet 2 of 2

Driller: DAVE 15 Drilling Eq:

Date: 6-13-97

Location: 18N269

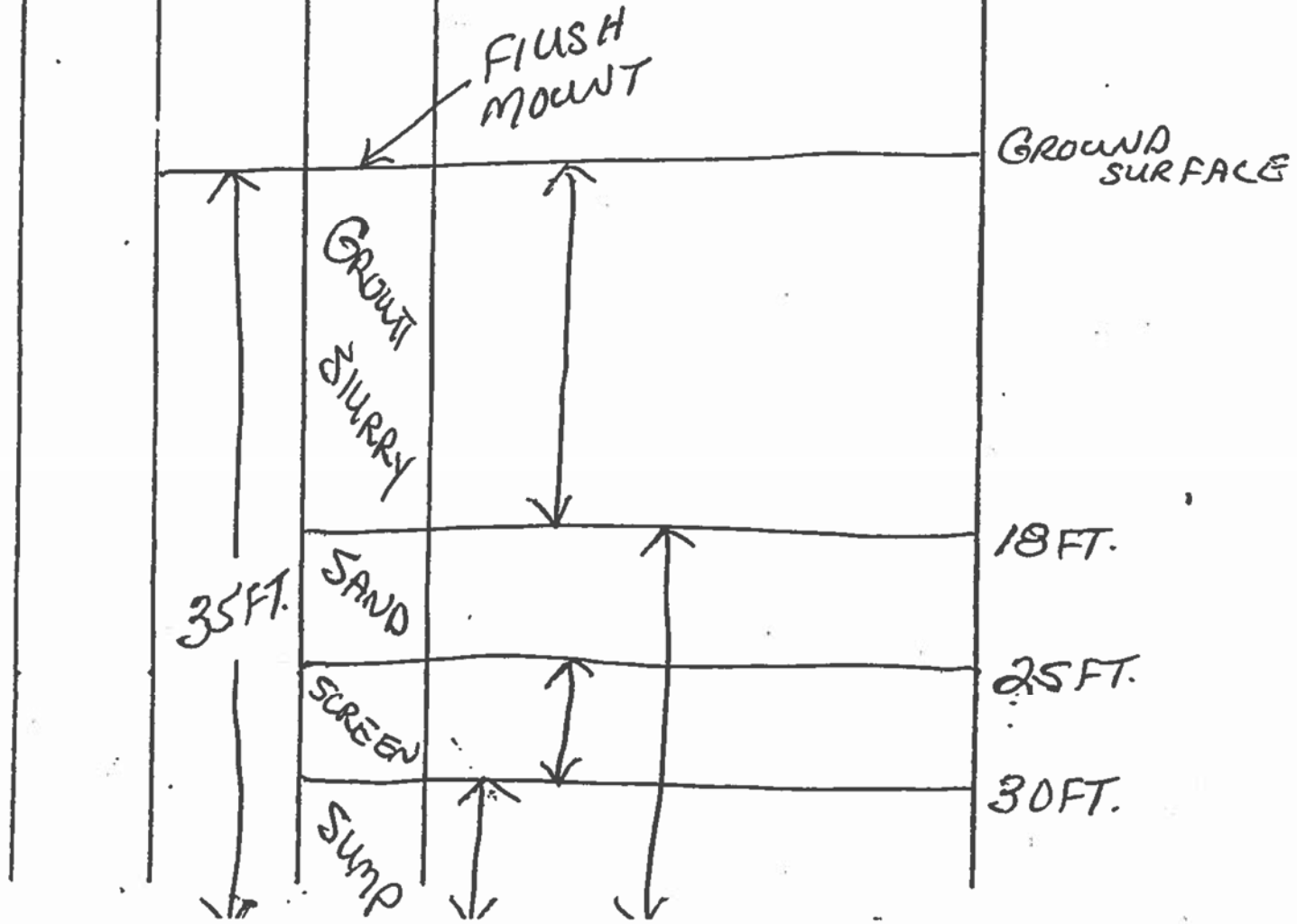
Geologist: BARBARA

Drilling System: 4¼ Hollow STEM AUGERS / KNOCK-OUT PLATE

Drill Hole: [redacted] [redacted]

Site: #1

Depth	Rotation PID	Instrumentation HNU	Instrumentation CGI	Description Of Material	Water Content & Remarks
				SUMP	5 FT.
				.020 SCREEN	5 FT
				BLANK PVC	25 FT.
				#2/12 SAND	3 BAGS
				¼" BENT PELLED	0 PAILS
				GROUT	3 BAGS



Drilling Log

DWR Well ID: 018N002W12G002M

[redacted]

Siteid 392545122015201 State Well No. 18N/2W-12F1 SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study

DRILLING LOG

State CA County Glenn Well Name (OTID) [redacted]

7.5' QUAD [redacted] Altitude _____ ft. Locati[redacted]

Land Owner [redacted] Contact Person & # [redacted]

Driller _____ Drilling Method Auger, Hollow Stem Type of Rig CME Bit size 8 5/8 in.

Date Work Began 7/15/97 Date Work Ended 7/15/97 Borehole Diameter 8 5/8 in. Depth of Borehole _____ ft.

depth (in feet)	graphic lithology	grain size, % gravel: cobble	gravel: pebble	gravel: granule	sand: very coarse	sand: coarse	sand: medium	sand: fine	sand: very fine	silt	clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
0														0-1/2' Sand mixed w/gravel from Rd ww 1/2-3' dry, dark brown silty sand	
2														3-6' moist, dark brown silty sand	
4															
6														6-11.5' moist, lt. brown-orange brown silty clay with some sand (~5%) sand grains are about 0.5mm size mostly no visible grains ribbons	
8															
10														11.5' cuttings stop coming up, driller said this is probably where the water zone starts ? w.t.	
12														11.5-16' lt brown silty clay w/some sand	
14															
16														16' tight-hard to drill-silty clay	
18														17' soft-easy to drill, starting to see water in hole, still no cuttings silty sand w/ some clay	
20														18.5' very hard to drill-clay 19' soft-cuttings starting to come up with water-silty sand w/clay 20' very hard-clay	
22														20.5' soft-silty sand w/clay 21.5 very hard-clay	
24														22' soft-mostly liquid cuttings silty sand w/clay	
26														26.5' very soft-silty sand w/clay & pebbles	
28															

Recorded By J. Shelton Date 7/15/97 Sheet 1 of 2

Siteid 392545122015201 State Well No. 18N/2W-12F1 SACR NAWQA Rice Land-use Study

Drilling Log Continued

depth	graphic lithology	grain size, % gravel: cobble	pebble	granule	sand: very coarse	coarse	medium	fine	very fine	silt	clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
28														Silty sand w/ clay & pebbles	
30															
														31' rig making noise - gravel silty sand w/ gravel	
32															
34															
35														35' stop drilling	
														Well construction:	
														Left site w/ flush mounted monument cover installed	
														0-2' cement	
														2' Top of Enviroplug grout	
														15' Top of 1/4" coated Bentonite pellets	
														19' Bottom of seal/Top of sand	
														19-20' CAVE-IN	
														20-25' SAND PACK	
														25-30 5' screen in 2/12 SAND PACK	
														30-35' 5' sump in 2/12 SAND PACK	

Recorded By J. Shelton Date 7/15/97 Sheet 1 of 2

3925451220152O1

27

DRILLER: DAVE

GEOLOGIST: BARBARA DAWSON

DATE: 1-15-97

LOCATION: [redacted]

SITE: [redacted]

DRILL HOLE: #1

DRILLING SYSTEM: 4¼ Hollow Stem Auger
KNOCK-OUT PLATE

DEPTH:	ROTATION PSI	PUMP PSI	DESCRIPTION OF MATERIAL	RECOVERY	U CON
			SUMP:	5FT.	
			.020 SCREEN:	5FT.	
			BLANK PVC:	25FT.	
			#2/12 SAND:	5 BAGS	
			¼" BENT PELLETS:	2 PAILS	
			GROUT:	3 BAGS	
			FLUSH MOUNT		
				GROUND SURFACE	
			GROUT SLURRY		
				15FT.	
			BENT PELLETS		
35FT.				LITLE SLUFF	
				20FT.	
			SAND		
				25FT.	
			SCREEN		
				30FT.	
			Sump		

Drilling Log

DWR Well ID: 018N001E08D001M

[redacted]

Siteid _____ State Well No. 18N/1E SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study

DRILLING LOG

State CA County Glenn Well Name (OTID) 18N/1E

7.5' QUAD _____ Altitude _____ ft. Location Butte City

Land Owner [redacted] Contact Person & [redacted]

Central Region USGS
Driller Dave Rader Drilling Method Auger, Hollow Stem Type of Rig CME Bit size 8 5/8 in.

Date Work Began 6/5/97 Date Work Ended 6/5/97 Borehole Diameter 8 5/8 in. Depth of Borehole 38.5 ft.
(* indicates change) Cemented 6/5/97, after grout set for ~ 3 hrs

depth	graphic lithology	grain size, % gravel: cobble, pebble, granule	grain size, % sand: very coarse, coarse, medium, fine, very fine	grain size, % silt	grain size, % clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
1st auger 0-5'								0-5' dark brown - dark grey, hard moist clay with some silt, slightly hard to drill through	
2									
4									
2nd	*							5-8' dark grey clay, moist	
6									
8.5' 8	*							8-12' light grey, moist, clay with some silt; a little bit softer to drill through than at 5-8'	
3rd 10									
12	*								
13.5' 14	*							12-14' light grey-brown, moist silty clay	
4th								14-17.5' light brown - yellowish orange, silty clay with some fine sand (0.3 - 0.4 mm)	
16								water is coming up with cuttings	
17.5' H2O 18								17.5-19' WET, yellowish-orange, soft, clayey silt with fine sand	
18.5'	*								
5th 20								19-21.5' light brown - yellowish orange, wet, silty clay; hard to drill through	
21.5' 22								21.5-23.5' yellowish orange, wet, soft, clayey silt with fine sand	
23.5' 24	*							23.5-25' light brown-yellowish orange silty clay, slightly harder to drill through	
6th	* H2O							25-28' yellowish orange, very wet, sandy silt with some clay; very soft to drill through	
28								28' hard to drill through; grey clay, wet	
28.5'	*								

Recorded By JJ Shelton Date 6/5/97 Sheet 1 of 3

[redacted]

Siteid _____ State Well No. 18N | 1E _____ SACR NAWQA Rice Land-use Study

Drilling Log Continued

depth	graphic lithology	grain size, % gravel: cobble	pebble	granule	sand: very coarse	coarse	medium	fine	very fine	silt	clay	cuttings	core	Descriptions color, sorting, grain texture, lithology drilling comments, date, weather	well construction
28.5														28.5-32.5' light brown-yellowish orange silty clay with fine sand, easier to drill through (softer), wet	
32.5														32.5-36.5' light brown silty clay; harder to drill through, wet	
36.5														36.5-38' light brown-yellowish orange silty clay with some fine sand, wet	
38.5														38-38.5' grey clay, hard to drill through	38.

Recorded By J. Shelton Date 6/5/97 Sheet 2 of 3

[redacted]

Siteid _____ State Well No. 18N/1E SACR NAWQA Rice Land-use Study

Flush mounte
Steel
monument
cover

Drilling Log Continued

depth	graphic lithology	grain size, % gravel: cobble, pebble, granule	grain size, % sand: very coarse, coarse, medium, fine, very fine	grain size, % silt	grain size, % clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
								CONCRETE	
5								BENTONITE SLURRY ~20% solids (~4 - 50lb bags ENVIRO PLUG)	
10									~20' PVC blank 2" threaded
15								TOTAL BENTONITE SEAL = 22'	
19'									
20								5' ¼" Bentonite Pellets (2-50 lb buckets)	
24'									
25								14.5' SAND PACK (5½ - 94 lb bags 2/12 SAND)	
30									5' screen
35									~5' sump
38.5'									
40									

264 loci ca on we cas

8.5

19

24

28.

33

38.5 hole casi dep

Recorded By J. Shelton Date 6/5/97 Sheet 3 of 5

Drilling Log

DWR Well ID: 019N003W25R001M

Siteid 392810122080901 State Well No. 19N/3W-25 SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study

DRILLING LOG

State CA County Glenn Well Name (OTID) [redacted]

7.5' QUAD Logandale Altitude _____ ft. Location [redacted]

Land Owner [redacted] Contact Person & # [redacted]

USGS Central Region

Driller Dave Rader Drilling Method Auger, Hollow Stem Type of Rig CME Bit size 8 5/8 in.

Date Work Began 6/4/97 Date Work Ended 6/4/97 Borehole Diameter 8 5/8 in. Depth of Borehole 38.5 ft.

? Completed 6/97

depth	graphic lithology	grain size, % gravel: cobble	pebble	granule	sand: very coarse	coarse	medium	fine	very fine	silt	clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology, drilling comments, date, weather	well construction
2														0-3.5' light brown silty clay with some very fine sand (<0.4mm) Dry, almost ribbons but crumbles	
4															
6														3.5-8.5' Light brown to yellowish orange silty clay w/v. fine sand, more clay than 0-3.5, slightly moist, makes a ribbon but crumbles,	
8	*7'													7' cuttings become moist	
10	*9.5													8.5-9.5' same as 3.5-8.5 9.5' Color change: yw orange to greenish grey brown silty sand w/some clay, more wet, ribbon holds together	
12														softer/easier to drill through, smooth	
14														13.5-18.5' same as 9.5-13.5' but softer and very smooth	
16															
18															
20														18.5-22.5' same color, slightly harder clay interbeds < 1/2', cuttings are balled up into road apples ~4" diameter, sample will make a very long ribbon	
22	*22.5	X													
24														22.5-25' light brown silty sand with black & white, angular, bimodal size (1/2 & 1 1/2 cm) gravels ranging from 3mm-2.25cm, mostly	
26	*													25' slightly harder to drill through	
														25-28.5' Alternating hard (silty clay) and soft sandy silt with clay interbeds < 1/2 ft each	

Recorded By J. Shelton Date 6/4/97 Sheet 1 of 3

DRILL SITE = [illegible]

Siteid 392810122080901 State Well No. 19N/3W-25R SACR NAWQA Rice Land-use Study

Drilling Log Continued

depth	graphic lithology	grain size, % gravel: cobble	gravel: pebble	gravel: granule	sand: very coarse	sand: coarse	sand: medium	sand: fine	sand: very fine	silt	clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
28															
	28.5 *													28.5' soft to drill through again	
30														28.5 - 33.5' lots of H2O coming up, cuttings contain more sand & sand is more coarse (~1 mm largest), but mostly fine sand & silt: sandy silt w/ some clay	
	* 33'													33' - 33.5 hard to drill through - silty clay	
	*													36 - 36.5' hard to drill through - silty clay	
38	*													38 - 38.5 harder to drill through than at 33, clay	
38.5															38.5

Recorded By J. Shelton Date 10/4/97 Sheet 2 of 3

[redacted]

Siteid 392810122080901 State Well No. 19N/3W-25R SACR NAWQA Rice Land-use Study

Fri. 6/6/97 ↓ Pour concrete & set 2640 lock cap w/flush mounted monument cover

Drilling Log Continued

depth	graphic lithology	grain size, % gravel: cobble, pebble, granule	grain size, % sand: very coarse, coarse, medium, fine, very fine	grain size, % silt	grain size, % clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction

Well Construction Summary Log

- Concrete ~2.5' (may set up after dried)
- 8.5'
- ~20' PVC
- ENVIRO PLUG ~21' Bentonite seal (4 bags)
- 23.5'
- 15' SAND PACK 2/12 SAND (5 1/2 bags)
- 28.5'
- ~0.02" 5' Screen
- 33.5'
- ~5' pvc Sump
- 38.5'

Recorded By J. Shelton Date 6/4/97 Sheet 3 of 3

10.

3928101220809O1

DRILLER: DAVE

GEOLOGIST: BARBARA DAWSON

DATE: 6-4-9

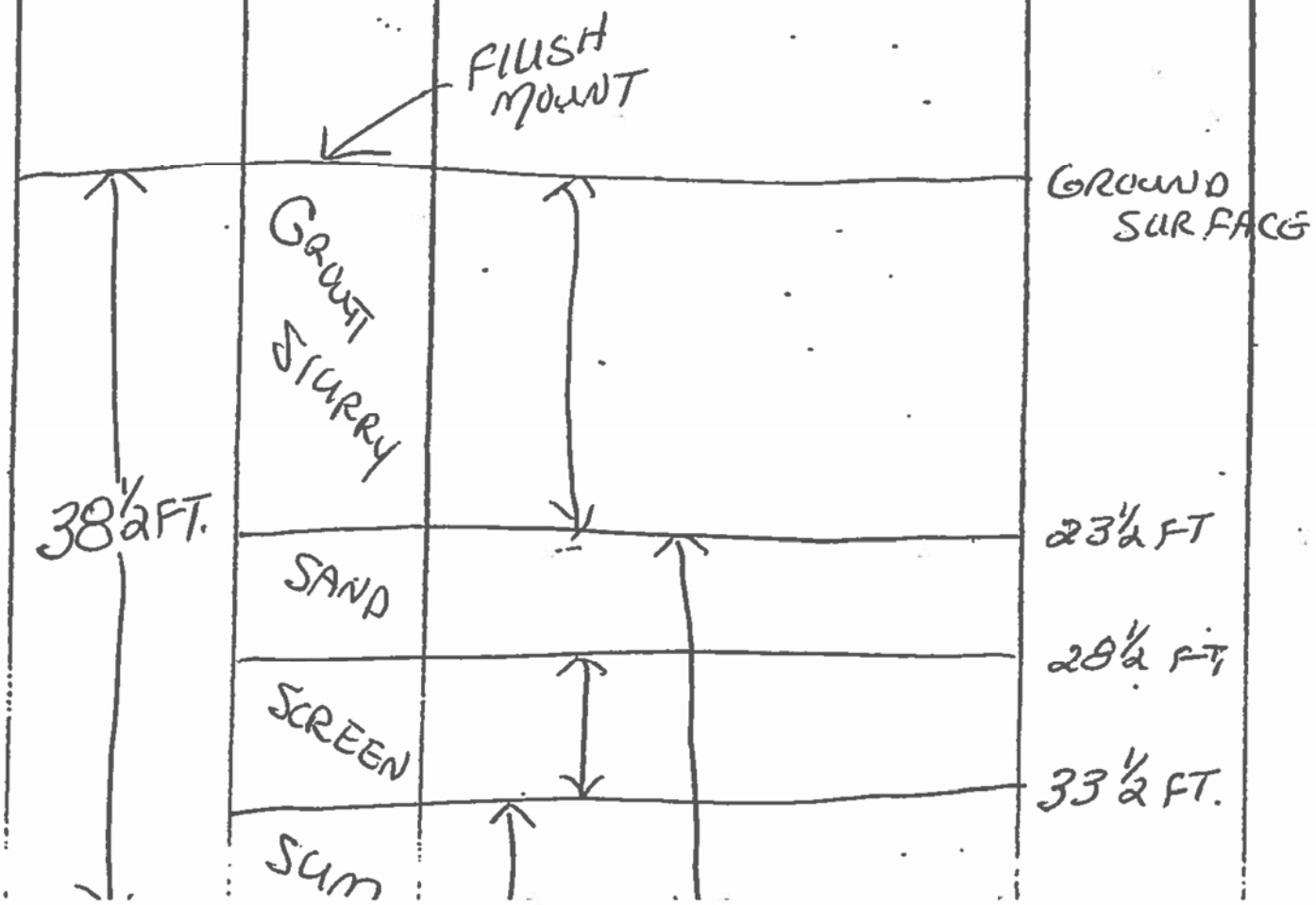
LOCATION: 17N3W25

SITE: [redacted]

DRILLING SYSTEM: 4¼ Hollow Stem AUGERS/KNOCK-OUT PLATE

DRILL HOLE: #1

DEPTH:	ROTATION PSI	PUMP PSI	DESCRIPTION OF MATERIAL	RECOVERY	CON
			SUMP	5 FT.	
			.020 SCREEN	5 FT	
			BLANK PVC	28½ FT.	
			#2/12 SAND	5 BAGS	
			¼" BENT PELLETS	0 PAILS	
			GROUT	4 BAGS	



Drilling Log

DWR Well ID: 019N003W25E001M

DRILLER: DAVE 18

GEOLOGISTS: BARBARA DAWSON

DATE: 6-15-97

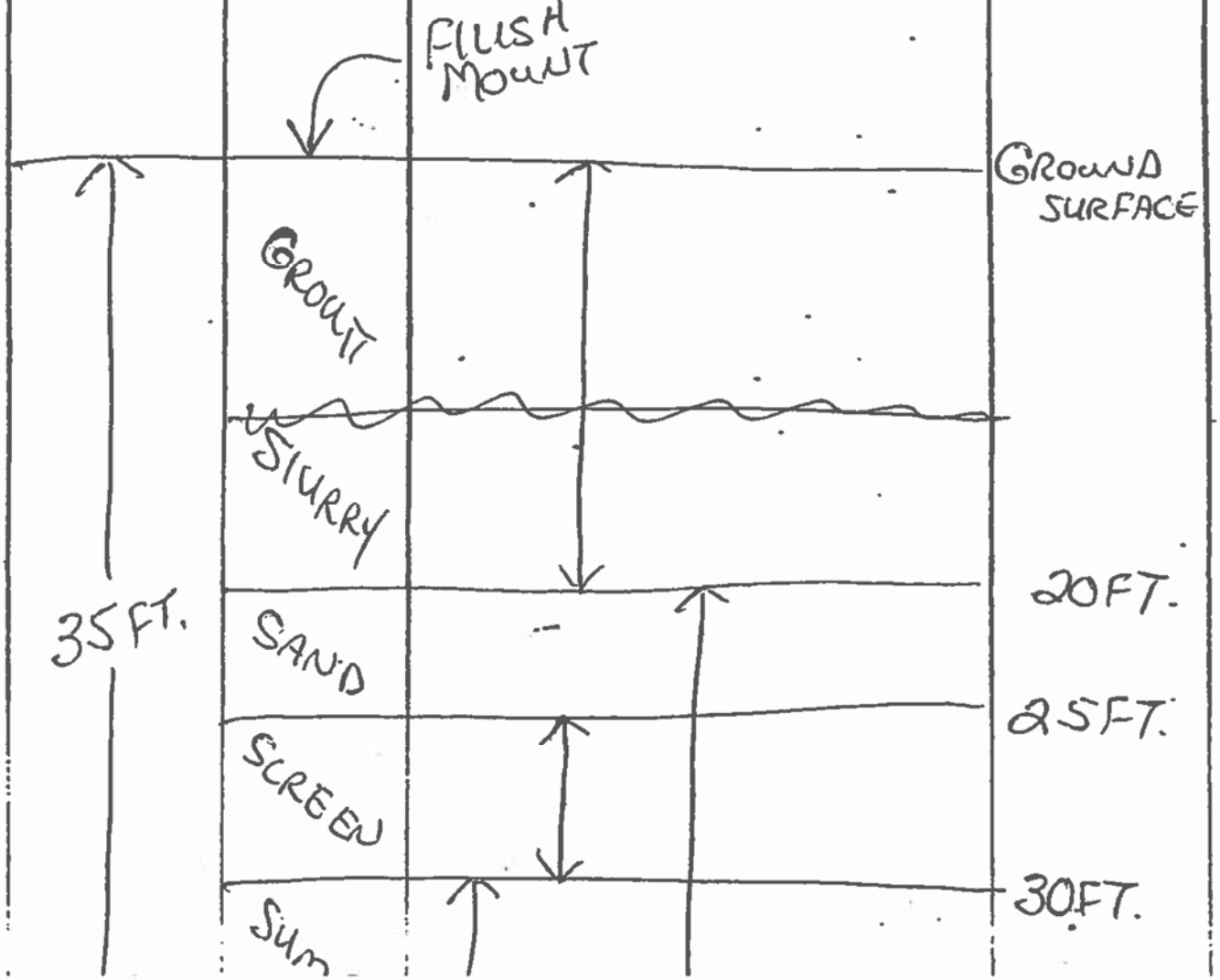
LOCATION: 19N3W26

SITE: [redacted]

DRILL HOLE: #3

DRILLING SYSTEM: 4¼ Hollow STEM AUGERS / KNOCK-OUT PLATE

DEPTH:	ROTATION PSI	PUMP PSI	DESCRIPTION OF MATERIAL	RECOVERY	W/ CONT.
			SUMP!	5 FT.	
			.020 SCREEN	5 FT	
			BLANK PVC	25 FT.	
			#2/12 SAND	3½ BAGS	
			¼ BENT PELLETS	0 PAILS	
			GROUT	4 BAGS	



Siteid 392824122091401 State Well No. 19N3W26 25E1 SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study

DRILLING LOG

State CA County Glenn Well Name (OTID) [redacted]

7.5' QUAD Logandale Altitude _____ ft. Location _____

Land Owner [redacted] Contact Person & # _____

Driller Reiner Drilling Method Auger, Hollow Stem Type of Rig CME Bit size 8 in.

Date Work Began 6/15/97 Date Work Ended 6/15/97 Borehole Diameter 8 in. Depth of Borehole 35 ft.

depth	graphic lithology	Descriptions color, sorting, grain texture, lithology drilling comments, date, weather	well construction
9:28a		Med Dark brown stiff clay almost no sand; some rust colored spots inside larger clay pieces	
5		lighter brown clay - easier to mold w/fingers some coarse sand - 1mm lithic weathered frags -	
10		stiffer light tan brown clay - coils more around flights - some coarse sand - wetter than above?	
		hard layer at 13ft for a few inches - then soft drilling again	
15		14-16ft = tight hard drilling	
		16-20 - soft drilling - no return	
20		Soft - hit gravel 23 feet - some arkosic? light tan sandy? water return - fine sand	
25		clay coiling around flights - also clayey fine sandy water	
30		less gravel - tighter again at 33 ft	
35		STOPPED	
rouad 10:00a		Formation collapsing around casing as flights pulled up	
		large gravel - 2.5-3cm rounded lithic-metamorphic, up to 5cm	

Recorded By B&M Dawson Date 6/15/97 Sheet 1 of 1

Drilling Log

DWR Well ID: 019N001E22B001M

ORIGINAL MISSING!

Siteid _____ State Well No. 19N/1E-22 SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study

DRILLING LOG

State CA County Butte Well Name (OTID) [redacted]

7.5' QUAD _____ Altitude _____ ft. Locati[redacted]

Land Owner [redacted] Contact Person & # [redacted]

Driller Dave Roder Drilling Method Auger, Hollow Stem Type of Rig CME Bit size 8 5/8 in.

Date Work Began 6/12/97 Date Work Ended 6/12/97 Borehole Diameter 8 5/8 in. Depth of Borehole 35 ft.

* indicates change - cemented 6/14/97 ssd.?

depth	graphic lithology	grain size, % gravel: cobble, pebble, granule	sand: very coarse, coarse, medium, fine, very fine	silt	clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
0								0-2' brown-olive grey hard silty clay	cement grou[t] flush mount[ed] cover
2	* color							2-4.5' light brown-yellowish orange soft clayey silt with fine sand, ribbons a little but falls apart moist	top of Bentonite slurry
4	* wet							4.5-8' Clayey silt with fine sand, wet ribbon's well, softer-but same color as above	Bentonite Seal (slurry)
6									
8	* soft								
10								8-12.5' Sandy silt with some clay, sand is more coarse than above, sizes 1/3-1/2 mm, very easy to drill through	
12	* hard							12.5-22.5' silty clay with fine sand, hard to drill through, no cuttings coming up while drilling-primary hydraulic pressure gauge at or above 1,000 PSI throughout, no interbeds	1/4" Bentonite Pellets — 15.5' Top of pellets
14									
16									
18									
20									20' Bo[ttom] Bentonite Seal
22	* interbeds start								Top of 15' SAND PACK
24								22.5-23.5' Clayey silt with fine sand, small dip in hydraulic pressure gauge; 23.5-24' silty clay with fine sand; 24-25' silty sand, very easy to drill through	25' Top of screen
26								25-26.5' silty clay with some fine sand, hard to drill through	5' screen
28								26.5-28' Interbeds - soft/hard to drill through	

Recorded By J. Shelton Date 6/12/97 Sheet 1 of 2

Siteid _____ State Well No. 10N/1E-22 SACR NAWQA Rice Land-use Study

Drilling Log Continued

depth	graphic lithology	grain size, % gravel: cobble	gravel: pebble	gravel: granule	sand: very coarse	sand: coarse	sand: medium	sand: fine	sand: very fine	silt	clay	cuttings	core	Descriptions — color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
28'															
30	* 28' soft													28-31' silty sand, very easy to drill through	5' screen in 2/12 SAND
32	* hard * interbed * very hard													31-32' silty clay, hard to drill through 32-32.5' interbed of softer material 33-35' silty clay, very hard to drill through	5' Sump with Bottom Plug in SAND
35															35' hole/ casing depth

Recorded By J. Shelton Date 6/12/97 Sheet 2 of 2

Drilling Log

DWR Well ID: 019N002W23E001M

MOUNT SOPRIS INSTRUMENT COMPANY,INC.
17301 WEST COLFAX AVENUE SUITE 255
GOLDEN CO 80401 USA
PHONE (303)279-3211 FAX: (303)279-2730

LOGGING REPORT

on site ~ 100pm
offsite 155pm

Date 1/28/98 Page ___ of ___

Hydrologist(s) Dawson / Cronfong

Truck ___

Well Depth: 35.5
Screen Depth: 25.5-30.5

Weather: Cloudy Sprinkles during ~~EM Run~~ (#2)

Elevation 80 Depth Ref land surface

State ___ County ___

Drilling Contractor USGS CR Drill Type Auger

Run No.	Tools	Speed Ft/Min	Time Start / Stop	Depth Bot Log / Top Log	Depth Error	Digital File Name / Digital Interval	Remarks/Comments	Fluid Level E-tape
1	Model: SN: / Module SN:	~12	1323 / 1326	34.7 / 3.7		rdvvgl	PGA 1000 Natural Gamma 3.71	2.24 ft 1311 pm
2	Model: SN: / Module SN:	~12	1338 / 1340	32.8 / 4.8		rdvvcl	2PIA 1000 Conductivity 0 to 1000 mS/m 4.85	2.28 ft 1347 p
	Model: SN: / Module SN:							
	Model: SN: / Module SN:							
	Model: SN: / Module SN:							
	Model: SN: / Module SN:							
	Model: SN: / Module SN:							
	Model: SN: / Module SN:							

Drilling Log

DWR Well ID: 019N001E09C002M

State Well No. _____ SACR NAWQA _____

Drilling Log Continued

depth	graphic lithology	Descriptions color, sorting, grain texture, lithology drilling comments, date, weather	well construction
		Surface sample	
Start	1045	10yr 6/3	
1	1045	dark brn silty sandy clay very dry.	
		2.5y 3/2	
3		clay some silt slightly damp, hard	
		2.5y 3/2	
Start	1052	same as above less silt more damp	
5		2.5y 3/2	
		soft clay no silt	
7		2.5y 4/3 mottled w/ some clay similar to above (5ft	
Start	1105	sticky, goopy clay, some silt/fine sand	
10		2.5y 5/4	
Stop	1110	wet soupy ~~clay silt~~	
15			
Start	1114	10yr 5/5 silt	
		same as above	
Stop	1120		
20			
Start	1127	tough clay, some silt, came up in ribbons	
25		10yr 4/3 around the auger. barely damp	
Stop	1133		
Start	1137	fine sand, silty, wet	
30		OR 5y 5/4	
Stop	1143		
Start	1149	fine sand/silt as above, wet	
35		OR 5y 5/4	
Stop	1152		
Start	1210	as above wet	
40		5y 5/4	
Stop	1212		
Start	1217	as above wet	
45		5y 5/4	
Stop	1219		
~~Stop~~	~~[redacted]~~		
Start	1225		
Stop	1227		

Recorded By Diane Lewis Date 6/1/06 Sheet 1 of 2

Siteid 393648121527401

019N001E09C002M

State Well No. _____ SACR NAWQA

(4) (2)

Drilling Log Continued

depth	graphic lithology	Descriptions color, sorting, grain texture, lithology drilling comments, date, weather	well construction
		auger flt 5ft x	
5ft		• casing ~~string~~ together in hole	
		• 5ft stickup	
		• 15 ft of sand (#3) 3.5 bags	
		to 30 ft bls	
		• 1 ft pellets	
		• 29 ft Pureboldgrout 6 bags	
		to surface	
		• well head installed	
		top of well head abt 6 in. abt PVC	
25	(2)	• 3 bags Portland Cement	
	20's	Well abandonment CADFG1	
		• dug down ~~abt~~ abt 2ft	
		• cut off PVC abt 1.8ft frm surface	
		• pressure pumped 2 bags	
		Pureboldgrout (4.4 ft³)	
		• capped PVC	
		• covered PVC w/ 3 (three)	
		• ~~cement~~ filled in hole	
35		Diane Lewis 6/2/06	
		screen (1)	
40			
		sump 5ft (1)	
45			

Recorded By Diane Lewis Date 6/1/06 Sheet 2 of 2

Drilling Log

DWR Well ID: 020N002W32J001M

[redacted]

Siteid 393235122055301 State Well No. 20N/2W-32J SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study

DRILLING LOG

State CA County Glenn Well Name (OTID) [redacted]

7.5' QUAD Willows Altitude _____ ft. Location Willows

Land Owner [redacted] Contact Person & # [redacted]

USGS-Central Region

Driller Dave Rader Drilling Method Auger, Hollow Stem Type of Rig CME Bit size 8 5/8 in.

Date Work Began 7/10/97 Date Work Ended 7/11/97 Borehole Diameter 8 5/8 in. Depth of Borehole 35 ft.

depth (feet)	graphic lithology	grain size, % gravel: cobble, pebble, granule	grain size, % sand: very coarse, coarse, medium, fine, very fine	grain size, % silt	grain size, % clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
2								0-1' dark brown, dry, sandy silt (sand < 1/3mm)	cement
								1-4' olive gray-brown, moist, silty clay w/ some sand (< 5%), ribbons	
4								4-11' light brown silty clay, ribbons, easy to drill through	
6									
8									
10									
12								11' light brown-orange brown silty clay slightly hard to drill through	
								12' lt. brown, wet, silty clay w/ fine sand (sand < 1/3mm)	
14									
16									
18								17' lt brown silty clay, a little hard to drill through	1/4" coated Bentonite Pellets
								18.5' Cuttings not coming up, little chatter in augers, silty sand (? pebbles)	
20								19-22' No cuttings - hard to drill through, silty clay	2/12 SAND
22								22-22.5' silty sand - soft/easy to drill	
								22.5-23.5' silty clay - slightly hard to drill	
24								23.5-28.5' yellowish brown, wet, silty sand (v. fine - fine sand = < 1/3mm - 1/3mm), a little chatter in auger cuttings - pebbles? Two clayey interbeds from 23.5-28.5	5' screen SAND
26									
28									

8" steel flush mounted monument cover
ground
10' PVC
Top of Bentonite grout
20' PVC blank
16' Top of pellet
Bottom of seal 20'
Top of 15' SAND PACK
25' Top of screen

Recorded By J. Shelton Date 7/10/97 Sheet 1 of 2

[redacted]

Siteid 393235122055301 State Well No. 20N/2W-32J SACR NAWQA Rice Land-use Study

Drilling Log Continued

28

depth	graphic lithology	grain size, % gravel: cobble, pebble, granule	grain size, % sand: very coarse, coarse, medium, fine, very fine	grain size, % silt	grain size, % clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
30								28.5 - 30.5' sandy silt	5' screen in sand
								30.5 - 31' slightly harder to drill silty clay w/ v. fine sand	30' Bottom of screen
32								31 - 32.5' silty sand or sandy silt? - soft easy to drill	5 ft PVC blank w/ bottom cap in 2 1/2 drill hole
								32.5' tight - slightly harder to drill silty clay	
34								33 - 35' 2 1/2 ft interbeds of silty sand & silty clay - hard! easy to drill through	
35									35' hole/ casing depth

Recorded By J. Shelton Date 7/10/97 Sheet 1 of 2

DRILLER: DAVE GEOLOGIST: BARBARA 23 DATE: 7-10-97

LOCATION: #20N2W32B2S DAWSON

SITE: [redacted] 393235122055301

DRILL HOLE: #1

DRILLING SYST: 4¼ Hollow STEM AUGER, KNOCK-OUT PLATE

DEPTH:	ROTATION PSI	PUMP PSI	DESCRIPTION OF MATERIAL	RECOVERY	% COR
			Sump	5 FT.	
			.020 SCREEN	5 FT.	
			BLANK PVC	25 FT.	
			#2/12 SAND	5 3/4 BAGS	
			¼" BENT PELLETS	2 PAILS	
			GROUT	2½ BAGS	
		FLUSH MOUNT			
				GROUND SURFACE	
		GROUT SLURRY		16 FT.	
		BENT PELLETS		20 FT.	
35 FT		SAND		25 FT.	
		SCREEN		30 FT.	
		SU...			

Drilling Log

DWR Well ID: 020N002W25A001M

[redacted]

Siteid 393353122013501 State Well No. 20N/2W-25A1 SACR NAWQA Rice Land-use Study

Department of the Interior, United States Geological Survey, Water Resources Division
Sacramento NAWQA Ground-water Rice Land-use Study

DRILLING LOG

State CA County Glenn Well Name (OTID [redacted]

7.5' QUAD Glenn Altitude [redacted]

Land Owner [redacted]

Driller Central Region - USGS Dave Rader Drilling Method Auger, Hollow Stem Type of Rig CME Bit size 8 5/8 in.

Date Work Began 7/14/97 Date Work Ended 7/16/97 Borehole Diameter 8 5/8 in. Depth of Borehole 35 ft.

7/17/97 cemented & installed flush mounted monument cover

depth (feet)	graphic lithology	grain size, % gravel: cobble, pebble, granule	grain size, % sand: very coarse, coarse, medium, fine, very fine	grain size, % silt	grain size, % clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
0									flush mounted monument cover
2								0-3.5' dry, grey-black silty clay w/sand ? gravel @ 3' — might be from road being built up	10' blank PVC; PVC cut below surface; cement ~2'
4								3.5' moist, grey-black sandy clay w/silt soft - easy to drill, sand ~0.3mm	Top of Bentonite Grout (2-50lb bags)
6								5' lt brown-olive grey sandy clay w/silt soft - easy to drill	
8									
10								10' sandy clay w/silt — less sand slightly tighter than previous	
12									
14								14' clay, tight - hard to drill 14.5' sandy clay w/silt	
16								16' wet, silty sand w/clay, sand ranges from <0.3-1mm, avg size 0.3mm very wet cuttings very soft - drilling w/no pressure	20' blank PVC; Bentonite; 16' = Top of 1/4" coated Bentonite Pellets (2-50lb bags)
18									Pellets
20								18.5 wet, lt brown silty sand <1% pebbles ~2-3mm, sand ranges from 0.5-1mm — took sample very soft - drilling w/no pressure	20' = Bottom of seal/Top of sand pack (5 1/4 - 94lb bags)
22									2/12 SAND PACK
24									
26									25' = Top of screen; 5' screen in 2/12 sand
28									

Recorded By J. Shelton Date 7/16/97 Sheet 1 of 2

[redacted]

Siteid _____ State Well No. 20N/2W- _____ SACR NAWQA Rice Land-use Study

Drilling Log Continued

28

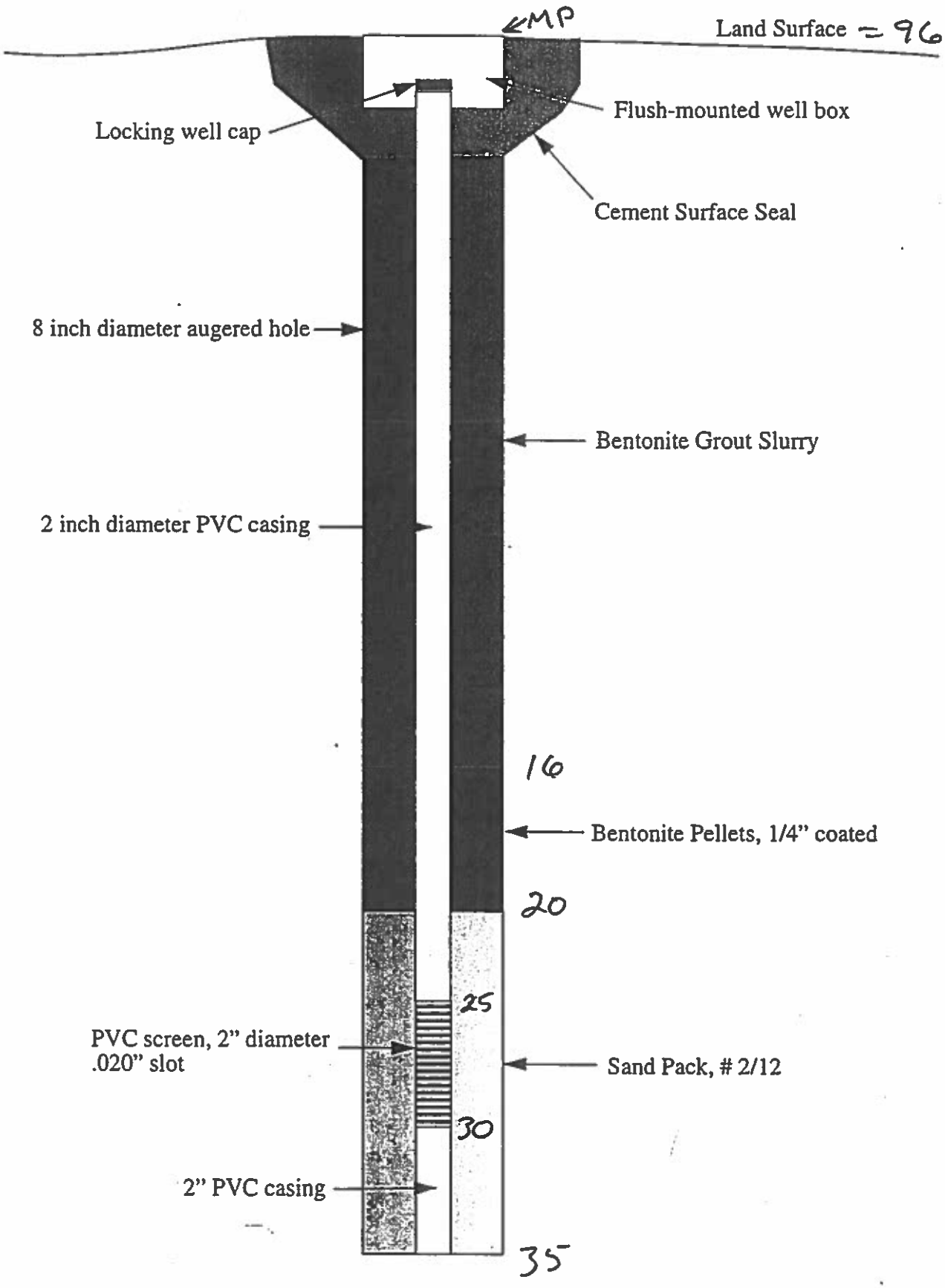
depth	graphic lithology	grain size, % gravel: cobble, pebble, granule	grain size, % sand: very coarse, coarse, medium, fine, very fine	grain size, % silt	grain size, % clay	cuttings	core	Descriptions: color, sorting, grain texture, lithology; drilling comments, date, weather	well construction
30									25-30' screen in 2/12 SAND PACK; 30' = bottom of screen
									5' sump in 2/12 SAND PACK
32									
								33.5' sandy clay, a little tighter - harder to drill 34' silty sand - soft 34.5-35' tight - sandy clay w/ silt	
34									
35									35' = hole / casing depth

Recorded By J. Shelton Date 7/16/97 Sheet 2 of 2

393353122013501

United States Geological Survey [redacted] Sacramento Basin NAWQA

WELL CONSTRUCTION 20N 2W 25A1 **Rice Land-Use Study**



Drilling Log

DWR Well ID: 020N002E08A001M

393630121455401

United States Geological Survey

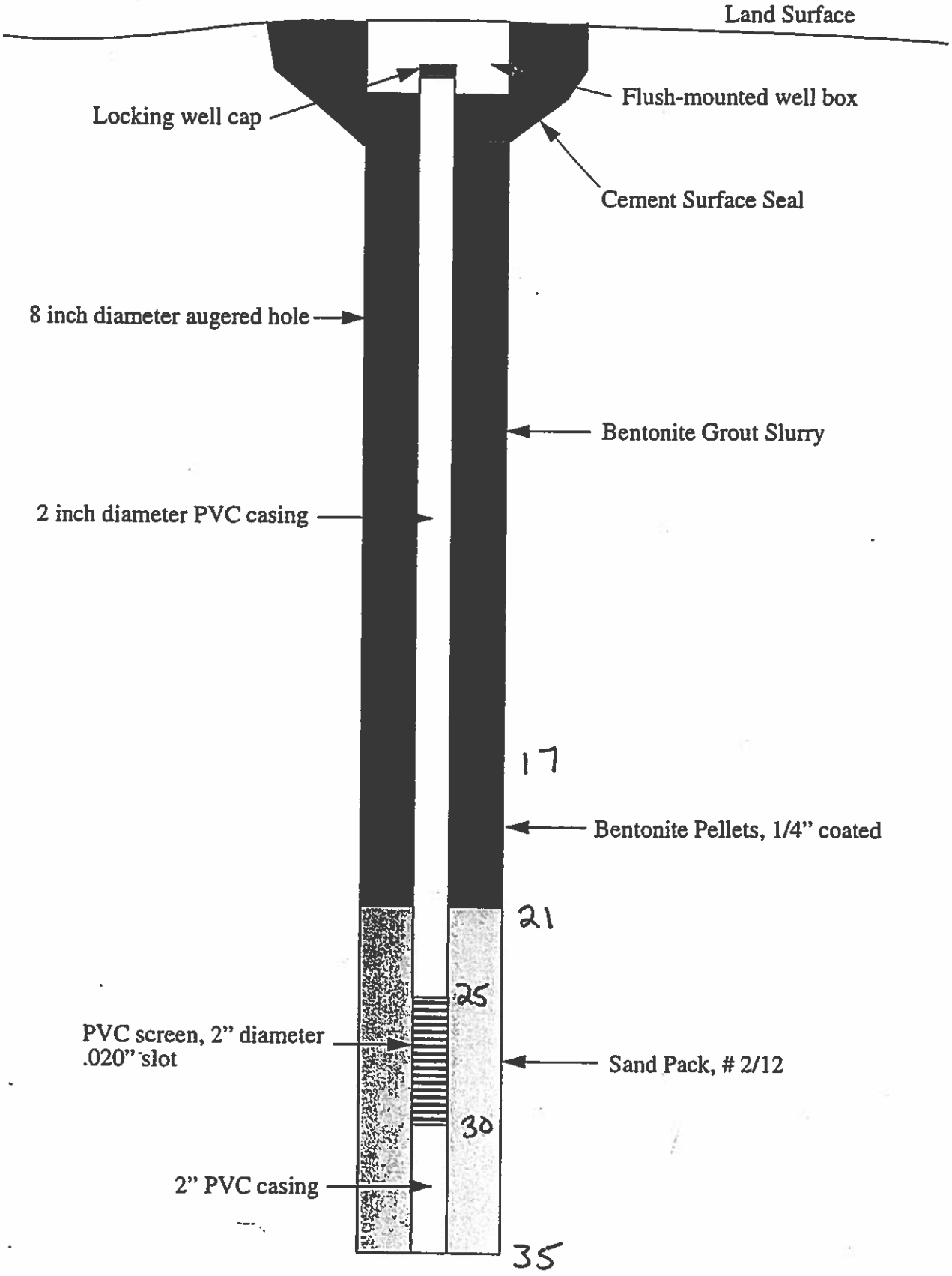
WELL CONSTRUCTION

[redacted]

20N 2E 8A1

Sacramento Basin NAWQA

Rice Land-Use Study



Appendix B
Groundwater Quality Assurance Project Plan

APPENDIX B

Quality Assurance Project Plan for California Rice Commission Groundwater Quality Trend Monitoring Program

Prepared for

Central Valley Regional Water Quality Control Board

On Behalf of

California Rice Commission

March 2016

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Acronyms and Abbreviations

°C	degree(s) Celsius
µmhos/cm	micromhos per centimeter
AMR	Annual Monitoring Report
CH2M HILL	CH2M
CI	Confidence Interval
Cl	Chloride
CLS	California Laboratory Services
CRM	Certified Reference Material
CRC	California Rice Commission
DWR	California Department of Water Resources
EPA	U.S. Environmental Protection Agency
ft bgs	foot (feet) below ground surface
GAR	Groundwater Assessment Report
GMAW	Groundwater Monitoring Advisory Workgroup
ID	Identification
MCL	Maximum Contaminant Level
MDL	method detection limit
mg/L	milligram(s) per liter
mL	milliliter
MRP	Monitoring and Reporting Program
MS	matrix spike
MSD	matrix spike duplicate
NAWQA	National Water Quality Assessment
PT	proficiency test
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
Rice WDR	Waste Discharge Requirements General Order R5-2014-0032
RL	reporting limit
RPD	relative percent difference
RWQCB	Central Valley Regional Water Quality Control Board
SOP	standard operating procedure
SRM	standard reference material
USGS	U.S. Geological Survey

SECTION 1

Introduction

The California Rice Commission (CRC) is a statutory organization representing approximately 2,500 rice farmers who farm approximately 550,000 acres of Sacramento Valley rice fields. The CRC implements water quality monitoring and reporting activities in compliance with the Waste Discharge Requirements General Order R5-2014-0032 (Rice WDR) for Sacramento Valley Rice Growers, as specified in the Monitoring and Reporting Program (MRP).

The CRC has monitored surface water quality since the 1980s under various programs of the Central Valley Regional Water Quality Control Board (RWQCB). As directed in the 2014 Rice WDR, groundwater quality trend monitoring is to be included as part of the monitoring program, as described in the Workplan.

This groundwater Quality Assurance Project Plan (QAPP) serves as an attachment to the CRC Surface Water QAPP, submitted to the RWQCB in April 2015 and reviewed by RWQCB staff in August 2015 (CRC 2015). Much of the information in the Surface Water QAPP is applicable to groundwater quality monitoring. This groundwater-specific QAPP highlights the key information from the Surface Water QAPP and includes groundwater-specific information that differs from the surface water information. This groundwater QAPP generally follows a similar format and outline as the Surface Water QAPP (where applicable), as specified in the 2010 CRC Order MRP, and should be considered a companion to that document.

SECTION 2

Distribution List

The Distribution Element provides for a comprehensive list of individuals and organizations that will require a copy of this groundwater QAPP and subsequent revisions. These individuals and/or organizations will retain a copy of the groundwater QAPP and are responsible for implementation of the approved groundwater QAPP and assessment of compliance with the QAPP requirements.

Table 2-1. Distribution List

California Rice Commission Groundwater QAPP

Title	Name (Affiliation)	Signature	Email	Tel. No.
Program Manager	Roberta Firoved/CRC		rfiroved@calrice.org	916-387-2264
Reporting Project Lead (CH2M HILL [CH2M])	Lisa Porta/CH2M		lporta@ch2m.com	916-286-0406
Monitoring Project Lead (Kleinfelder)	Sue Gardner/Kleinfelder		SGardner@kleinfelder.com	916-366-1701
Lead Field Technician	Mark Lee/Kleinfelder		mlee@kleinfelder.com	916-336-1701
Quality Assurance (QA) Officer	Jenny Krenz-Ruark/CH2M		jkrenz@ch2m.com	608-318-0884
Regional Board Irrigated Lands Program	Sue McConnell/RWQCB		smcconnell@waterboards.ca.gov	916-464-4798
Regional Board Irrigated Lands Program CRC Liaison	Ashley Shaddy/RWQCB		Ashley.Shaddy@waterboards.ca.gov	916-464-4857
Regional Board QA Officer	Renee Spears/SWRCB		Renee.spears@waterboards.ca.gov	916-341-5583
California Laboratory Services (CLS)	James Liang		jamesl@californialab.com	916-638-7301

SECTION 3

Project Organization

The Project Organization element provides a detailed breakdown of key participating individuals and organizations and identifies their individual roles and responsibilities within the project. This element also provides information about the chain of authority and the levels at which key decisions and project assessment reviews will take place.

3.1 Involved Parties and Roles

Project organization for groundwater sampling activities will be similar to those described in Section 4.1 of the Surface Water QAPP (CRC 2015) with the following exceptions:

- Kleinfelder will perform all the field sampling and will remain the primary point of contact for the lab. Kleinfelder will transfer chemistry results to CH2M for data review and reporting.
- The laboratory that will be used for analysis of the groundwater samples is California Laboratory Services (CLS). It will perform analysis for all of the laboratory parameters.
- It is expected that data entry for groundwater quality sampling will be performed in California Environmental Data Exchange Network or other similar system as specified by the Executive Officer.

3.2 Responsibilities

The remainder of the roles and responsibilities for groundwater sampling will remain as described in Section 4.2 of the Surface Water QAPP (CRC 2015).

SECTION 4

Project Definition/Background

The Problem Definition/Background element provides for a statement of the Project objectives and an overview of historical background for the problem the project is addressing. Existing and applicable regulatory information should also be identified within this section.

4.1 Program Objectives

The CRC implements groundwater quality monitoring and reporting activities in compliance with the Rice WDR. The CRC has monitored surface water quality since the 1980s, and under various programs of the RWQCB, and as directed in the 2014 Rice WDR, will begin groundwater quality trend monitoring, scheduled to begin in 2017.

The objectives of the Groundwater Quality Trend Monitoring Program are outlined in the MRP as follows:

- To determine current water quality conditions of groundwater relevant to rice operations.
- To develop long-term groundwater quality information that can be used to evaluate the regional effects (that is, not site-specific effects) of rice operations and its practices.

The Groundwater Monitoring Advisory Workgroup (GMAW) developed a list of seven questions to be answered through groundwater monitoring. Answers to each question were provided in Appendix I of the *Rice-Specific Groundwater Assessment Report* (GAR; CRC 2013). However, trend monitoring was developed with the objective of corroborating and/or clarifying those answers, especially to the following GMAW questions:

1. *What are irrigated agriculture's impacts to the beneficial uses of groundwater and where has groundwater been degraded or polluted by irrigated agricultural operations (horizontal and vertical extent)?*

4. *What are the trends in groundwater quality beneath irrigated agricultural areas (getting better or worse) and how can we differentiate between ongoing impact, residual impact (vadose zone) or legacy contamination?*

In addition, trend monitoring may help to answer GMAW question 3 by further validating the answer provided in the GAR:

3. *To what extent can irrigated agriculture's impact on groundwater quality be differentiated from other potential sources of impact (e.g., nutrients from septic tanks or dairies)?*

The approved GAR (CRC 2013) provides a comprehensive groundwater quality analysis, including data from a network of 28 U.S. Geological Survey (USGS) rice wells used to monitor shallow groundwater quality underneath rice fields. Because of the wells' proximity to the rice fields and their representation of shallow groundwater, a subsample of the USGS rice well network will be used for groundwater trend monitoring. The USGS has informally confirmed that the CRC may collaborate with the National Water Quality Assessment (NAWQA) team in Sacramento, California, to obtain its sampling results and gain access to these wells for further sampling.

4.2 Approaches to Meet Objectives

The approaches that will be used to achieve the program objectives are shown in Table 4-1.

Table 4-1. MRP Plan Objectives and Approaches
California Rice Commission Groundwater QAPP

	MRP Plan Objective	Approach to Achieving the Objective
1.	Determine current water quality conditions of groundwater relevant to rice operations.	At representative locations under rice fields, collect samples of select representative constituents for analysis and compare monitoring results against water quality objectives and thresholds.
2.	Develop long-term groundwater quality information that can be used to evaluate the regional effects of rice operations and practices.	Evaluate water quality monitoring results to identify water quality concerns; compare monitoring results over the duration of monitoring to identify changes in quality.
3.	Support the development and implementation of the Rice WDR.	Monitoring, data analysis (overall trends, spatial and temporal trends), reporting management practice implementation, and submit annual monitoring report (AMR).
4.	Verify the adequacy and effectiveness of the Rice WDR's conditions.	Monitoring, data analysis, and submit AMR.
5.	Evaluate the Coalition Group's compliance with the terms and conditions of the Rice WDR.	Monitoring, data analysis, and submit AMR.

4.3 Applicable Regulatory Information

The CRC implements groundwater quality monitoring and reporting activities in compliance with RWQCB Order R5-2014-0032, Waste Discharge Requirements General Order for Sacramento Valley Rice Growers, and associated MRP Order R5-2014-0032.

The performance goals for this project are guided by the Basin Plan Numeric Water Quality Objectives for the Sacramento River Watershed (Table 7 of Attachment B of the 2014 MRP) and U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels (MCLs). Table 4-2 displays the applicable performance goals for this program. It should be noted that the other parameters being collected do not have established performance goals applicable to groundwater.

Table 4-2. Established Performance Goals for Constituents of Interest
California Rice Commission Groundwater QAPP

Parameter	Performance Goal
Chloride	250[a] (mg/L)
Conductivity (at 25°C)	900-1600[a] (µmhos/cm)
Nitrate + nitrite (as N)	10 (mg/L)
pH	6.5 – 8.5
Sulfate	250[a] (mg/L)
Total dissolved solids	500[a] (mg/L)

[a] Secondary Maximum Contaminant Level (MCL)

Notes:

°C = degree(s) Celsius
µmhos/cm = micromhos per centimeter
mg/L = milligram(s) per liter

4.4 Decisions or Outcomes

WDR monitoring of groundwater beneath rice lands is expected to:

- Assess compliance with the Rice WDR
- Determine conditions of groundwater beneath rice lands
- Aid in development of long-term groundwater quality trend information

4.5 Project Background and Historic Information

Project background and historical information is provided in Section 5.5 of the Surface Water QAPP (CRC 2015).

SECTION 5

Project Description

The Project Description element provides for a summary of all work that is to be performed and the schedule for implementation. This element also provides for a detailed description of the geographical area where sampling is to be performed.

5.1 Detailed Summary of Work to Be Performed

This groundwater QAPP presents the Rice WDR requirements for the initial groundwater quality trend monitoring schedule to be initiated in 2017.

Monitoring parameters are shown in Table 5-1. All monitoring wells and all parameters will be monitored during the initial monitoring year. After the initial monitoring year, monitoring shall be conducted on a rotating basis, with half of the wells monitored the second year, and the other half monitored the following year. Group B parameters are to be monitored in the first year, then once every 5 years. This rotating monitoring schedule will continue unless modified by the Executive Officer. After the third monitoring year, the CRC may request a reduction in groundwater monitoring for approval by the Executive Officer. The USGS is scheduled to monitor its entire rice well network in the summer of 2017. The CRC will coordinate with the USGS to obtain the sampling data.

Table 5-1. Groundwater Monitoring Parameters
California Rice Commission Groundwater QAPP

	Field Measurement	Laboratory Measurement
Group A (annual sampling)		
Conductivity (at 25 °C) (µmhos/cm)	✓	
pH (standard units)	✓	
Dissolved oxygen (DO) (mg/L)	✓	
Temperature (°C)	✓	
Total dissolved solids (TDS) (mg/L)		✓
Nitrate + nitrite as nitrogen (mg/L)		✓
Total ammonia as nitrogen (mg/L)		✓
Group B (sampled initially, then once every 5 years)		
Anions (carbonate, bicarbonate, chloride, and sulfate)		✓
Cations (boron, calcium, sodium, magnesium, and potassium)		✓

Notes:

°C = degree(s) Celsius
µmhos/cm = micromhos per centimeter
mg/L = milligram(s) per liter

5.2 Schedule of Major Project Work Benchmarks

The schedule for project milestones is summarized as follows:

- **Well Sampling:** Sampling will be initiated in 2017, as described under Project Schedule section. Sampling will continue annually through 2019, when the CRC may request a reduction in monitoring, if warranted.

- **AMR:** The AMR is due to the RWQCB on December 31 of each year. The information required for inclusion in the AMR is detailed in the Rice WDR.

5.3 Detailed Geographical Information

5.3.1 Selected Wells

A subsample of the USGS rice well network was selected for groundwater trend monitoring. Wells were selected for their proximity to rice lands and representativeness of the surrounding area. The 20 selected monitoring wells, along with information about each well, are listed in Table 5-2. Figure 2-2 of the Groundwater Trend Monitoring Workplan shows the locations of these wells.

Table 5-2. Groundwater Quality Monitoring Wells
California Rice Commission Groundwater QAPP

DWR State Well Number	Mapping ID	Latitude	Longitude	Well Depth (ft bgs)	Top and Bottom Perforation Depths (ft bgs)	Subbasin	County
012N003E18H001M	18H1M	38°53'12.90"N	121°40'21.88"W	50	40 to 45	Sutter	Sutter
012N002E09B002M	09B2M	38°54'30.56"N	121°45'18.24"W	29	19 to 25	Sutter	Sutter
014N002E10R001M	10R1M	39°04'15.43"N	121°43'39.14"W	44	34 to 39	Sutter	Sutter
015N002W16R001M	16R1M	39°08'54.05"N	122°04'45.38"W	35	25 to 30	Colusa	Colusa
015N002W03E001M	03E1M	39°10'59.40"N	122°04'41.10"W	35	25 to 30	Colusa	Colusa
017N003W35M001M	35M1M	39°16'54.46"N	122°10'18.83"W	35	25 to 30	Colusa	Colusa
017N002W14G001M	14G1M	39°19'46.34"N	122°9'48.82"W	35	25 to 30	Colusa	Colusa
018N001W27B001M	27B1M	39°23'27.50"N	121°57'19.11"W	33.5	23.5 to 28.5	West Butte	Glenn
018N002E09L001M	09L1M	39°25'35.40"N	121°45'41.96"W	35	25 to 30	East Butte	Butte
018N002W12G002M	12G2M	39°25'44.41"N	122°01'56.53"W	35	25 to 30	Colusa	Glenn
018N001E08D001M	08D1M	39°26'05.43"N	121°53'18.16"W	38.5	28.5 to 33.5	West Butte	Glenn
019N003W25R001M	25R1M	39°28'14.87"N	122°08'12.71"W	38.5	28.5 to 33.5	Colusa	Glenn
019N003W25E001M	25E1M	39°28'22.76"N	122°09'51.42"W	35	25 to 30	Colusa	Glenn
019N001E22B001M	22B1M	39°29'24.94"N	121°50'51.37"W	35	25 to 30	East Butte	Butte
019N002W23E001M	23E1M	39°29'29.75"N	122°03'21.01"W	35.5	25.5 to 30.5	Colusa	Glenn
019N001E09C002M	09C2M	39°31'18.1"N	121°52'14.1"W	45	35 to 40	West Butte	Glenn
020N002E35J002M[a]	35J2M	39°32'29.6"N	121°42'27.1"W	24.2	19.2 to 24.2	East Butte	Butte
020N002W32J001M	32J1M	39°32'34.52"N	122°05'56.82"W	35	25 to 30	Colusa	Glenn
020N002W25A001M	25A1M	39°33'52.51"N	122°01'39.34"W	35	25 to 30	Colusa	Glenn
020N002E08A001M	08A1M	39°36'29.27"N	121°45'56.86"W	35	25 to 30	East Butte	Butte

[a] New DWR Well ID for this replacement well is not currently available. Construction information in this report is updated to reflect the new well.

Notes:

DWR = California Department of Water Resources
ft bgs = foot (feet) below ground surface
ID = identification

5.4 Site Photos

Photos of all sampling sites will be taken during the first sampling event and at any time where the sampling conditions are not typical.

5.5 Project Schedule

Sampling will occur annually during the month of August, which is peak rice growing season. Samples will be collected before the fields are drained to assess the initial influence of rice field flooding on groundwater levels and potential nutrient migration to the water table.

The USGS is scheduled to monitor its entire rice well network in the summer of 2017 and will collect samples for water quality analysis. Based on the USGS sampling schedule, the CRC is proposing to adjust the trend monitoring sampling schedule accordingly, with rice well monitoring starting in 2017. The CRC will coordinate with the USGS to obtain the sampling data in the same manner as it did during the development of the GAR (CRC 2013).

Table 5-3 shows the proposed monitoring schedule for each parameter group listed in Table 5-1. All monitoring wells and all parameters will be monitored by the USGS in the summer of 2017. Per MRP requirements, after the initial monitoring year, monitoring shall be conducted on a rotating basis, with half of the monitoring wells monitored during the second year (2018) and the other half monitored the next year (2019). Group B parameters are to be monitored in the first year (2017), then once every 5 years. This rotating monitoring schedule will continue unless modified by the RWQCB Executive Officer. After the third monitoring year, the CRC may ask the Executive Officer to approve a reduction in groundwater monitoring.

Table 5-3. Groundwater Monitoring Schedule (sampling will occur in August)
California Rice Commission Groundwater QAPP

DWR Well ID	2017 [a]	2018	2019 [b]	2020	2021	2022
012N003E18H001M	A, B	A		A		A, B
012N002E09B002M	A, B	A		A		A, B
014N002E10R001M	A, B	A		A		A, B
018N001E08D001M	A, B	A		A		A, B
019N001E22B001M	A, B	A		A		A, B
019N001E09C002M	A, B	A		A		A, B
020N002E35J002M[c]	A, B	A		A		A, B
018N001W27B001M	A, B	A		A		A, B
018N002E09L001M	A, B	A		A		A, B
020N002E08A001M	A, B	A		A		A, B
015N002W16R001M	A, B		A		A	A, B
019N003W25R001M	A, B		A		A	A, B
019N003W25E001M	A, B		A		A	A, B
015N002W03E001M	A, B		A		A	A, B
019N002W23E001M	A, B		A		A	A, B

Table 5-3. Groundwater Monitoring Schedule (sampling will occur in August)
California Rice Commission Groundwater QAPP

DWR Well ID	2017 [a]	2018	2019 [b]	2020	2021	2022
017N003W35M001M	A, B		A		A	A, B
017N002W14G001M	A, B		A		A	A, B
020N002W32J001M	A, B		A		A	A, B
020N002W25A001M	A, B		A		A	A, B
018N002W12G002M	A, B		A		A	A, B

[a] USGS is scheduled to sample the entire Rice Wells network for water quality constituents.

[b] The 2019 AMR will determine if a reduction in sampling will be proposed to the Executive Officer.

[c] New DWR Well ID for this replacement well is not currently available. Construction information in this report is updated to reflect the new well.

Notes:

A = field parameters, total ammonia, nitrate-nitrite, and total dissolved solids.

B = anions and cations; see Table 5-1.

DWR = California Department of Water Resources

ID = identification

5.6 Project Constraints

Constraints to the monitoring program may arise under extreme weather conditions. Extremely wet weather, though highly unlikely, may limit access to the monitoring locations. Extremely dry weather may limit the amount of water present in the wells.

Another project constraint could be due to well inaccessibility because of obstruction by farming equipment. In this case, arrangements with the landowner will be made to sample on an alternate day within the same month. If the well is found to be damaged or the cap cannot be removed for sampling, the USGS will be contacted for advice on how to proceed.

SECTION 6

Quality Objectives and Criteria for Measurement Data

The Quality Objectives (QC) and Criteria element provides the QC objectives as well as the performance criteria to achieve those objectives. The analytical measurements must meet the requirements defined for a particular method. The completeness criteria (90 percent) will be calculated and reported with the submittal of each AMR.

6.1 Data Quality Objectives

Data quality objectives are identical to those described in Section 7.1 of the Surface Water QAPP (CRC 2015) and include accuracy, precision, and completeness. These data quality objectives apply to both field monitoring and laboratory analyses. Table 6-1 outlines acceptable data quality criteria for field and laboratory monitoring. Additional details regarding the calculation of accuracy, precision, and completeness can be found in Section 7.1 of the Surface Water QAPP (CRC 2015).

Table 6-1. Data Quality Objectives and Criteria for Measurement Data (adapted from Appendix B of 2010 MRP Attachment C)

California Rice Commission Groundwater QAPP

Group	Parameter	Requirements			
		Accuracy	**Precision**	**Recovery**	**Completeness**
Field Testing	Dissolved Oxygen	± 0.5 mg/L	± 0.5 or 10%	NA	90%
	Temperature	± 0.5 ºC	± 0.5 or 5%	NA	90%
	Conductivity	± 5%	± 5%	NA	90%
	pH by Meter	± 0.5 units	± 0.5 or 5%	NA	90%
Laboratory Analyses	Conventional Constituents in Water	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material If not available then with 80% to 120% of true value.	Laboratory duplication, blind field duplicate, and MS/MSD ± 25% RPD if Result >10X the MDL. Laboratory duplicate minimum.	Matrix spike 80% to 120% or control limits at ± 3 standard deviations based on actual lab data.	90%
	Trace metals in water	Standard Reference Materials (SRM, CRM, PT) 75% to 125%.	Field duplicate, laboratory duplicate, and MS/MSD ± 25% RPD, if result >10X MDL.	Matrix spike 75% to 125%.	90%

Notes:

°C = degree(s) Celsius

CI = confidence interval

CRM = certified reference material

MDL = method detection limit

mg/L = milligram(s) per liter

MS/MSD = matrix spike/matrix spike duplicate

PT = proficiency test

RPD = relative percent difference

SRM = standard reference material

6.2 Laboratory Performance Criteria Goals

Table 6-2 lists the approved analytical methods and target reporting limits (RLs) for the analytes included in the Groundwater Quality Monitoring Program.

Table 6-2. Performance Criteria Goals (Methods and Reporting Limits)
California Rice Commission Groundwater QAPP

Matrix	Chemical	Method	RL	Units
General Physical Parameters				
Water	Total dissolved solids	SM 2540C	10	mg/L
Nutrients				
Water	Nitrate + nitrite (as N)	EPA 300 / SM 4500	0.05	mg/L
Water	Total ammonia (as N)	SM 4500 NH_3	0.1	mg/L
Minerals				
Water	Carbonate	SM 2320B	5.0	mg/L
Water	Bicarbonate	SM2320B	5.0	mg/L
Water	Chloride	EPA 300	0.5	mg/L
Water	Sulfate	EPA 300	0.5	mg/L
Water	Boron	EPA 200.7	1.0	mg/L
Water	Calcium	EPA 200.7	1.0	mg/L
Water	Sodium	EPA 300	1.0	mg/L
Water	Magnesium	EPA 200.7	1.0	mg/L
Water	Potassium	EPA 300	1.0	mg/L

Notes:

EPA = U.S. Environmental Protection Agency

mg/L = milligram(s) per lite

RL = reporting limit

The CRC will continue to contract with CLS for laboratory services. CLS is located at 3249 Fitzgerald Road, Rancho Cordova, California, 95742. The contact number for CLS is 916-638-7301.

6.3 Monitoring Parameters with Practical Quantitation Limits (PQLs) and Analytical Methods

The requirements for practical quantitation limits and MDLs, as described in Section 7.3 of the Surface Water QAPP (CRC 2015), remain the same for groundwater sampling. QC measurements of representativeness, comparability, completeness, precision, and accuracy are required and will be calculated as described in Section 7.3 of the Surface Water QAPP (CRC 2015).

SECTION 7

Special Training Needs/Certification

The Special Training Needs/Certification Element provides information regarding any training that is required for field, laboratory, and other project staff and lists the individuals or organizations that are responsible for ensuring that the training is adequate and completed.

Similar procedures for personnel training and management, as outlined in Section 8 of the Surface Water QAPP (CRC 2015), will be followed. Additional procedures specific to groundwater sampling are included below.

7.1 Project Field Personnel Training

Field Sample Collection Training specific to groundwater sampling will be conducted at the beginning of each monitoring season. This training will include instruction on the following:

- Site conditions documentation
- Proper use and decontamination of non-disposable field equipment such as the water level meter and completion of the Field Observation Data Sheet (water level log)
- Use of the YSI multi-probe water quality field parameter monitoring meter, including calibration, operation, end of day calibration, and documentation on the field form
- Sample collection, labelling, and transportation to the laboratory
- QC sample collection including field blanks, trip/travel blanks, duplicates, matrix spike/matrix spike duplicates (when, where, what)
- Unique sample handling (i.e. field filtering, short hold times)
- Chain of custody requirements and documentation
- Order of operations (open well caps, water levels, monitoring wells in order of clean to dirty, purging, and sample collection)

7.2 Training Renewal

Members of the field crew are to undergo Field Sample Collection Training once per season, prior to the first time they collect samples during the season.

7.3 How Training is Provided

The Lead Field Technician, or his designee, will provide training; prior to the first time a person collects samples during the season. The training will be provided in-office, or as a tail-gate meeting prior to sample collection.

7.4 Training Documentation

Training will be documented on the form included as Attachment B1 to this QAPP. Each person receiving training will complete one form. The form will be signed by the person receiving and by the person providing the training. The training elements included in the training will be initialed.

7.5 Training Records

The Lead Field Technician will maintain the training documentation records.

SECTION 8

Documents and Records

The documents and records element describes the required documents and records necessary for project quality assurance, including the project QAPP.

Copies of field sheets, chain-of-custody forms, and original preliminary and final laboratory reports must be kept and made available for review by RWQCB staff as needed. **The project field crew must retain original field logs. The project contract laboratory shall retain original chain-of-custody forms and copies of the preliminary and final data reports for a period of no less than 5 years.**

Kleinfelder will collect records for sample collection and field analyses. Samples will be sent to CLS for chemistry analysis and will include a chain-of-custody form. CLS will generate records for sample receipt and storage, analyses, and reporting.

All records generated by this project will be stored at the CRC office. The laboratory records pertinent to this project will be maintained at the lab, Kleinfelder, CH2M, and CRC offices. The parties responsible for maintaining the records for this project are as follows:

- Sue Gardner, Kleinfelder Field Project Manager, will maintain all sample collection, chain-of-custody, and field analysis forms.
- Field Project Manager and CRC Program Manager will maintain all records associated with the receipt and analysis of samples analyzed.
- CH2M will maintain a database of all field and laboratory records.
- CLS laboratory director will maintain the laboratory records.
- CRC Program Manager will oversee the actions of these persons and will arbitrate any issues relative to record retention and any decisions to discard records.

The CRC will maintain copies of the records in the form of the AMR indefinitely, along with an electronic database.

8.1 Reporting Format

8.1.1 Field Sheets and Lab Reports

Table 8-1 lists the forms and reports that are produced during sampling events as part of the CRC's Groundwater Quality Monitoring Program. Meter calibration and field data sheets are provided in Attachment B2 to this QAPP.

Table 8-1. Forms and Reports Produced for Sampling Events
California Rice Commission Groundwater QAPP

QC Form	Required	Documentation
Meter Calibration Log	1 per sampling event	Field Crew → Field Project Manager
Field Data Sheet	1 per site, per sampling event	Field Crew → Field Project Manager
Chain of Custody – CLS	1 per site, per sampling event	Field Crew → CLS→ Included in CLS Results Report → Field Project Manager
CLS Results Report	1 per event	CLS → Field Project Manager

SECTION 9

Sampling Process Design

The Sampling Process Design element provides for discussion on the Project's data collection design in relation to the Project's objectives. These sections include a description of the monitoring approach.

9.1 Data Collection Design and Rationale

The rice-specific GAR (CRC 2013) provides a comprehensive groundwater quality analysis for areas farming rice and includes data from a network of 28 rice wells developed, maintained, and sampled by the USGS. Because of the network's proximity to the rice fields and its representation of shallow groundwater, the USGS rice well network has been useful for assessing shallow groundwater quality underneath the rice fields. Based on the conclusions of the analysis, the GAR (CRC 2013) provided recommendations to sample seven USGS Rice Wells for the trend monitoring network. After discussions with RWQCB staff, CRC compromised and settled on sampling 20 wells from the current active network.

As described in the Groundwater Trend Monitoring Workplan, the CRC selected 20 of the active wells in the USGS monitoring network to be part of the trend monitoring network based on a detailed land use representation analysis that was performed for each of the 28 original USGS rice wells. A summary of the analysis for the 20 selected trend monitoring rice wells is found in Section 2.4.1.1 of the Trend Monitoring Workplan. While most of the USGS rice wells are surrounded by land used to grow rice and are therefore representative of rice agriculture, a few wells are located closer to the edges of the core rice growing area and might be influenced by other land uses.

Currently, 24 USGS Rice Wells are active and used for water level monitoring and groundwater quality sampling. After two full network sampling events, the USGS used five network wells for trend monitoring as part of the USGS National Water Quality Assessment (NAWQA) Cycle II groundwater monitoring activities (from 2004 to 2014). Under the current monitoring program, now in Cycle III (2014 to 2024), water level monitoring is conducted bi-annually. In 2017, water quality monitoring will include the full network of active wells. The USGS has informally confirmed that the CRC may collaborate with the NAWQA team in Sacramento to obtain its sampling results and gain access to these wells for further sampling.

9.2 Monitoring Schedule for Each Location

Table 5-3 shows the proposed monitoring schedule for Group A and B parameters, as listed in the MRP. All monitoring wells and parameters will be monitored by the USGS in the summer of 2017. Per MRP requirements, after the initial monitoring year, monitoring will be conducted on a rotating basis, with half of the monitoring wells monitored during the second year (2018) and the other half monitored during the next year (2019). Group B parameters will be monitored in the first year (2017) and then once every 5 years. This rotating monitoring schedule will continue unless modified by the RWQCB Executive Officer. After the third monitoring year, the CRC may ask the Executive Officer to approve a reduction in groundwater monitoring.

9.3 Type and Total Number of Samples, Matrices, and Runs/Trials Expected for the Project

Appropriate sample bottles and volumes will be collected for each analyte of interest.

9.4 Sample Locations

Figure 2-2 of the Groundwater Trend Monitoring Workplan shows the locations of the 20 USGS rice wells identified for the Groundwater Quality Trend Monitoring Program. They are all located within or in close proximity to rice fields.

9.5 Site Inaccessibility

In the event a well is not accessible for sampling because of obstruction by farming equipment, arrangements with the landowner will be made to sample on an alternate day within the same month.

9.6 Critical Project Data

All groundwater data collected for this project are considered critical to the program. A complete dataset is important for both determining current groundwater quality conditions, and in developing a long-term groundwater quality dataset for establishment of trends.

9.7 Variability

Variability is expected in the data, however, sampling at the same time each year will help to reduce environmental variability. Weather conditions, market conditions (changing the acreage of rice planted), and water availability are all environmental sources of variability outside of the CRC's control.

9.8 Bias and Interpretation

The groundwater quality trend monitoring program was developed to prevent bias from influencing the outcomes. Samples are collected in the field by Kleinfelder, analyzed by CLS, and the results compiled and reviewed by CH2M. No single person has control of the outcome of the data or report.

Several members of the CH2M team, along with the CRC Program Manager, review all final reports. This enables the interpretation of the results to be reviewed by several people before submission to the RWQCB for review by their staff.

SECTION 10

Sample Collection Methods

The Sample Collection Methods element provides for information regarding how samples will be collected consistently between all locations and by all sampling staff. The methods for sample collection preparation, physical collection, handling, and transportation must include measures to avoid contamination, ensure accurate tracking, and preserve sample integrity for analysis.

10.1 Criteria for Acceptable Versus Unacceptable Water Samples

Acceptable water samples will be delivered to the laboratory at the required holding temperature. The analyses will be performed within the required holding time for the method. Sample bottles and seals will be intact, and a chain-of-custody form will accompany the samples.

During the summer, there may not be enough time for samples collected late in the day to be chilled to the required 4°C temperature. In the event that a sample is collected late in the day, iced immediately, and delivered per the standard transport procedures, this sample will be deemed to be in compliance with sample preservation requirements.

Samples that are not intact, are broken, are not at the correct temperature, or are analyzed outside the holding time will be considered unacceptable.

10.2 Sample Collection Method Standard Operating Procedures

The CRC has developed Groundwater Sample Collection Standard Operating Procedures (SOPs) for this project (Attachment B3). These SOPs are briefly outlined below.

10.2.1 Well Condition Documentation

Photo documentation will be used to track the physical conditions at each sampling point during the first monitoring event. If conditions change at the site, additional photos will be taken. Special care will be taken to document non-typical conditions. Notes will be taken to document any issues with accessing the well, including apparent well damage.

10.2.2 Field Instrument Calibration and Documentation

Field instruments will be calibrated at the beginning of each sample day, prior to instrument use. A final calibration check will be performed at the end of each sample day to document any variances in the meter's readings. Calibration logs will be included with the sample event's field sheets.

All meters are sent to the manufacturer annually for routine maintenance and as needed if problems are encountered during use.

10.2.3 Water Level Measurements

Static water level measurements will be taken with a conductivity sensing water level meter prior to purging and sampling a well. The measurement procedure is outlined in Attachment B3 to this QAPP.

10.2.4 Groundwater Monitoring and Sample Collection

A groundwater sample is collected from a monitoring well after removing the standing water from the well casing. This is accomplished by purging a minimum of three but not more than five well casing volumes of water, thereby causing water from the aquifer to flow into the well via the well screen. The purging and sampling procedure is explained in more detail in Attachment B3 to this QAPP.

10.2.5 Sample Integrity and Post-Purge Procedures

The sample collection personnel will us a new pair of nitrile gloves prior to performing each task (calibration, opening wells, taking water levels, purging wells, and sample collection). If the gloves come into contact with a contaminated surface or substance, the gloves will be discarded and a new pair of gloves donned.

After the well has been sampled, the high-density polyethylene tubing and foot valve will be removed from the well and discarded. The well casing cap will be replaced and the outer protective housing locked.

10.3 Sample Container Sizes, Preservation, and Transportation

Sample handling and custody procedures are described in Section 12 of the Surface Water QAPP (CRC 2015) and will be followed during groundwater sampling. Table 10-1 displays sample container, volume, preservation, and holding time information for the parameters of interest for groundwater sampling.

Table 10-1. Water Sample Analysis Sample Containers, Volume, Preservation, and Holding Time (adapted from Appendix D of the 2010 MRP)
California Rice Commission Groundwater QAPP

Parameters for Analysis in Water Samples	Specified Containers	Sample Volume	Initial Field Preservation	Maximum Holding Time (analysis must start by end of max)
Total Suspended Solids	Polyethylene bottle	1 liter	Cool to 6°C, dark	7 days at 6°C, dark
Nitrate + Nitrite (as N)	Polyethylene bottle	1 liter	Cool to 6°C, dark	48 hours at 6°C, dark
Total Ammonia (as N)	Polyethylene bottle	500 mL	Cool to 6°C, dark	48 hours at 4°C, dark or, if acidified, 28 days at 6°C, dark
Chloride and Sulfate	Polyethylene bottle	300 mL	Cool to 6°C, dark	28 days at 4°C, dark
Carbonate and bicarbonate	Polyethylene bottle	300 mL	Cool to 6°C, dark	14 days at 6°C, dark
Cations	Polyethylene bottle	300 mL	Cool to 6°C, dark	28 days at 4°C, dark

Notes:
°C = degree(s) Celsius
mL = milliliter(s)

10.4 Sample Equipment Cleansing and Decontamination

Sample equipment cleansing and decontamination procedures are discussed in the Groundwater Sample Collection SOP (Attachment B3). In addition, the YSI meter used for field parameter determination will be used aboveground with a flow through cell attached to the meter. The system will be purged of water after each use and decontaminated. As the meter does not go down the well hole, it will not affect sample or groundwater quality.

10.5 Corrective Action Measures for Problematic Situations

A 1-liter amber bottle will be filled with sample water at each location during each event to serve as backup water.

If bottle breakage occurs and no backup sample is available, the site will be resampled within the same week and the samples will be submitted for analysis.

10.6 Field Procedures

Photo Documentation: Photo documentation will consist of providing a representative photo for each site. When site conditions are unique or out of the ordinary, a photo will be taken and the conditions noted on the field data sheet.

Recognize and Avoid Potential Sources of Contamination: Field personnel must be instructed in the proper collection of samples prior to the sampling event and in how to recognize and avoid potential sources of contamination. These instructions will be discussed during the required Field Sample Collection Training, which is part of the monitoring program.

Acceptable versus Unacceptable Sample: Field personnel must be able to distinguish acceptable versus unacceptable water samples in accordance with pre-established criteria, as described previously.

Sample Bottles: Sample containers must be new, pre-cleaned, and certified to be free of contamination according to the EPA specification for the appropriate methods. Sample bottles will be provided by the analytical laboratories or purchased through a supply company. Samples will be held on wet ice (4^{o}C) until delivered to the laboratory for analysis or sample control. Backup samples will be collected and held in secure sample control (4^{o}C) until the initial data analyses are complete.

Decontamination: All field and sampling equipment that comes in contact with field samples must be decontaminated after each use in a designated area to minimize cross-contamination. Decontamination procedures (proper procedures for how and when to clean the equipment) are specified in the Groundwater Sample Collection SOP (Attachment B3). In addition, the YSI meter used for field parameter determination will be used aboveground with a flow through cell attached to the meter. The system will be purged of water after each use and decontaminated.

Sample Numbering: All samples are to be identified with a unique number to ensure that results are properly reported and interpreted. Samples must be identified by the site, sampling location, matrix, sampling equipment, and sample type (that is, normal field sample or QC sample). The Field Project Manager provides the Lead Field Technician with sample ID information prior to the sampling event. This sample ID is recorded on the bottle and the chain-of-custody form as the basis of reporting used by the laboratories.

Custody and Documentation: The Field Project Manager is responsible for ensuring that the field sampling team adheres to proper custody and documentation procedures. A master binder of field datasheets shall be maintained for all samples collected during each sampling event. The QA Officer is responsible for confirming adherence to custody and documentation requirements described herein.

Documentation: All field activities must be adequately and consistently documented to ensure defensibility of any data used for decision-making and to support data interpretation. Pertinent field information must be recorded on the field sheets, along with field measurements.

Corrective Action: For the fieldwork, Kleinfelder staff will communicate problems via cell phone. The Kleinfelder team will communicate the issue with the Program Manager at the CRC. The Program Manager will communicate any changes in the monitoring schedule and/or site locations to the RWQCB.

All corrective action procedures are documented immediately through e-mail communication and the semi-annual reports and AMRs.

SECTION 11

Sample Handling and Custody

The Sample Handling and Custody element provides a discussion of the sample integrity maintenance requirements as well as tracking and chain-of-custody procedures. The components of this element must describe the efforts that will be taken to ensure the physical and chemical integrity of a sample from collection to disposal.

11.1 Identify Sample Holding Times, Integrity, and Storage Measures

Refer to Table 10-1 for sample holding times, integrity, and storage measures.

11.2 Corrective Action for Samples That Do Not Meet Preservation and/or Holding Times

Corrective action for samples that do not meet preservation and/or holding times will be addressed as discussed in Section 12.2 of the Surface Water QAPP (CRC 2015).

11.3 Physical Transport of Samples from the Field

Physical transport guidelines outlined in Section 12.3 of the Surface Water QAPP (CRC 2015) will be adhered to for groundwater samples.

11.4 Sample Handling and Custody Documentation

Sample handling and custody documentation will be recorded on the COC form, as outlined in Section 12.4 of the Surface Water QAPP (CRC 2015).

11.5 Sample Chain-of-Custody Procedures

Sample chain-of-custody procedures, as outlined in Section 12.5 of the Surface Water QAPP (CRC 2015), will be maintained for groundwater sampling.

11.6 Individuals Responsible for Verifying Procedures

Procedures will be verified as described in Section 12.6 of the Surface Water QAPP (CRC 2015).

11.7 Field Custody Procedures

Field custody procedures outlined in Section 12.7 of the Surface Water QAPP (CRC 2015) will be maintained for groundwater sampling.

11.8 Chain-of-Custody Forms

A chain-of-custody form will be completed after sample collection at each sampling event and prior to sample shipment or release. The chain-of-custody forms will be filled out with indelible ink. The chain-of-custody form, sample labels, and field documentation will be cross-checked to verify sample

identification, type of analyses, sample volume, and number and type of containers. A standard chain-of-custody form will be used to track possession of all samples.

Chain-of-custody forms should include the following items:

- Sampler name
- Name of person receiving the laboratory results
- Address where results should be sent
- Bottle temperatures and bottle condition at log-in
- Sample identification
- Type of analysis
- Number of containers of each type (that is, plastic, glass, vial, whirlpak)
- Sample collection date and time
- Comments and/or special instructions
- Sample relinquishment information (signature, print name, date).
- Sample receipt information (signature, print name, date).

11.9 Sample Control Activities

Sample control activities, as outlined in Section 12.9 of the Surface Water QAPP (CRC 2015), will be maintained for groundwater sampling.

SECTION 12

Analytical Methods

The Analytical Methods and Field Measurements elements provide information regarding the specific methods and procedures used to extract, analyze, and/or take measurements of the samples, as well as the performance criteria. Specific methods are discussed in Section 12.7.

12.1 Methods and SOPs

The groundwater sample collection field method and SOP document is provided in Attachment B3. In addition, several parameters will be monitored in the field.

Table 12-1. Field Analytical Methods
California Rice Commission Groundwater QAPP

Analyte	Laboratory / Organization	Project Action Limit (units, wet or dry weight)
pH	Field monitoring by Kleinfelder field staff	Measured to the nearest 1.0 pH unit
Dissolved oxygen	Field monitoring by Kleinfelder field staff	Measured to the nearest 1.0 mg/L
Electrical conductivity	Field monitoring by Kleinfelder field staff	µmhos/cm
Temperature	Field monitoring by Kleinfelder field staff	°C
Turbidity	Field monitoring by Kleinfelder field staff	NTUs

Notes:

°C = degree(s) Celsius

umhos/cm = micromhos per centimeter

mg/L = milligram(s) per liter

NTU = nephelometric turbidity unit

12.2 Instrumentation and Kits Associated with Field and Laboratory Measurements

Several instruments are used to measure field parameters. They include the following:

- Multiparameter instrument (Temperature, pH, Dissolved Oxygen, Electrical Conductivity): YSI 556 MPS
- Turbidity meter: LaMotte 2020

12.3 Sample Disposal Procedures

Sample disposal procedures outlined in Section 13.3 of the Surface Water QAPP (CRC 2015) will be maintained for groundwater sampling.

12.4 Method and Instrument Performance Criteria, Detection, and Quantitation Limits

See Table 6-2 for RLs. CLS's SOPs will be obtained and compiled prior to the first sampling event and reviewed for method and instrument performance criteria.

12.5 Corrective Action Measures and Documentation for Test/Measurement Failure

Corrective action measures and failure documentation procedures outlined in Section 13.5 of the Surface Water QAPP (CRC 2015) will be maintained for groundwater sampling.

12.6 Describe How Instruments Should Store and Maintain Raw Data (Methods or SOPs may be referenced and attached to the QAPP)

Raw data are not stored in the YSI probe or turbidity meter. CLS's QAPP will describe how raw data are stored by the laboratory.

12.7 Specify Laboratory Turnaround Times Needed

No specific turnaround time is needed; however, a 2-week turnaround is standard.

12.8 Additional Requirements Not Mentioned Above

12.8.1 a) Laboratory Corrective Actions

Corrective action measures should be discussed in the event of instrument failure or performance criteria exceedances. Specific activities that will take place when a failure occurs must be discussed, and the QA Office and the Field Project Manager must ensure the laboratory follows the corrective action procedures stated in its QAPP.

When an out-of-control situation occurs, analyses or work must be stopped until the problem has been identified and resolved. The analyst responsible must document the problem and its solution and all analyses since the last control point must be repeated or discarded. The nature and disposition of the problem must be documented in the data report that is sent to the RWQCB.

12.8.2 (b) Laboratory Calibration Curves

Laboratory adjustments to calibration curves and also to recovery acceptance limits are method dependent. However, when these adjustments are changed during project implementation, these changes need to be communicated to RWQCB staff to ensure that the new limits will meet the program requirements.

12.8.3 (c) Alternative Analytical Methods

Analytical methods are to be identified by number, date, and regulatory citation. Analytical methods used for chemistry analyses must follow a procedure approved by the EPA or provided in *Standard Methods for the Examination of Water and Wastewater* (19th Edition). When there is a program need to

analyze for contaminants that do not have an EPA or Standard Methods procedures, then the USGS, American Society of Testing Materials (ASTM), and Association of Official Analytical Chemist (AOAC) methods may be used by accredited laboratories.

Laboratory development of a performance-based method validation package and SOP are required when analytes or quantification levels are outside the analyte list or differ by 10 times the measurement levels stated in the published method. The validation package must include all data for the "Initial Demonstration of Laboratory Capability," which includes:

1. MDL studies (the analyst shall determine the MDL for each analyte according to the procedure in Title 40 of the *Code of Federal Regulation* (CFR) Part 136, Appendix B, using the apparatus, reagents, and standards that will be used in the practice of this method)
2. Initial precision and recovery
3. QC samples, where applicable
4. Linear calibration ranges

12.8.4 (d) References for Analytical Methods

Article 3 (commencing with Section 100825) of Chapter 4 of Part 1 of Division 101 of the Health and Safety Code provides pursuant to the analysis of any material required by this Program shall be performed by a laboratory that has accreditation or certification. Specific method modifications may be approved by the Executive Officer of the RWQCB if sufficient justification is provided.

SECTION 13

Quality Control

The quality control (QC) element provides information regarding the QC activities that will take place for the Project. Definitions for all QC samples described here are included in Section 14 of the Surface Water QAPP (CRC 2015). A summary table must be provided, which includes required and optional QC and the frequency. The QC summary table should address all sampling, measurement, and analysis techniques.

Internal QC is achieved by collecting and/or analyzing a series of duplicate, blank, spike, and spike duplicate samples to check that analytical results are within the specified QC objectives. The QC sample results are used to quantify precision and accuracy, and identify any problem or limitation in the associated sample results. The internal QC components of a sampling and analyses program ensure that data of known quality are produced and documented. The internal QC samples are described in the following sections.

13.1 Chemical Analyses

The one "QC Set" standard, as defined in Section 14 of the Surface Water QAPP (CRC 2015), will be maintained for groundwater monitoring, as follows:

At a minimum, one "QC Set" must be included per analytical method batch per Sampling Event. The minimum required samples for chemical analyses must include:

1. *Field blank*
2. *Field duplicate*
3. *Matrix spike (MS) and matrix spike duplicate (MSD)*
4. *Laboratory control spike (LCS) and laboratory control spike duplicate (LCSD)*
5. *Laboratory blank*
6. *Laboratory duplicate (MS/MSD or LS/LSD pair may serve this function)*

Field duplicate samples should be collected at a rate of 1 field duplicate for every 10 samples (that is, if 10 samples are collected, 1 field duplicate is needed; if 11 samples are collected, 2 field duplicates are needed).

Optional QC samples that might be used by project management include travel blanks, equipment blanks, laboratory duplicates, equipment blank/rinsate samples, and field split samples. Descriptions of the types of QC samples, their role, and their requirements are included in Section 14 of the Surface Water QAPP (CRC 2015).

13.2 Blank Specifications

Laboratory blank specifications, as outlined in Section 14.1 of the Surface Water QAPP (CRC 2015), will be maintained for groundwater sampling.

13.3 Matrix Spike and Spike Duplicate Specifications

Matrix spike and spike duplicate specifications, as outlined in Section 14.2 of the Surface Water QAPP (CRC 2015), will be maintained for groundwater sampling. Calculations for accuracy and precision, as well as the data quality objective for precision, will also be maintained.

13.4 Laboratory Control Spike and Spike Duplicate Specifications

Laboratory control spike and spike duplicate specifications, as outlined in Section 14.3 of the Surface Water QAPP (CRC 2015), will be maintained for groundwater sampling. Calculations for accuracy and precision, as well as the data quality objective for precision, will also be maintained.

13.5 Field Duplicate Specifications

Field duplicate specifications, as outlined in Section 14.7 of the Surface Water QAPP (CRC 2015), will be maintained for groundwater sampling.

SECTION 14

Instrument/Equipment Testing, Inspection, and Maintenance

The Instrument/Equipment Testing, Inspection, and Maintenance element provides for information regarding how personnel can assure that equipment will function properly when needed, as well as the methods for recording equipment failure to track problematic units.

Field and laboratory equipment will be tested, inspected, and maintained as needed and as outlined in Section 15 of the Surface Water QAPP (CRC 2015), with the exception of field equipment used, as outlined in Section 14.1.

Field Equipment Requiring Routine Maintenance:

- YSI multi-probe

Laboratory Equipment Maintenance

- CLS's QAPP and SOPs will outline the necessary periodic equipment maintenance, if any.

SECTION 15

Instrument/Equipment Calibration and Frequency

The Instrument/Equipment Calibration and Frequency element provides for information regarding how continual quality performance of equipment and instruments will be ensured.

Field and laboratory equipment will be calibrated as needed and as outlined in Section 16 of the Surface Water QAPP (CRC 2015).

SECTION 16

Inspection/Acceptance Requirement for Supplies and Consumables

The Inspection/Acceptance of Supplies and Consumables element provides information about how supplies and consumables shall be inspected and accepted for use in the project if applicable.

Inspection/acceptance requirements for supplies and consumables will be the same as those described in Section 17 of the Surface Water QAPP (CRC 2015).

SECTION 17

Non-Direct Measurements

The Non-Direct Measurements element provides an identification and discussion of the types of data needed for project implementation or decision-making that is obtained from non-measurement sources such as computer data bases, programs, literature files, and historical data bases.

Wherever data from non-direct measurement sources are used, standards outlined in Section 18 of the Surface Water QAPP (CRC 2015) will be applied.

SECTION 18

Data Management

The data management element provides a detailed discussion of the data management process, tracing the path of the data from their generation to their final use and storage.

18.1 Identify the Data Management Scheme from Field to Final Use and Storage for All Data Types

Copies of field data logs, COC forms, original preliminary and final laboratory reports, and electronic media reports will be kept for review by CH2M, Kleinfelder, and the CRC. The field crew will retain original field data logs. The contract laboratory will retain original COC forms, and copies of the preliminary and final data reports.

Field and laboratory data will be stored in hard copy and electronic format (when applicable) as part of the project file. This information will be retained in the project file until project completion and closeout. Upon project closeout, all records will be archived for permanent storage. Records will be maintained for five years after the final report is issued.

18.2 Standard Record Keeping and Tracking Practices and Corresponding SOPs (Where Applicable)

The Project Team, through use of electronic mail and the AMR, will implement standard record keeping.

18.3 Entering Field Data and Laboratory Data or Uploading into the Required Data Submission Format

All field and laboratory data resulting from groundwater sampling will be entered into the electronic form specified by the Executive Officer.

18.4 Control Mechanism for Detecting and Correcting Errors and for Preventing Loss of Data during Data Reduction, Data Reporting, and Data Entry to Forms, Reports, and/or Databases

Control mechanisms outlined in Section 19.4 of the Surface Water QAPP (CRC 2015) will be maintained for groundwater sampling.

18.5 Individual(s) Responsible for Data Management

The QA Manager is responsible for data management.

SECTION 19

Assessments and Response Actions

The assessment and response action elements provide information regarding how a project's activities will be assessed to ensure that the QAPP is being implemented as approved.

Assessments and response actions will be conducted as outlined in Section 20 of the Surface Water QAPP (CRC 2015).

SECTION 20

Reports to Management

The Reports to Management element provides information regarding how management will be kept informed of project oversight, assessment, activities, scheduling, and findings. The Reports to Management element must include the following components:

- QA reports, along with associated data, will be submitted to the QA officer. The QA Officer will review data within 3 working days of receipt.
- CRC reports monitoring results to the RWQCB annually through the AMR. The RWQCB receives the draft annual report for comment around mid-December, and the final annual report is due by December 31.

Table 20-1. QA Management Reports
California Rice Commission Groundwater QAPP

Type of Report	Frequency (daily, weekly, monthly, quarterly, annually, etc.)	Projected Delivery Dates(s)	Person(s) Responsible for Report Preparation	Report Recipients
Monitoring results summary	Annually	End of August/first of September	CH2M	Roberta Firoved
Draft final report for review	Annually	Mid-December	CH2M	Roberta Firoved
AMR	Annually	December 31	CH2M, CRC	RWQCB

SECTION 21

Data Review, Verification, and Validation Requirements

The data review, verification, and validation elements provide the criteria used to review and validate data. These steps help ensure that the data satisfy the quality criteria required by the Rice WDR.

21.1 Assess the Criteria Used to Validate Project Data

The assessment criteria for groundwater data remain the same as those outlined in Section 22 of the Surface Water QAPP (CRC 2015).

SECTION 22

Verification and Validation Methods

The Verification and Validation Methods element provides for the identification of methods or processes for verifying and then validating project information.

Methods will be validated and processes verified using the same processes outlined in Section 23 of the Surface Water QAPP (CRC 2015).

SECTION 23

Reconciliation with User Requirements

The Reconciliation with User Requirements element provides for a discussion on how validated data will be evaluated to see if it answers the original questions asked within the monitoring objectives.

Validated data will be evaluated to see if the results answer the original project questions as outlined in Section 24 of the Surface Water QAPP (CRC 2015).

SECTION 24

References

Central Valley Regional Water Quality Control Board (RWQCB). 2014. Order No. R5-2014-0032 Waste Discharge Requirements General Order for Sacramento Valley Rice Growers. March 2014.

California Rice Commission (CRC). 2013. *Final Rice-Specific Groundwater Assessment Report.* Prepared for the Central Valley Regional Water Quality Control Board on behalf of the California Rice Commission. Prepared by CH2M HILL and PlanTierra. July.

California Rice Commission (CRC). 2015. *Quality Assurance Project Plan for California Rice Commission Water Quality Programs*. Draft Version 3.0. April.

Attachment B1
Training Certification Form

CALIFORNIA RICE COMMISSION WATER QUALITY MONITORING PROGRAM
DOCUMENTATION OF TRAINING

Prior to sample collection for the CRC's water quality monitoring programs, each field crew personnel is required to undergo field sample training. The training shall be considered effective for one sampling season, and shall be renewed prior to collecting samples during a new sampling season.

PART I. VERIFICATION OF PERSON BEING TRAINED

I, _____, verify that I have received field training for the California Rice Commission Water Quality Monitoring Programs on this day, _____ (date) by _____ (name of trainer). I understand the requirements and will seek clarification when necessary.

SIGNED _____

PART II. VERIFICATION OF PERSON PROVIDING THE TRAINING

I, _____, verify that I have provided field training for the California Rice Commission Water Quality Monitoring Programs on this day, _____ (date) to _____ (name of person being trained). I am an experienced and competent person in performing groundwater sampling and have properly trained the above person.

SIGNED _____

PART III: TRAINING ELEMENTS COVERED

Please initial the following, to confirm that each training element was covered in the training sessions.

Training Element	Initials of Person Being Trained	Initials of Trainer
Site conditions documentation		
Proper use and decontamination of non-disposable field equipment such as the water level meter and completion of Field Observation Data Sheet (water level log)		
Use of the YSI multi-probe water quality field parameter monitoring meter, including calibration, operation, end of day calibration, and documentation on the field form		
Sample collection labelling, and transportation to laboratory		
QC sample collection including field blanks, trip/travel blanks, duplicates, matrix spike/matrix spike duplicates (when, where, what)		
Unique sample handling: IE field filtering, short hold times		
Chain of Custody Requirements and Documentation		
Order of operations (open well caps, water levels, monitoring wells in order of clean to dirty, purging, sample collection)		

Attachment B2
Field Data Sheets and Instrument Calibration Form

KLEINFELDER
FIELD OBSERVATION DATA SHEET

PROJECT NO. _____ EMPLOYEE(S) NO. _____

	Location No.	Date			Military Time		Code Number*	Measurement	Alt. Msmt. (product)	Comments
		M	D	Y	Hr.	Min.				
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
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15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										

* Code

0 Depth Water, Feet (TCC)
1 Water Level Elevation, Feet (MSL)
2 Depth Water, Feet (Cristy Box)
3 Depth Water/Product, Feet (TCC)
4 Water/Product Elevation, Feet (MSL)
5 Depth Water/Product, Feet (Cristy)
6 Oil Flow Rate, GPM
7 Cumulative Oil, Gallons
20 Pumping Depth, Feet
21 Pumping Rate, GPM
22 Pressure, PSI
23 Flow Rate, GPM
24 Stream Flow, CFS
60 Volume, mL
27 pH, Water Sample
28 pH, Probe (Lowered into Well)
29 Air Temperature (°C)
30 Water Temperature (°C)
31 Residual Chlorine
32 Dissolved Oxygen, mg/l
33 Specific Conductance, umhos/cm
34 Nitrogen as Ammonia, mg/l
35 Nitrate Nitrogen, mg/l
36 Precipitation, Inches/Day
39 Cumulative Gallons
40 Cumulative Acre-Feet
57 Residual Vacuum
58 Reset Vacuum (in centibars)

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CALIFORNIA RICE COMMISSION WATER QUALITY PROJECT
GROUNDWATER SAMPLING FIELD DATA SHEET

Project Name:	Project #:	Date:	Sampler Name:

Purge Equipment Type (Bailer, Pump, etc.)	Water Quality Euipment and Calibrations											
	Cal..Time:	See Cal Sheet	Dissolved Oxygen:	Model See	Serial # Cal Log	Conductivity Meter	Model See	Serial # Cal Log	pH Meter	Model See	Serial # Cal Log
Disposable Bailer x 1	Man. Cal. ?	☐ ph ☐ D.O. ☐ Turbidity									
	Water Level Meter	Model: water line	Unit #: 300	Calibrated	mg/l at	Standard	mS/cm at C		pH / at C		
Sample Equipment Type (Bailer, Pump, etc.)			Turbidity:	Model See	Serial # Cal Log	Measured	mS/cm at C		pH / at C		
	Casing Volume multipliers: 1" =0.04 g/ft 2"=0.16 g/ft.XXX 3" = 0.37 g/ft 4"=0.65 g/ft. 12"= 5.9 g/ft					ORP	Model See	Serial # Cal Log	Filtration Equipment		micron filter
Disposable Bailer x 2	Boring Voume multipliers: 2" = 0.78 g/ft 4"= 1.51 g/ft. .		Standard 1:	Reading							
			Standard 2:	Reading		Standard bailer sampling @3 volumes					

Well #:	Casing Dia. (in): 2"	Total Depth (ft.)	Static W.L.: (ft)	Water Thick.: (ft)	Casing Volume: (gal)

Time	Casing Volumnes Removed	Gallons Removed	Temp. (C)	pH	Conductivity (mS/cm)	Dissolved O (mg/L)	ORP (mV)	SWL (feet)	Pump Rate Ltr. / Gal	Pump Depth (ft.)	Remarks
	0	0		***start***	***purge***	***of***	***well***				Color: Odor:
	1										
	2										
	3										

Oxygen Reduction Potential: (mV)	Sample WL: (ft. bgs)	Sample WL: (ft. bgs) n/a	PPE Level: ☐ B ☐ C ☐ D	PID/FID Readings	Initial (ppm)	Sample (ppm)
Sample #	QA/QC? ☐ Yes ☑ No	Type: ☐ Duplicate ☐ Rinsate ☐ MS ☐ MSD ☐ Trip		Bkgnd:	n/a	n/a
Sample Time: @		80% Revocery: (ft).	Purge Containerized? ☐ Yes ☐ No	TOC:	n/a	n/a
Well Condition:		Lock? ☐ Yes ☐ No	Cap? ☐ Yes ☐ No	Stick-up: (ft) no	BZ:	n/a	n/a

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INSTRUMENT CALIBRATION LOG

Sampler Name/No. _____ **Date** _____

Project No. _____ **Job Name** _____

pH Meter (make/number) _____ **EC Meter (make/number)** _____

	Time	Temp.	pH4	pH7	pH10
Reading (initial)					
Calibration (initial)					
Reading (intermediate)					
Calibration (intermediate)					
Reading (end of day)					

	1413 umho	-umho	-umho
Reading (initial)			
Calibration (initial)			
Reading (intermediate)			
Calibration (intermediate)			
Reading (end of day)			

Comments:

Comments:

Turbidity Meter (make/number) _____

	NTU	NTU	NTU	Battery Check
Reading (Initial)				
Calibration				

D.O. Meter (make/number) _____

	Hg in inches	Hg in mm
Weather Service		
Reading (initial)		
Reading (adj.)		

Attachment B3
Groundwater Sample Collection
Standard Operating Procedure (SOP)

Groundwater Sample Collection Standard Operating Procedure (SOP)
California Rice Commission

Overview

The procedure outlined below describes the steps that will be followed for the collection of groundwater samples from existing groundwater wells assigned by the California Rice Commission (Client).

Groundwater sample collection involves documenting of well conditions, calibration of sampling equipment, groundwater level measurements, purging of the well, collecting groundwater samples, and protocols for delivery of the sample to the receiving analytical laboratory.

It is assumed that ground water samples will be collected from one well at each location, as opposed to a group of wells at a single location. Kleinfelder assumes the wells assigned by the Client will not contain a dedicated/operational pumping system.

Well Condition Documentation

Initial photo documentation will be used to track the physical conditions at each sampling point during the first monitoring event. Additional photos will be taken to document changes in conditions at the monitoring site. Photo documentation is especially important for those sites/events where non-typical conditions exist. Or when typical standard operating procedures require deviation.

Field Instrumentation Calibration and Documentation, YSI Model 556 Multi-Probe Water Quality Instrument

Routine calibration will be performed at the beginning of each sample day prior to instrument use in the field. A final calibration check will be performed at the end of each day to document any variances in the meter's readings, if any. The meter will be re-calibrated in the field, if during the course of the day the readings appear to be unusual or suspected to be compromised (probe malfunction, low batteries high/low readings) Calibration logs are to be completed and included with the records for the sampling event on a daily basis. The specific calibration information required is summarized as follows:

YSI 556 Meter:

- Temperature - the YSI meter has an automatic temperature compensator that adjusts all readings to a temperature of 25 degrees Celsius (°C). No field calibration is necessary, however, the probe will be compared against a certified laboratory grade thermometer
- pH – will be calibrated on two standards: a pH 7.0 standard and a pH 10.0 standard. However, the meter may be calibrated to a pH 7.0 standard and a pH 4.0 standard depending on the concentrations anticipated at the wells.
- Dissolved Oxygen (DO) – will be calibrated using the current barometric pressure for the geographical area in which the meter is being calibrated via the YSI-556 on-board barometer. DO is calibrated to percent (%) oxygen which simultaneously calibrates the meter in milligrams per liter (mg/L).
- Electrical Conductivity as Specific Conductance (EC) – will be calibrated using a 1 point calibration on a 1413 micro Siemens per centimeter (µS/cm) standard.

La Motte Model 2020ie Portable Turbidity Meter:

- The meter will be calibrated using 3 standards including a 0.00 Nephelometric Turbidity Unit (NTU) standard, a 1.0 NTU standard, and 10.0 NTU.

Meters will be sent to the manufacturer annually for routine maintenance and as needed if problems are encountered with routine calibrations or in-situ performance. Additionally the meters are cleaned on a daily basis during use and batteries are changed out on a regular basis.

Water Level Measurements

Static water level measurements are made in the well with a conductivity sensing water level meter prior to purging and sampling. Measurement procedure is as follows:

- Prior to obtaining water level measurements, the protective housing will be unlocked and the well casing cap opened to allow for the wells to equilibrate for a period of approximately ½ hour.
- The conductivity sensing water level meter's tape and probe are decontaminated using a non-phosphate detergent wash, followed by a distilled water rinse, prior to use in each well.
- Water level measurements are made using the conductivity sensing water level meter. Depth-to-water is generally measured from a surveyed mark on the north rim of the PVC well casing. If no survey mark is present, the measurement will be taken from the north rim of the well casing.
- Water level measurements are recorded on the Field Observation Data Sheet (water level log), along with date, time and any observations, abnormalities or changed conditions at the well.

If possible, the water level measurements will be converted to elevations using the surveyed casing elevations.

Groundwater Monitoring and Sample Collection

Groundwater samples are collected from the monitoring wells subsequent to the removal of the well's standing water column from the well casing measured in feet to the nearest 0.01'. This is accomplished by purging a minimum of 3 but not more than 5 well casing volumes of water thereby causing water from the aquifer to flow into the well via the well screen. The purging and sampling protocol for each well is as follows:

- The volume of water (gallons) standing in the well casing is calculated by subtracting the depth to groundwater measurement (the water level measurement acquired earlier in feet to the nearest 0.01') from the designed total depth of the well and multiplying by the appropriate conversion factor for the wells diameter (e.g.; 0.16 for 2-inch wells, and 0.65 for 4-inch wells) to yield a well casing volume.
- A minimum of three, but not more than five casing volumes of water will be purged from each well while monitoring field parameters for stabilization at each casing volume removed. Kleinfelder understands that some wells will (for reasons unknown) may not stabilize during the purge process and therefore limits the maximum number of casing

volumes to be purged at 5. This will be documented on the Ground Water Sampling Field Data Sheet.

- Monitoring wells will be purged and sampled using the Waterra Inertial Pumping System (Waterra). The Waterra system includes a portable above ground actuator that is secured to the wells protective housing. The actuator has an arm that extends over the well and secures a length of 5/8" diameter, high density polyethylene (HDPE) tubing submerged inside the well with a check ball style foot-valve threaded at the bottom of the tubing that cycles water upward. The foot-valve will be positioned approximately 10 feet above the bottom of the well, to ensure that water removed is from the screened interval. New tubing and foot-valves will be used at each well, to reduce the potential for cross-contamination.
- The discharge end of the Waterra HDPE tubing will be connected to a flow through cell which houses the probe-bulkhead of the YSI 556 water quality multi-probe instrument. This allows for the monitoring of field parameters including pH, electrical conductivity (EC), dissolved oxygen (DO), and temperature for stability (fluctuation of less than 10%) while purging. An additional length of HDPE tubing will be attached to the flow through cell outlet from which the field measurement for turbidity will be collected before the water is discharged to the ground surface away from the well's outer protective housing. Field parameter measurements are recorded onto the Ground Water Sampling Field Data Sheet, along with the time and volume of water purged at each measurement. Field parameter measurements are collected at each casing volume milestone.
- Ground Water Samples will be collected using the Waterra. Prior to sample collection and after the purge process has been completed, the Waterra will be shut down, and a post purge water level measurement will be collected to determine the well's drawdown (if any) during the purge process. If a drawdown is noted, the well will be allowed to recharge until the water level is approximately 80% of the original water level measurement. The amount of time required for this recovery will be monitored and a recovery rate will be calculated and recorded on the Ground Water Field Sampling Data Sheet.
- Subsequent to well recharge, the YSI 556 flow through cell will be disconnected from the HDPE tubing and the tubing's end will be trimmed at its former connection to the flow through cell. The Waterra will be powered-on and the speed at which water flows from the well during the purge process will be reduced to minimize disturbance of the compounds contained in the water and water will be transferred into sample bottles prepared and provided by the contracted analytical laboratory.
- Sample bottles will be pre-labeled (prior to use at each well) with a unique sample identification number and placed in cooler with wet ice immediately after sample collection. The sample identification number and the time of sample collection will be recorded on the Ground Water Sampling Field Data Sheet, the Sample Date Sheet and the Chain-of-Custody (COC) Document form(s) prior to departure from the Site. The COC will be reviewed with the project manager over the phone to ensure all samples were collected and correct analysis requested.
- Samples for dissolved metals analysis are often filtered in the field at the time of collection, depending on the constituents to be analyzed and the laboratory performing the analysis. Field filtering (if required) will be performed using an in-line 0.45 micron high capacity filter attached to the end of the HDPE tubing where water transfers into the appropriate sample bottle.

Additional Information and Post Purge Procedures

Prior to performing each task (instrument calibration, opening wells, measuring water levels, purging wells and sample collection) a new pair of nitrile gloves will be used by sample collection

personnel to maintain the integrity of the water sample. If the gloves come in contact with a contaminating surface or substance, the gloves will be discarded and a new pair gloves donned.

After the well has been sampled, the HDPE tubing and foot valve will be removed from the well and discarded. The well casing cap will be replaced and the outer protective housing locked.

The samples will be delivered to the analytical laboratory or laboratories under chain-of-custody control.

Appendix C
Rice-Specific Groundwater Data Gap Analysis

APPENDIX C

Rice-Specific Groundwater Data Gap Analysis

The *Rice-Specific Groundwater Assessment Report* (GAR; California Rice Commission [CRC] 2013), submitted to the Central Valley Regional Water Quality Control Board (RWQCB) in July 2013, identified data gaps in the analysis. In the Yuba County area, which contains a large portion of rice fields overlying groundwater basins, shallow groundwater quality data were lacking based on the U.S. Geological Survey (USGS) monitoring networks reviewed. In addition, most of the Yuba County rice fields are located on better drained soil than the rest of the area and in hydrogeologic vulnerable areas. A secondary data gap was identified in the valley fringe areas of northern Glenn, eastern Sutter, and Placer counties, in which moderately well-drained and well-drained soil occur, similar to the Yuba County areas; no shallow groundwater wells were identified in this area during the GAR analysis.

The purpose of this technical appendix is to provide additional data and a refined analysis for the Yuba County data gap area and the soil-related data gaps.

Background of Data Gap

Yuba County overlies the southern half of the North Yuba groundwater subbasin and the entire South Yuba groundwater subbasin, as defined by California Department of Water Resources (DWR) Bulletin 118 (see Figure C-1). The northern half of the North Yuba subbasin extends into Butte County.

Groundwater flows from the upland areas towards the valley floor and then south along the rivers. Recharge to groundwater primarily occurs along the rivers. A spring 2012 groundwater elevation contour map for the Yuba subbasins (Yuba County Water Agency [YCWA] 2013) shows how groundwater flows from the Sierra Nevada at a steep gradient and then flows towards the center of the Sacramento Valley.

Yuba County includes close to 39,000 acres of surveyed rice land or about 25 percent of the total county acreage. The portion of Butte County overlying the North Yuba subbasin represents approximately 2,300 acres of surveyed rice land. The rice lands in this area are spread out and discontinuous. In the Yuba County portion of the North Yuba subbasin, rice fields are planted in contiguous areas. As described in the GAR (CRC 2013), over half of the rice acreage in Yuba County overlies initial California State Water Resources Control Board (SWRCB) hydrogeologically vulnerable areas (HVAs) (also shown on Figure C-1).

None of the shallow USGS rice monitoring wells reviewed for the GAR covered the North and South Yuba subbasins. Additional sources of well data had to be identified for the analysis of groundwater quality in this area (see Figure C-1). Additional groundwater quality information was collected for the two Yuba County groundwater subbasins, as described in the following sections.

In addition, a detailed soil analysis was performed to identify potential restrictive layers in the Yuba County areas that have well-drained surficial soil. A shallow depth to duripan was found in most areas, which may restrict the vertical flow of water and nutrients to the groundwater. A similar analysis was suggested in the GAR (CRC 2013) for the fringe data gap areas to be able to correlate the Yuba County data back to the rice fields in that area. The details of this analysis are provided in this appendix.

Data Sources

Yuba County Groundwater Quality

The DWR North Central District and the YCWA were contacted by the CRC team to inquire about local monitoring well networks. DWR installed three sets of monitoring wells in the Yuba County groundwater basins in the 1990s, the 2000s, and more recently in 2006 and 2011. These wells are now managed by the YCWA but are monitored only for water levels and field data. Groundwater quality in the Sacramento Valley is measured by the DWR every other year for each of its monitoring wells. YCWA receives groundwater quality data from DWR to prepare its annual groundwater status report. As presented in the Groundwater Quality Trend Monitoring Workplan, there are two main types of well networks sampled for groundwater quality in Yuba County:

1. **YCWA "PMW series" monitoring wells**: These are dedicated monitoring wells installed by YCWA with grant funding and assistance from DWR in 2006 and in 2011–2012. YCWA and DWR coordinate sampling, as described previously. Table C-1 shows the construction details for the YCWA monitoring wells, and the locations of the wells are shown on Figure C-2.
2. **DWR-sampled wells**: These are 10 wells in the Yuba County area that are sampled by the DWR. A select number of wells are sampled every other year for a variety of groundwater constituents. The DWR shares the analytical results with YCWA. The locations of the DWR-sampled wells are shown on Figure C-3.

Another set of wells is monitored primarily for groundwater levels, with occasional groundwater quality sampling:

California Statewide Groundwater Elevation Monitoring (CASGEM) wells: These are 23 observation wells and piezometers monitored by YCWA and DWR as part of the CASGEM program. They are installed with a water level logger that records a continuous data record of groundwater levels. Some of these wells have also been monitored for groundwater quality constituents, including nitrate. The locations of these wells are shown on Figure C-4.

In addition to reviewing the results from these well networks, a brief review of three documents pertaining to groundwater management and groundwater quality in Yuba County is included:

- Hydrogeologic Understanding of the Yuba Basin (YCWA 2008)
- Groundwater Management Plan (YCWA 2010)
- Groundwater Management Plan, Annual Monitoring and Measuring Report, 2012-2013 (YCWA 2013a)

Soil Data

Soil survey data from the Natural Resource Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) were downloaded for each survey area of interest. Soil data for each soil survey were compiled to determine the spatial distribution of characteristics of interest. For the primary area (Yuba County), the Soil Survey of Yuba County, California (NRCS 2014) was used. For the secondary area (Northern Glenn County and Eastern Sutter and Placer counties), the Soil Surveys of Glenn, Sutter, and Placer (western part) counties (NRCS 2014) were used.

Yuba County Groundwater Quality Data Gap Analysis

This section provides an overview of the data sets used for the groundwater quality analysis in Yuba County and describes the results of the analysis.

Yuba County PMW Series Monitoring Wells

The construction details for each of the YCWA PMW series monitoring wells are presented in Table C-1. Monitoring wells 02, 07, and 01 are multi-completion wells that are screened in two to three different zones of the aquifer. Most of these wells are relatively shallow, with total depths of less than 200 feet below ground surface (ft bgs) (Table C-1).

Groundwater levels in the wells were sampled during the well development phase. Water levels are also monitored continuously through automated data loggers. Results are presented in Table C-1. Depth to water ranges between an average of 80 ft and 15 ft below the top of casing.

As shown in Table C-2, none of the PMW series monitoring wells had a nitrate concentration above the Maximum Contaminant Level (MCL). Only two wells had a nitrate concentration slightly above half the MCL.

Salinity is indicated either as total dissolved solids (TDS) (in milligrams per liter [mg/L]) or as the water source's conductivity (the ability of water to conduct an electrical current). When soluble salts dissolve in water, the resulting ions behave as conductors. Therefore, electrical conductivity (EC) (in microSiemens per centimeter [μS/cm], referred to as specific conductance when normalized to 25 degrees Celsius [°C]) measured in the field is an indirect measurement of salinity.

The recommended limits (secondary MCL) for EC and TDS in drinking water are as follows:

- EC: 900 μS/cm at 25°C (upper limit is 1,600 μS/cm)
- TDS: 500 mg/L (upper limit is 1,000 mg/L and state non-regulatory agriculture recommended limit is 450 mg/L)

Only one of the YCWA-monitored wells has a field-measured value slightly exceeding these limits: PMW-29. In February 2012, the TDS concentration in PMW-29 was 548 mg/L and EC at this location was near (but not exceeding) the 900 μS/cm limit. PMW-29 is located in northern Yuba County near the upstream boundary of the Yuba groundwater basin (see Figure C-2).

Yuba County DWR Sampled Wells–Groundwater Quality Data

DWR has collected groundwater quality samples at 13 wells in Yuba County and continues to sample 9 of these wells, which are shown on Figure C-3. Five wells are sampled in odd numbered years, and five wells are sampled in even numbered years. Well depth is not readily available for these wells.

Nitrate Results

Figure C-5 shows the entire nitrate data set for each well that DWR continues to sample routinely, with data as early as 1965. The following two wells have exceeded the MCL for nitrate:

- Well 16N03E36E002M, which exceeded the MCL in 2001, 2003, 2005, and 2007, with a maximum value of 56.3 mg/L. This well is located in the North Yuba subbasin within a rice field but close to other land use types that might be influencing the groundwater quality at this well. The nitrate concentration was below the MCL in 2013.
- Well 13N04E12H004M, which exceeded the MCL in 2008, with a maximum value of 77.6 mg/L. This well is located in the South Yuba subbasin outside of the rice fields in an area that grows different crops. Therefore, rice fields are probably not influencing the water quality at this well.

Basic statistics on these samples for nitrate concentrations are provided in Table C-3.

Salinity Results

As described previously, TDS and EC are typical salinity indicators used to evaluate the amount of salts in groundwater. Figure C-6 shows the entire TDS data set for each well that DWR continues to sample routinely. The following three wells have exceeded the MCL for TDS:

- Well 14N05E16Q001M has consistently exceeded the MCL, with a maximum value of 1,654 mg/L. This well is located downgradient of the rice fields but within other land use types.
- Well 13N04E12H004M has exceeded the MCL almost consistently, with a maximum value of 898 mg/L (below the upper limit of 1,000 mg/L). This well is located outside the rice fields in an area that grows different crops; therefore, rice fields are probably not influencing the water quality at this well.
- Well 16N03E36E002M has exceeded the MCL slightly in 2001, 2003, 2005, and 2007, with a maximum value of 551 mg/L in 2007. These values are still below the upper limit of 1,000 mg/L.

Basic statistics on these samples for TDS concentrations are provided in Table C-4.

Figure C-7 shows the entire EC data set for each well that DWR continues to sample routinely. The following two wells have exceeded the MCL for EC:

- Well 14N05E16Q001M has consistently exceeded the MCL, with a maximum value of 2,465 µS/cm. This well is located downgradient of the rice fields but within other land use types.
- Well 13N04E12H004M has exceeded the MCL in 1972, 1976, and 2008, with a maximum value of 1,288 µS/cm (below the upper limit of 1,600 µS/cm). This well is located outside the rice fields in an area that grows different crops; therefore, rice fields are probably not influencing the water quality at this well.

Basic statistics on these samples for EC values are provided in Table C-5.

Yuba County CASGEM Wells

YCWA and DWR monitor water levels in 23 observation wells and piezometers within Yuba County as part of the CASGEM program (see Figure C-4). Four of these wells are near rice fields and have been sampled for groundwater quality constituents; the results of nitrate, TDS, and field EC for these wells are shown in Table C-6. The wells are also equipped with water level loggers that continuously record groundwater level at 15-minute intervals. None of the sampling results from these wells have exceeded the MCL for nitrate or salinity. Well depth is not readily available for these wells.

Yuba County Groundwater Reports Review

The YCWA manages water resources, including groundwater, in the North and South Yuba subbasins, and has performed several studies to better characterize the aquifer. A comprehensive groundwater quality study of the North and South Yuba subbasins was performed in 2008 and is summarized in *Hydrogeologic Understanding of the Yuba Basin* (YCWA 2008). This study concluded that "groundwater quality in the Yuba Basin appears to be generally very good," on the basis of a review of historical and recent groundwater quality data from several well networks (including the ones that were reviewed above) (YCWA 2008).

Following this study, YCWA developed a Groundwater Management Plan (GWMP) for the North and South Yuba subbasin within Yuba County. The GWMP referred back to the 2008 study and confirmed that the shallow groundwater in wells less than 200 feet deep did not exceed drinking water MCLs in the North Yuba subbasin (YCWA 2010). In the South Yuba subbasin, a nitrate MCL exceedance occurred at one well. In addition, wells deeper than 200 feet showed higher salinity levels and exceedances of TDS MCL in some instances (YCWA 2010).

The 2012–2013 GWMP Annual Monitoring Report summarized more recent groundwater quality data, which are from the same samples as the ones summarized in this appendix. In addition to nitrate and salinity, the YCWA Annual Monitoring Report also summarizes sampling results for arsenic and sodium. Arsenic concentrations are very low and have consistently been below the MCL. Sodium concentrations are less than 90 mg/L (YCWA 2013a).

Soil Data Gap Analysis

Soil survey data (SSURGO data) from the NRCS was compiled for the data gap area to determine spatial distribution of characteristics of interest (NRCS 2014). The NRCS's Soil Data Viewer tool was used in ArcMap to export data of interest and to compile characteristic maps.

Soil characteristics that restrict vertical water movement were found in the majority of the data gap areas identified in the GAR (CRC 2013). While the main rice-growing area of the Sacramento Valley has poorly drained, high clay content soils with low hydraulic conductivity, the fringe areas discussed below have better drained surficial soils, with water-restricting features in the subsoil. The water restricting features include duripans and clay layers, which cause slow vertical movement of water due to their low hydraulic conductivities. These low hydraulic conductivities are essential to rice production; without them it would be difficult to provide the flooded conditions required.

The primary and secondary data gap areas identified in the GAR are discussed below, along with the soil characteristics unique to each area.

Primary Area – Yuba County

Yuba County is unique in that the majority of the rice land has moderately well drained to well drained soil, as opposed to the poorly drained soil of the valley floor as seen in Butte, Colusa, Sutter and Yolo counties. As described in Section 6 of the GAR (CRC 2013), approximately 78 percent of the initial HVA land (as defined by SWRCB and described in the GAR) has a duripan at less than 60 inches bgs. This duripan layer restricts vertical movement of water and has very low hydraulic conductivity. Additional investigation into the soil characteristics within HVA land in Yuba County revealed that additional restrictive layers, such as shallow clay layers, underlie the majority of the land that does not have a duripan. These clay layers also restrict the vertical movement of water and constituents because of their moderately low to low vertical hydraulic conductivity.

Secondary Area – Northern Glenn County and Eastern Sutter and Placer Counties

Soil in the northern Glenn County area, although well drained, has either clayey textures throughout the soil profile or clayey subsoil. Clayey textures yield low hydraulic conductivity, restricting the vertical movement of water. It should be noted that this area in Glenn County included approximately 6,700 acres of rice in 2010, and about 4,000 acres in 2013, or about 40 percent less acreage of rice in 2013 compared to 2010. This recent decrease in rice acreage in this area is due to a rapid conversion of rice crops to tree crops. Therefore, this fringe area has a decreasing influence from rice agriculture.

Soil in Eastern Sutter and Placer counties is also moderately well drained or well drained. Rice soil in Eastern Sutter County generally has a duripan layer within 60 inches of the ground surface, or, as in northern Glenn County, has clay textures either at the surface or in the subsoil, which restrict vertical movement of water.

Figures C-8, C-9 and C-10 show the Rice HVAs and depth to a restrictive feature as defined by the NRCS. The combination of the presence of laterally continuous poorly drained soil or clay textures and/or restrictive layers in better drained soil restricts the vertical movement of water and allows for the successful use of these areas for rice farming.

Relevance of Reviewed Data to Satisfy Data Gap Analysis

Following the approach outlined in the Workplan satisfied the Yuba County groundwater quality data gap analysis.

First, the data gap analysis included a review of water quality results from three sets of well data: Yuba County PWM wells, DWR monitoring wells, and CASGEM wells. These three well networks provide adequate geographic coverage to identify whether groundwater impacts resulting from rice farming would occur. In addition, the wells are relatively shallow and have recently been monitored, so water quality data are available from which to draw conclusions.

A detailed soil analysis was performed to identify the potential presence of restrictive layers underneath the coarser shallow soil in the fringe areas, where no groundwater quality data were available during the GAR analysis (CRC 2013).

This data gap analysis satisfied the objectives outlined in the GAR (CRC 2013) and provided sufficient information from which to draw conclusions of low vulnerability and recommend a path forward for groundwater quality trend monitoring, as identified in the following sections.

Conclusions

For this data gap analysis, existing groundwater quality data in the Yuba County rice growing area were considered and specific soil characteristics in the fringe areas were evaluated. Groundwater in the North and South Yuba subbasins is generally of very good quality. The analysis focused on nitrate and salinity, which are the primary constituents of concern in agricultural areas that could discharge to groundwater. Figure C-11 shows the maximum nitrate concentrations measured at each of the three monitoring networks identified in this analysis.

In the North Yuba subbasin portion of Butte County, no wells were identified. However, the rice fields in this region are sparse, encompassing only approximately 2,300 acres, and overly mostly poorly drained and somewhat poorly drained soil (Figure 3-1). In the North Yuba subbasin portion of Yuba County, 10 wells were identified that had nitrate concentrations. These wells are located mostly within rice fields and in areas upgradient and downgradient of these fields. One well showed nitrate exceeding the MCL. This well lies at the southwestern fringe of rice fields and could be influenced by other adjacent agricultural practices. This area of Yuba County has soil with restrictive layers less than 60 inches below the surface, which would greatly impede the vertical movement of water and other constituents below rice fields.

In the South Yuba subbasin, 18 wells were identified that included nitrate concentrations. These wells are scattered within and surrounding rice fields. One well showed nitrate exceeding the MCL. This well lies outside of rice fields, close to the Bear River. Other agricultural land uses (deciduous fruit and nut trees) are grown in-between the rice fields and the Bear River, which could be impacting the groundwater quality at this well. Therefore, this well is not indicative of potential impacts to groundwater from rice culture. In addition, surface water monitoring from rice field drainages in this area showed very good water quality and required surface water monitoring was reduced on the east side (Feather River area) due to little impact from rice fields.

The maximum nitrate concentrations in all other wells sampled were below the MCL. Two wells had a maximum value above half the MCL but below the MCL.

These nitrate results, combined with the fact that soil restrictive layers occur within 60 inches of the surface, indicate that the rice fields likely are not impacting shallow groundwater quality in Yuba County.

As presented in the GAR, a rice-specific conceptual site model was developed to provide a comprehensive approach to the analysis of potential pathways and transformations for water and

applied materials in the subsurface under rice-farming conditions. The generally large, contiguous acreage in the Sacramento Valley farmed continuously in rice, combined with the uniqueness and consistency of rice-farming practices, supports the correlative approach between the different rice-farming areas, based on similarities in soil types.

The soil analysis for the fringe data gap areas confirmed that soil restrictive layers or clayey textures exist in these areas, which is similar to the soil conditions in Yuba County. These areas would be subject to reducing conditions in the soil that enable denitrification (see detailed soil and geochemical analysis in the GAR [CRC 2013]). Therefore, a correlation can be drawn between the potential groundwater quality impacts from farming rice in the fringe areas and in the Yuba County area. Since the groundwater quality in the Yuba County data gap area is good, it can be inferred that the groundwater quality in the fringe areas is of similar quality because of the similarity in soil and farming practices. Groundwater quality data recently analyzed as part of the Sacramento River Watershed GAR showed that the groundwater quality in the fringe area of Eastern Sutter and Placer Counties is not impacted by high nitrate concentrations (NCWA 2016). In addition, a DWR-sampled well in the Glenn County data gap area, just outside a mapped rice field (State ID 21N03W07E003M), has a single nitrate measurement from 2006 of 7.4 mg/L. This further confirms the low potential for groundwater quality impacts from rice farming and supports the low vulnerability classification for these data gap areas.

Recommendations

Based on the data gap analysis conclusions, the following recommendations are made for the rice groundwater quality trend monitoring program:

- Include the results of DWR's bi-annual groundwater quality sampling of six wells in Yuba County in the review of water quality sampling (in conjunction with the USGS rice well monitoring network data).
  - The six DWR wells to be included for the trend monitoring data review are located within rice fields, and are distributed between the North Yuba Subbasin (3 wells) and the South Yuba Subbasin (3 wells). Table C-7 presents the well construction information and Table C-8 includes the sampled parameters. Refer to Figure C-3 for the location for the wells. Well completion reports are available in Attachment C1. These wells are sampled every other year based on an even/odd numbered year schedule.
- No further special study is needed in the fringe areas, as the soil analysis combined with the rice-specific conceptual site model and the similarity in rice farming practices confirmed the low potential for groundwater quality impact from rice fields in those areas and the low vulnerability designation.

References

California Department of Water Resources (DWR). 2007. *Monitoring Well Construction Technical Assistance*. Yuba County Water Agency. April.

California Department of Water Resources (DWR). 2015. Unpublished data: Yuba County wells, groundwater quality monitoring data.

California Rice Commission (CRC). 2013. *Final Rice-Specific Groundwater Assessment Report.* Prepared for the Central Valley Regional Water Quality Control Board on behalf of the California Rice Commission. Prepared by CH2M HILL and PlanTierra. July.

California Statewide Groundwater Elevation Monitoring (CASGEM) Online System – Public Portal. http://www.water.ca.gov/groundwater/casgem/online_system.cfm

Natural Resources Conservation Service (NRCS). 2014. Soil Survey Geographic (SSURGO) Database. Available online at http://sdmdataaccess.nrcs.usda.gov/.

Northern California Water Association (NCWA). 2016. *Groundwater Quality Assessment Report.* Final. January.

Yuba County Water Agency (YCWA). 2008. *Hydrogeologic Understanding of the Yuba Basin.* September.

Yuba County Water Agency (YCWA). 2010. *Groundwater Management Plan.* December.

Yuba County Water Agency (YCWA). 2013a. *Groundwater Management Plan, Annual Monitoring and Measuring Report, 2012-2013*.

Yuba County Water Agency (YCWA). 2013b. *Regional Monitoring Well Program – Phase 2 Monitoring Well Completion Report.* September.

Tables

Table C-1. Yuba County PMW Series Monitoring Wells Construction Information

CRC Rice-Specific Groundwater Data Gap Analysis

Well Name	State ID	Casing Elevation[a] (ft amsl)	Ground Surface Elevation[a] (ft amsl)	Screen Interval (ft bgs)	Depth to Water (ft below casing)[b]	Total Depth (ft bgs)	Construction Date
PMW-02A	16N04E14L001M	164.33	164.55	92–122	80.66	127	2006
PMW-02B	16N04E14L002M	164.26	164.55	150–180	80.41	185	2006
PMW-02C	16N04E14L003M	164.19	164.55	210–240	80.71	245	2006
PMW-05	14N04E27P001M	63.08	63.68	80–100	14.93	105	2006
PMW-06	13N04E02F004M	67.05	67.45	224–244	18.47	249	2006
PMW-07A	14N05E31L001M	74.39	71.71	56–66	20.94	71	2006
PMW-07B	14N05E31L002M	74.24	71.71	142–202	21.22	207	2006
PMW-07C	14N05E31L003M	74.13	71.71	425–445	23.31	450	2006
PMW-16	16N04E26H001M	97.22	97.79	176–196	15.10	201	2006
PMW-21	15N04E34B001M	70.94	71.19	80–100	15.57	105	2006
PMW-25	14N05E19P002M	85.63	85.98	260–280	39.05	285	2006
PMW-27	14N05E34F003M	107.76	108.30	150–170	51.62	175	2006
PMW-01A	16N03E01H001M	82.27	82.82	120–130	14	140	2011
PMW-01B	16N03E01H002M	82.33	82.82	216–226	14.9	236	2011
PMW-10	16N04E29R001M	77.62	77.94	308–318	14.62	328	2012
PMW-13	17N04E27N001M	113.25	113.81	206–216	31.25	226	2011
PMW-22	14N04E04P001M	66.07	66.75	228–238	22.07	248	2011
PMW-23	14N05E11K001M	121.29	121.72	110–130	25.29	140	2011
PMW-29	6N04E02A001M	121.05	121.7	145–155	23.55	165	2011

Notes:

[a] Datum: North American Vertical Datum of 1988 (NAVD88)

[b] Approximate values taken shortly after well construction at beginning of the recording period

amsl = above mean sea level

bgs = below ground surface

ft = foot (feet)

ID = identification

Source: DWR 2007; YCWA 2013b

Table C-2. Yuba County PMW Series Monitoring Wells Groundwater Quality

CRC Rice-Specific Groundwater Data Gap Analysis

	Well Name	State ID	Sampling Date	Field EC (µS/cm)	TDS (mg/L)	Dissolved Nitrate as NO_3[a] (mg/L)
Shallow (less than 170 ft bgs)	PMW-01A	16N03E01H001M	2/15/2012	521	322	2.7
	PMW-02A	16N04E14L001M	12/7/2006	406		3.9
	PMW-05	14N04E27P001M	12/14/2006	587	369	4.9
	PMW-07A	14N05E31L001M	10/20/2006	410	276	25.5
	PMW-21	15N04E34B001M	12/25/2006	312		8
	PMW-23	14N05E11K001M	2/15/2012	260	204	16.4
	PMW-29	6N04E02A001M	2/15/2012	831	548	<0.1
Deep (greater than 170 ft bgs)	PMW-01B	16N03E01H002M	2/15/2012	261	220	0.9
	PMW-02B	16N04E14L002M	12/7/2006	353		<0.1
	PMW-02C	16N04E14L003M	12/7/2006	442		<0.1
	PMW-06	13N04E02F004M	10/17/2006	360	233	<0.1
	PMW-07B	14N05E31L002M	10/20/2006	403	266	28.6
	PMW-07C	14N05E31L003M	10/20/2006	537	340	0.7
	PMW-10	16N04E29R001M	6/20/2012	293	160	1.4
	PMW-13	17N04E27N001M	2/15/2012	321	134	<0.1
	PMW-16	16N04E26H001M	12/25/2006	190		4.4
	PMW-22	14N04E04P001M	2/15/2012	236	163	<0.1
	PMW-25	14N05E19P002M	10/17/2006	310	225	3.1
	PMW-27	14N05E34F003M	12/14/2006	469	306	5.6

[a] Primary Maximum Contaminant Level (MCL) is 45 mg/L

Notes:

µS/cm = microSiemen(s) per centimeter

EC = electrical conductivity

ft bgs = foot (feet) below ground surface

ID = identification

mg/L = milligram(s) per liter

NO_3 = nitrate

TDS = total dissolved solids

Source: DWR 2007; YCWA 2013b

Table C-3. Summary of Nitrate Data from DWR Wells

CRC Rice-Specific Groundwater Data Gap Analysis

State Well ID	Number of Samples	Sampling Years	Average Nitrate Concentration (mg/L)	Minimum Nitrate Concentration (mg/L)	Maximum Nitrate Concentration (mg/L)
13N04E02A002M	11	1969 – 2014	15.1	2.7	**28.3**
13N04E12H004M	10	1970 – 2014	**31.5**	5.3	**77.6**
14N04E14J002M	9	1965 – 2013	18.3	4.8	**29.6**
14N05E16Q001M	10	1970 – 2014	4.0	2.7	4.9
15N04E23Q001M	11	1965 – 2013	6.9	<0.1	12.5
16N03E36E002M	9	1970 – 2013	**34.2**	14	**56.3**
16N04E34E001M	9	1969 – 2013	4.3	3	5.5
16N04E27F002M	12	1970 – 2014	2.8	1	4.9
16N03E24M002M	8	1970 – 2013	**28.6**	17	**42.6**
14N04E20D002M	7	1970 – 2011	0.14	<0.1	0.2

Notes:

Primary Nitrate MCL is 45 mg/L. Values in **bold** are at least half of the MCL; values in **red** exceed the MCL.

Undetected measurements were given the value of 0.05 mg/L (half of the reporting limit) to calculate average nitrate concentrations.

Depth of wells is not available for this data set.

ID = identification

MCL = Maximum Contaminant Level

mg/L = milligram(s) per liter

Source: DWR 2015

Table C-4. Summary of Total Dissolved Solids Data from DWR Wells

CRC Rice-Specific Groundwater Data Gap Analysis

State Well ID	Number of Samples	Sampling Years	Average TDS Concentration (mg/L)	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)
13N04E02A002M	11	1969 – 2014	**369**	204	**445**
13N04E12H004M	11	1970 – 2014	**553**	**373**	**898**
14N04E14J002M	9	1965 – 2013	**286**	163	**382**
14N05E16Q001M	9	1970 – 2014	1407	**597**	**1654**
15N04E23Q001M	11	1965 – 2013	187	97	233
16N03E36E002M	10	1970 – 2013	**444**	**310**	**551**
16N04E34E001M	10	1969 – 2013	164	125	197
16N04E27F002M	10	1970 – 2014	125	90	154
16N03E24M002M	8	1970 – 2013	**384**	**286**	**442**

Notes:

Primary TDS MCL is 500 mg/L. Values in **bold** are at least half of the MCL; values in **red** exceed the MCL.

Undetected measurements were given the value of 0.05 mg/L (half of the reporting limit) to calculate average nitrate concentrations.

Depth of wells is not available for this data set.

ID = identification

MCL = Maximum Contaminant Level

mg/L = milligram(s) per liter

TDS = total dissolved solids

Source: DWR 2015

Table C-5. Summary of Electrical Conductivity Data from DWR Wells

CRC Rice-Specific Groundwater Data Gap Analysis

State Well ID	Number of Samples	Sampling Years	Average EC Concentration (µS/cm)	Minimum EC Concentration (µS/cm)	Maximum EC Concentration (µS/cm)
13N04E02A002M	17	1968 – 2014	**457**	260	**723**
13N04E12H004M	17	1970 – 2014	**760**	432	**1288**
14N04E14J002M	17	1965 – 2013	330	190	**648**
14N05E16Q001M	18	1970 – 2014	**1626**	**720**	**2456**
15N04E23Q001M	17	1968 – 2013	267	170	401
16N03E36E002M	16	1968 – 2013	**666**	**510**	**785**
16N04E34E001M	18	1968 – 2013	241	171	331
16N04E27F002M	19	1968 – 2014	175	140	220
16N03E24M002M	16	1970 – 2013	**573**	**460**	**772**

Notes:

Primary EC MCL is 900 µS/cm. Values in **bold** are at least half of the MCL; values in **red** exceed the MCL.

Undetected measurements were given the value of 0.05 mg/L (half of the reporting limit) to calculate average nitrate concentrations.

Depth of wells is not available for this data set.

µS/cm = microSiemen(s) per centimeter

EC = electrical conductivity

ID = identification

MCL = Maximum Contaminant Level

Source: DWR 2015

Table C-6. Yuba County CASGEM Monitoring Wells Groundwater Quality

CRC Rice-Specific Groundwater Data Gap Analysis

Well Name	State ID	Screened Interval (ft bgs)	Sampling Date	Field EC (µS/cm)	TDS (mg/L)	Dissolved Nitrate as NO_3[a] (mg/L)	Min – Max Groundwater Elevation (NAVD88)[b]
YCWA-10	14N03E13J001M	180–200	3/22/2006	262	164	<0.1	5.6–29
YCWA-12	13N04E07L001M	155–175	3/22/2006	417	251	<0.1	9.3–29.3
YCWA-13	13N05E06R004M	180–200	5/16/2006	338	227	2.9	25.4–54
YCWA-15	14N05E28A002M	175–195	3/30/2006	415	285	6.9	1.8–59.2

[a] Primary MCL is 45 mg/L

[b] CASGEM Online System – Public Portal

Notes:

Groundwater elevation measured for all wells between August 2011 and April 2015.

µS/cm = microSiemen(s) per centimeter
ft bgs = foot (feet) below ground surface
EC = electrical conductivity
ID = identification
MCL = Maximum Contaminant Level
mg/L = milligram(s) per liter
TDS = total dissolved solids

Table C-7. DWR Wells in Yuba County to be Added to Trend Monitoring Data Review

CRC Rice-Specific Groundwater Data Gap Analysis

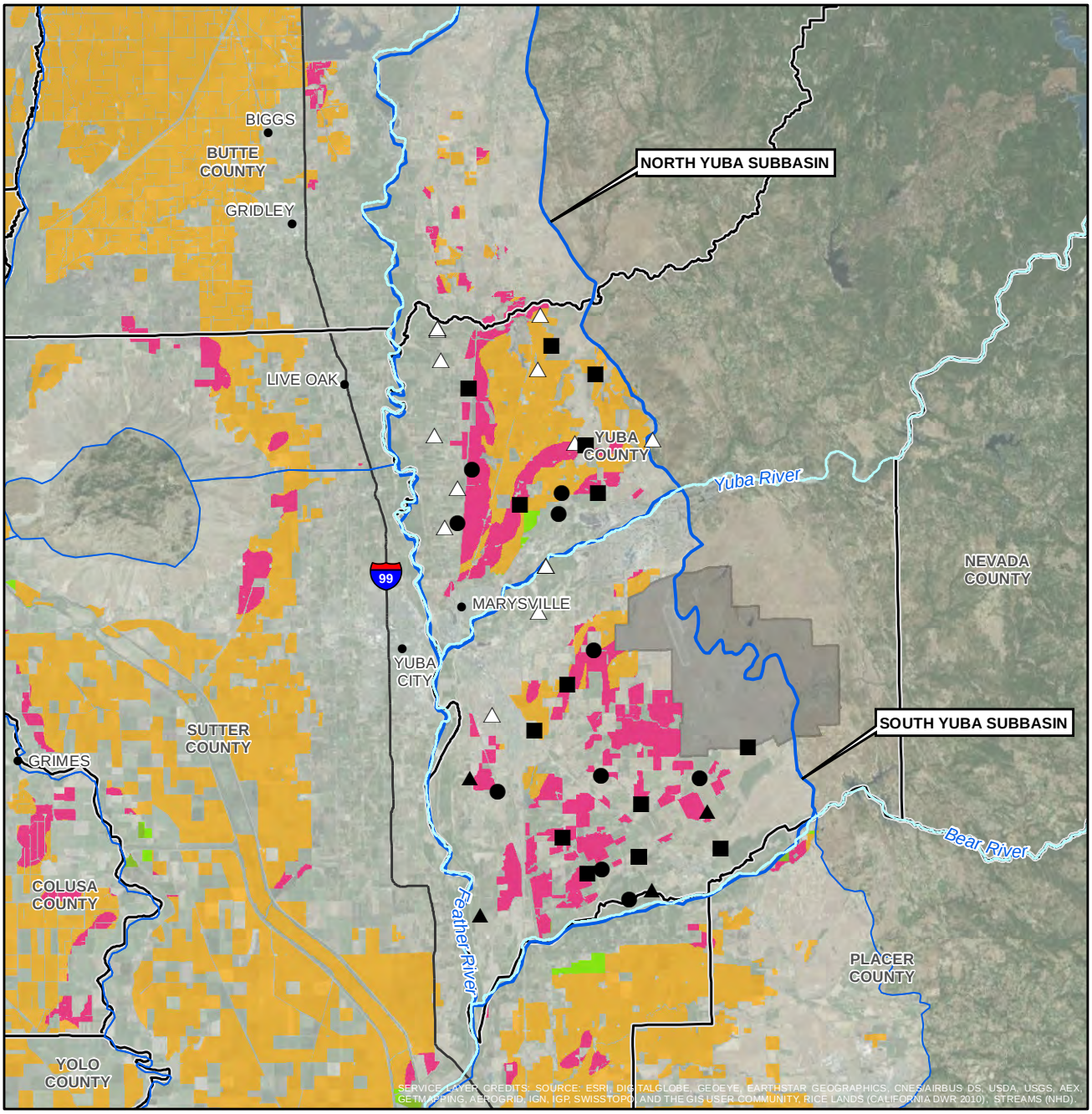
Well ID	Well Type	Well Depth (ft)	Screened Interval[a] (ft)	Date Completed	Sanitary Seal Information	Subbasin	Next Sampling Year
13N04E02A002M	Irrigation	185	Not available	9/4/1950	Not available	South Yuba	2016, 2018
14N04E14J002M	Domestic	162	84-162	8/11/1954	No seal installed	South Yuba	2017
15N04E23Q001M	Domestic/Irrigation	120	84-120	12/16/1952	Not available	South Yuba	2017
16N03E24M002M	Domestic	105	76-105	3/4/1968	Installed but depth not specified	North Yuba	2017
16N03E36E002M	Domestic	86	80-86	12/19/1963	Installed to a depth of 2'	North Yuba	2017
16N04E27F002M	Domestic	105	56-105	12/23/1954	Not available	North Yuba	2016,2018

[a] The “screen interval” for each well is open-borehole. This means casing was installed to a particular depth and the well is open to the total depth.

Table C-8. Monitoring Parameters for DWR Wells in Yuba County to be Added to Trend Monitoring Data Review
CRC Rice-Specific Groundwater Data Gap Analysis

Type of Parameter	Parameter Name(s)
Field Parameters	Conductance (EC), pH, dissolved oxygen, water temperature
Major Laboratory Parameters	Total Dissolved Solids, nitrate
Anions	Carbonate, bicarbonate, chloride, sulfate
Cations	Boron, calcium, sodium, magnesium, potassium

Figures



LEGEND

MONITORING WELL
- DWR WELL
- YCWA PMW WELL

CASGEM YCWA MONITORING WELL
- WATER LEVEL ONLY
- WATER LEVEL & QUALITY

MAJOR RIVER

GROUNDWATER BASIN

COUNTY

RICE WITHIN DPR LEACHING AREA

RICE WITHIN INITIAL SWRCB HVA

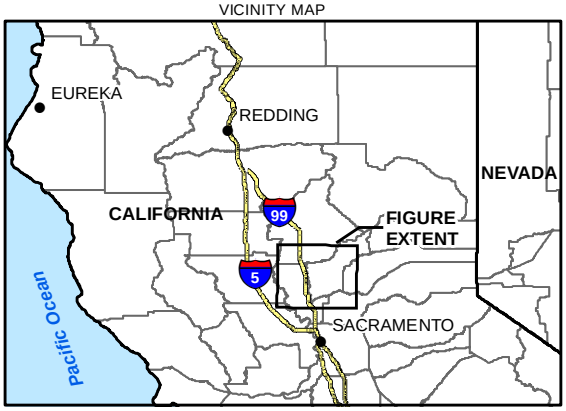
RICE LAND

BEALE AIR FORCE BASE

NOTE:

DATA SOURCES: GROUNDWATER BASINS, RICE LANDS, URBAN AREAS, BEALE AFB (CALIFORNIA DWR); COUNTY (CAL FIRE); MONITORING WELLS (YUBA COUNTY WATER AGENCY); HVA (SWRCB). HORIZONTAL DATUM IS NAD83

VICINITY MAP

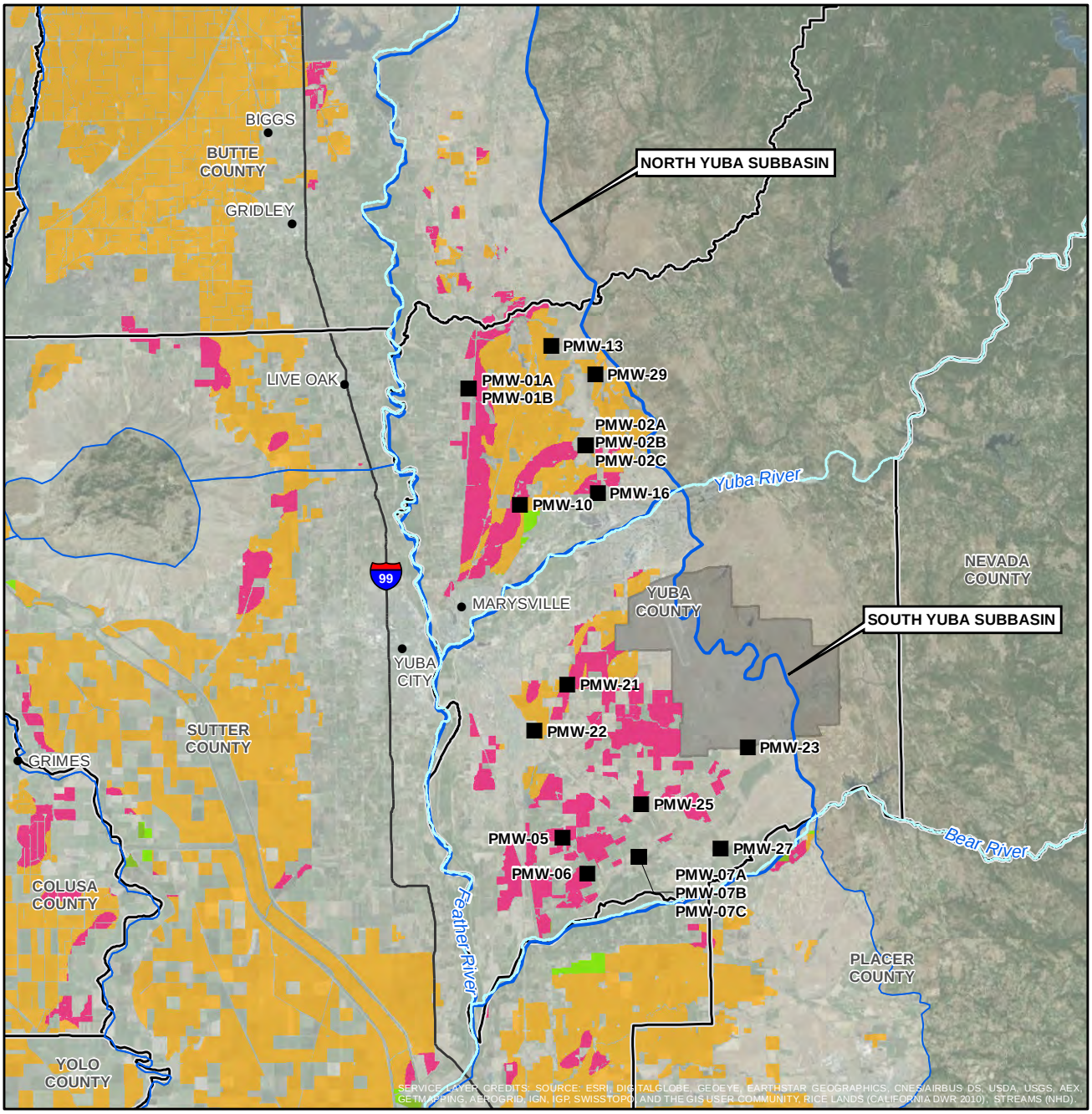


California Rice

0 6 12
Miles

N

FIGURE C-1
HVA Areas within Yuba County Rice Lands
Groundwater Trend Monitoring Workplan
California Rice Commission



LEGEND

- YUBA COUNTY PMW WELL
- MAJOR RIVER
- GROUNDWATER BASIN
- COUNTY
- RICE WITHIN DPR LEACHING AREA
- RICE WITHIN INITIAL SWRCB HVA
- RICE LAND
- BEALE AIR FORCE BASE

VICINITY MAP

NOTE:

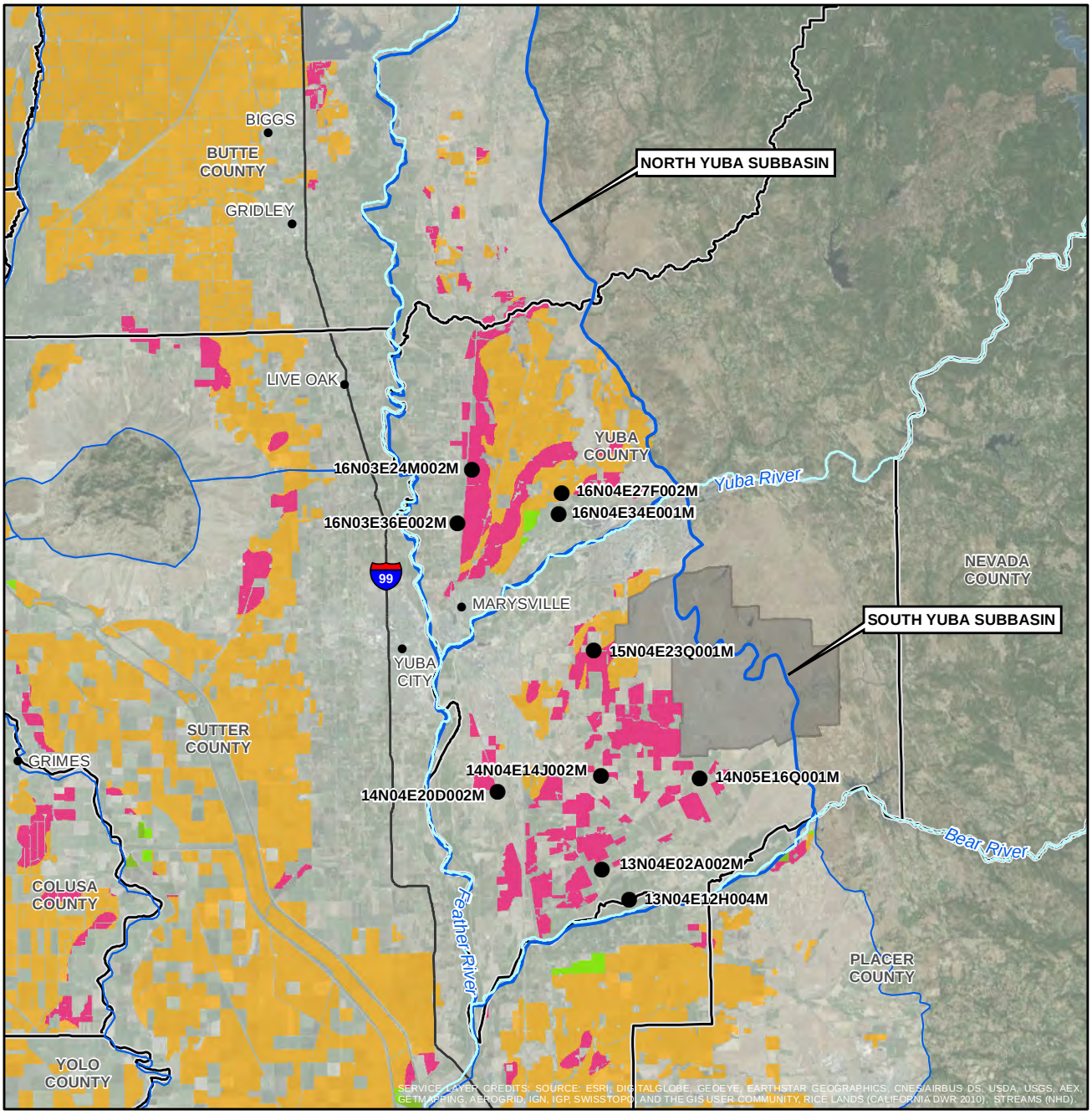
DATA SOURCES: GROUNDWATER BASINS, RICE LANDS, URBAN AREAS, BEALE AFB (CALIFORNIA DWR); COUNTY (CAL FIRE); MONITORING WELLS (YUBA COUNTY WATER AGENCY); HVA (SWRCB). HORIZONTAL DATUM IS NAD83

California Rice

0 6 12
Miles

N

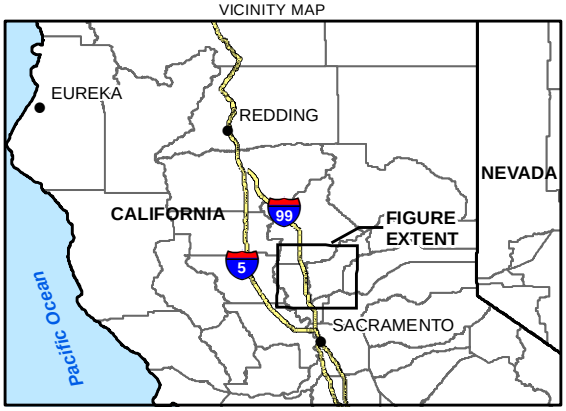
FIGURE C-2
Yuba County Sampled Wells
Groundwater Trend Monitoring Workplan
California Rice Commission



LEGEND

- DWR WELL
- MAJOR RIVER
- GROUNDWATER BASIN
- COUNTY
- RICE WITHIN DPR LEACHING AREA
- RICE WITHIN INITIAL SWRCB HVA
- RICE LAND
- BEALE AIR FORCE BASE

VICINITY MAP



NOTE:

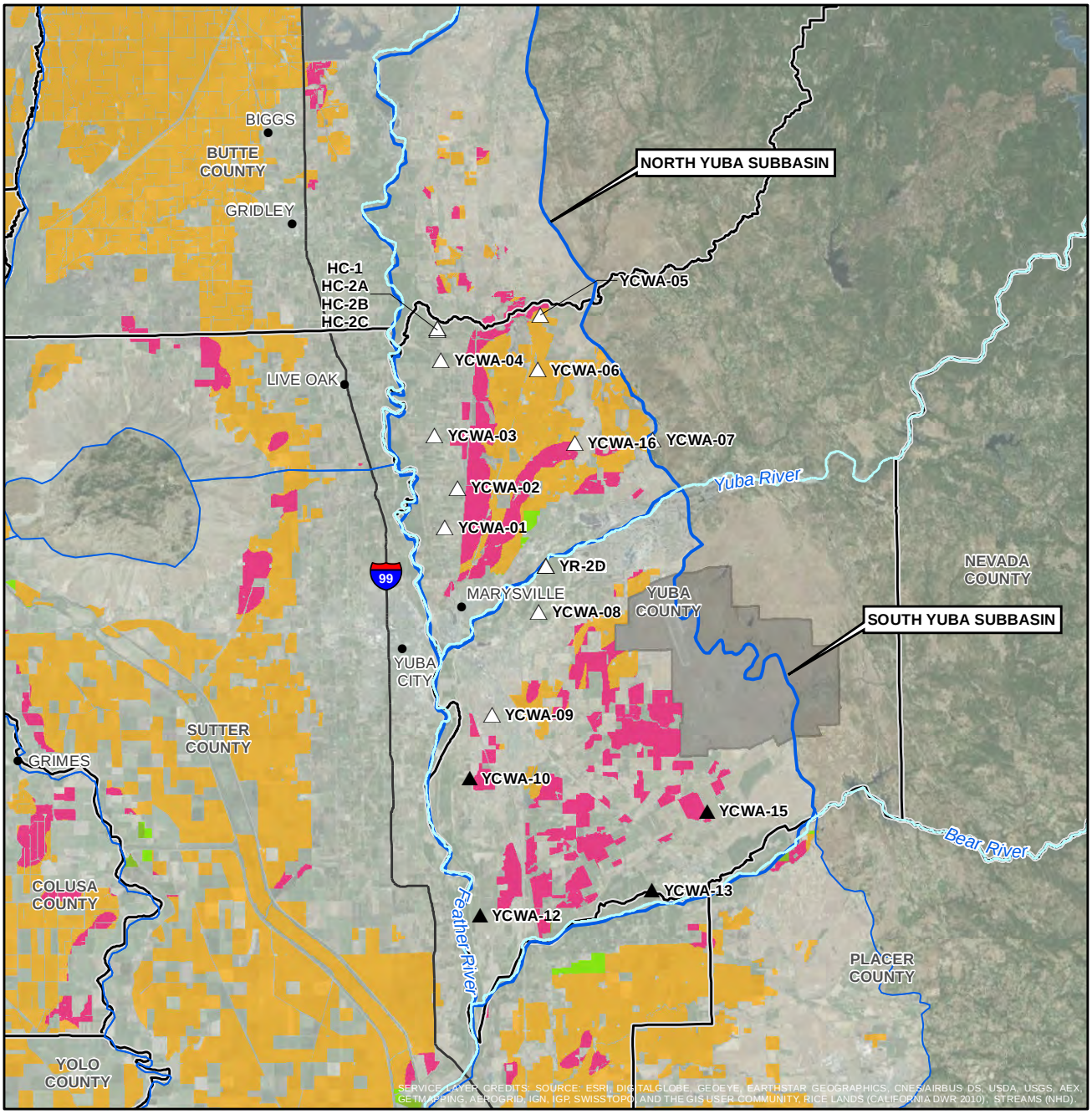
DATA SOURCES: GROUNDWATER BASINS, RICE LANDS, URBAN AREAS, BEALE AFB (CALIFORNIA DWR); COUNTY (CAL FIRE); MONITORING WELLS (YUBA COUNTY WATER AGENCY); HVA (SWRCB). HORIZONTAL DATUM IS NAD83

California Rice

0 6 12
Miles

N

FIGURE C-3
DWR Sampled Wells
Groundwater Trend Monitoring Workplan
California Rice Commission

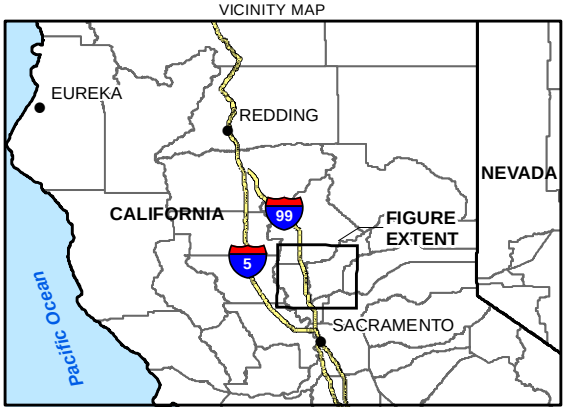


LEGEND

CASGEM YCWA MONITORING WELL

- △ WATER LEVEL ONLY
- ▲ WATER LEVEL & QUALITY
- MAJOR RIVER
- GROUNDWATER BASIN
- COUNTY
- RICE WITHIN DPR LEACHING AREA
- RICE WITHIN INITIAL SWRCB HVA
- RICE LAND
- BEALE AIR FORCE BASE

VICINITY MAP



NOTE:

DATA SOURCES: GROUNDWATER BASINS, RICE LANDS, URBAN AREAS, BEALE AFB (CALIFORNIA DWR); COUNTY (CAL FIRE); MONITORING WELLS (YUBA COUNTY WATER AGENCY); HVA (SWRCB). HORIZONTAL DATUM IS NAD83

California Rice

0 6 12
Miles

N

FIGURE C-4
YCWA Sampled Wells (CASGEM Program)
Groundwater Trend Monitoring Workplan
California Rice Commission

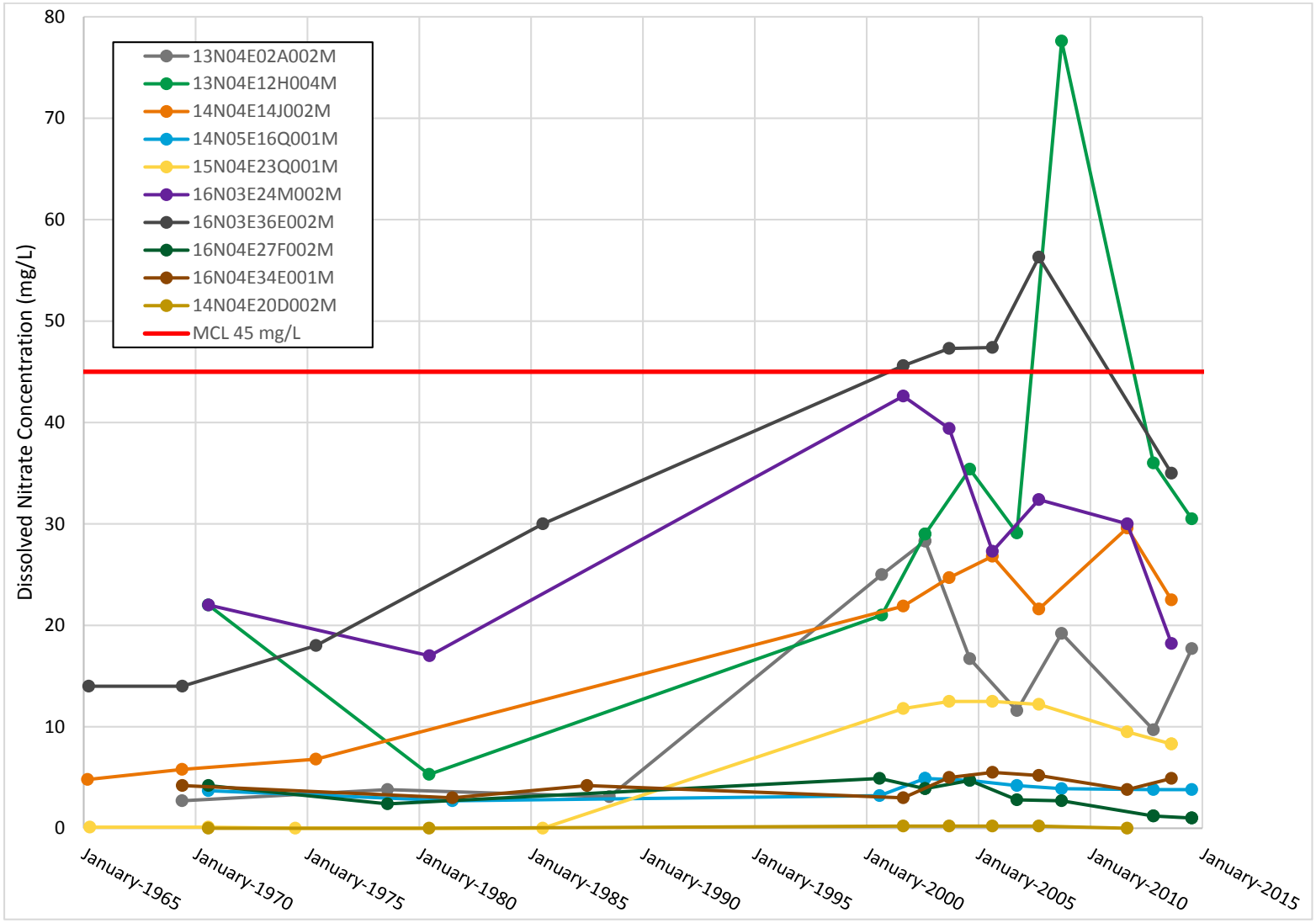


Figure C-5. Nitrate Concentrations Measured in Groundwater Wells Monitored by DWR

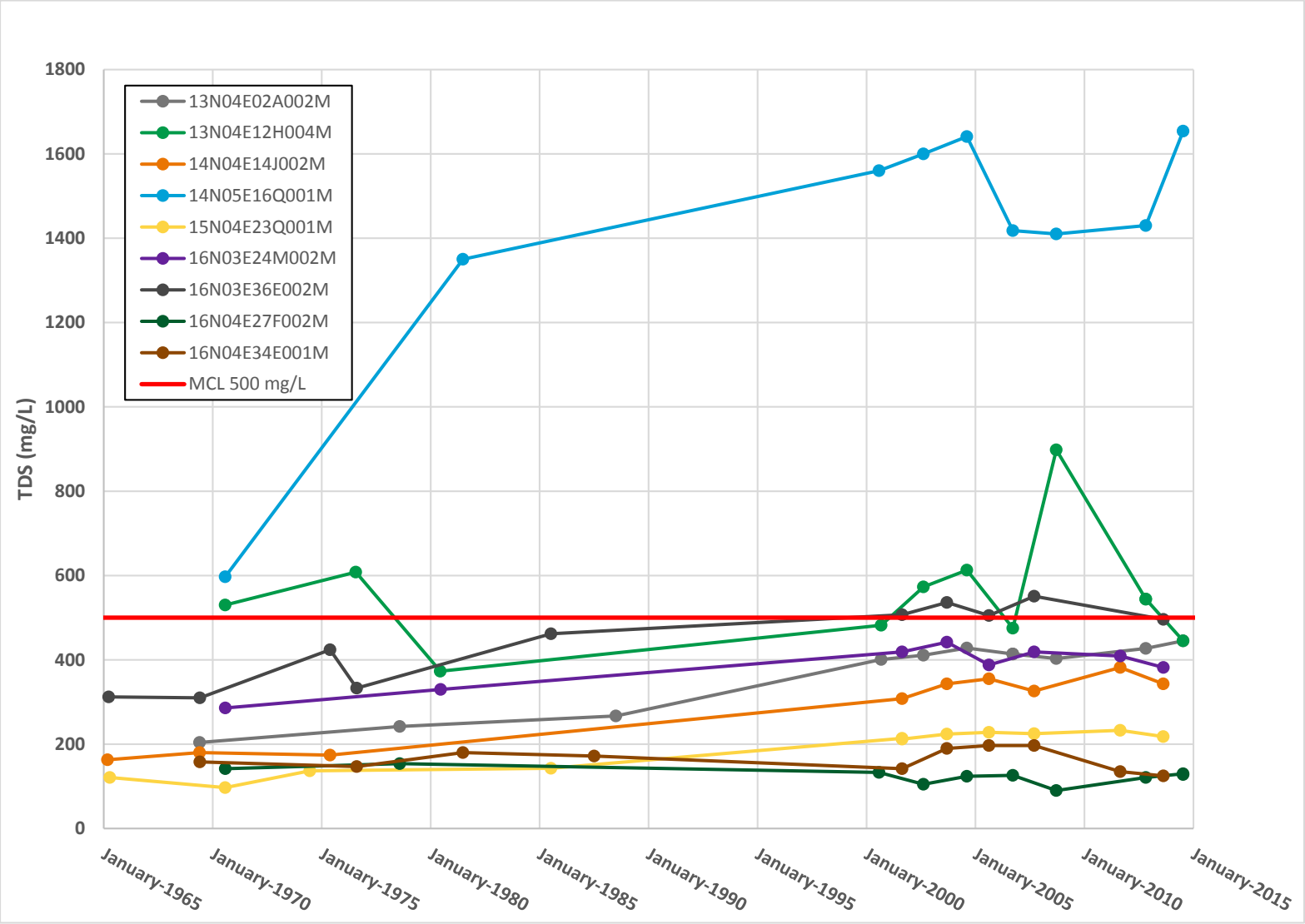


Figure C-6. Total Dissolved Solids Concentrations Measured in Groundwater Wells Monitored by DWR

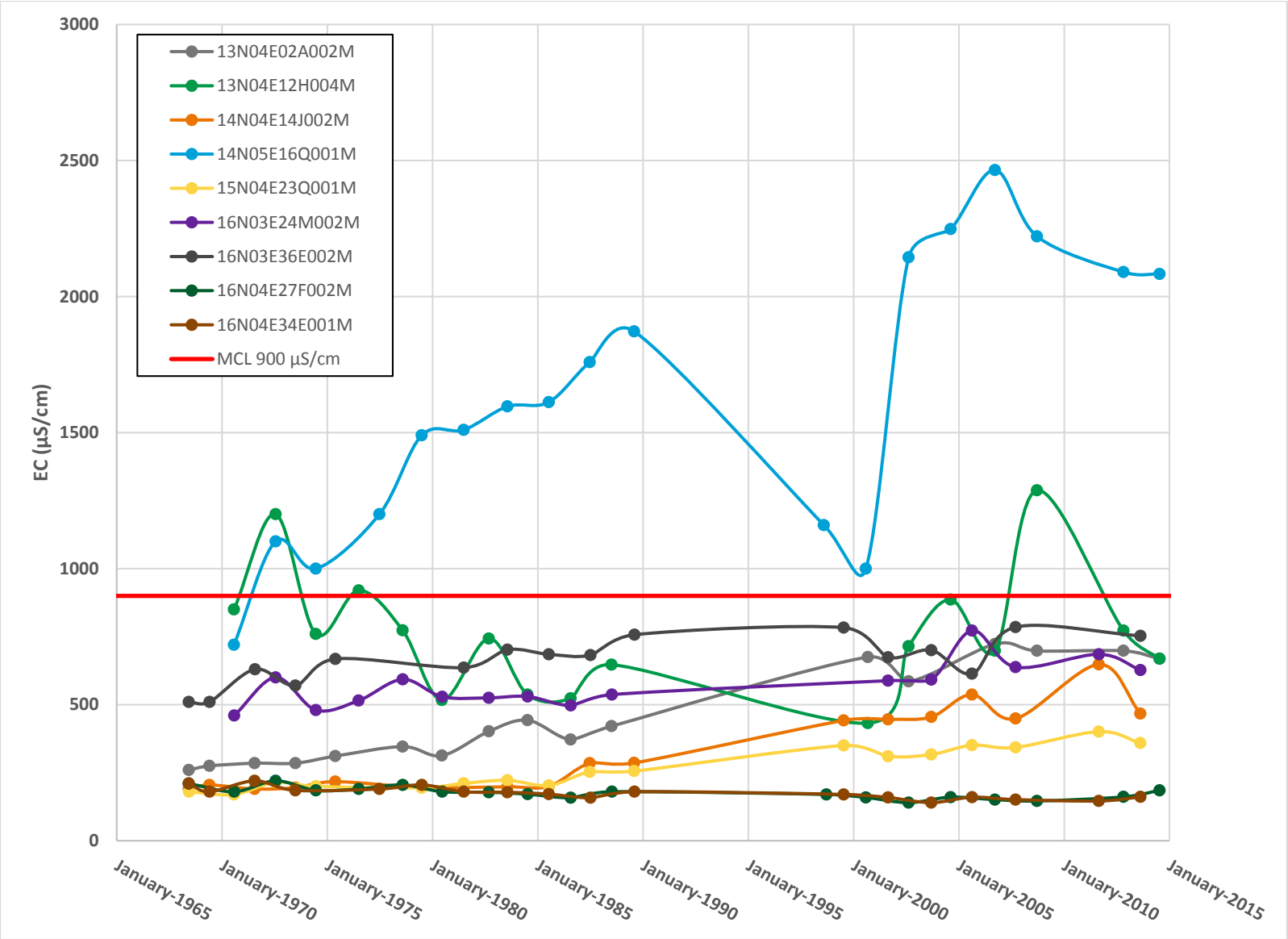
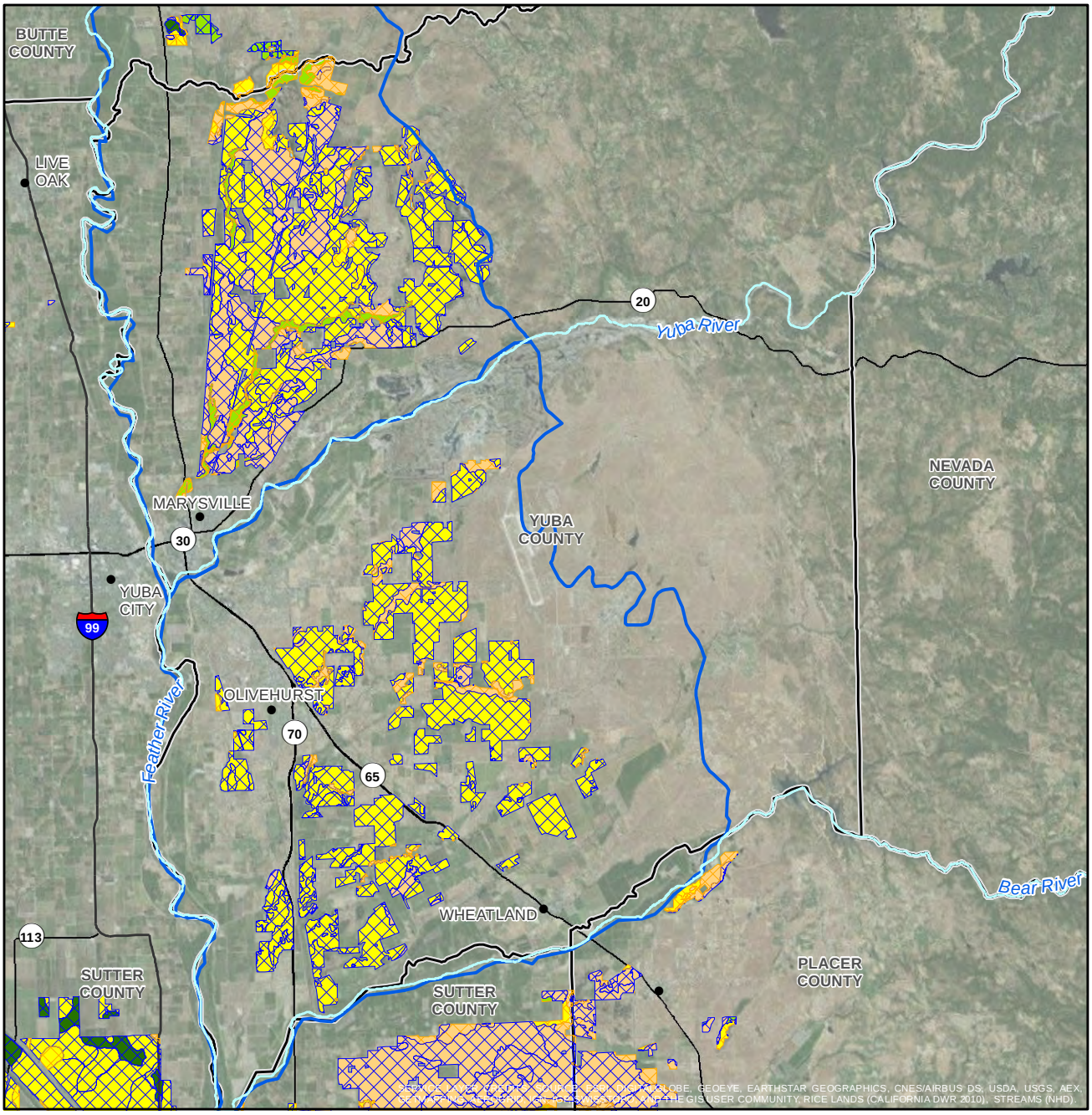


Figure C-7. Electrical Conductivity Concentrations Measured in Groundwater Wells Monitored by DWR



LEGEND

- MAJOR RIVER
- COUNTY
- GROUNDWATER BASIN

DEPTH TO RESTRICTIVE LAYER

- <60 INCHES TO RESTRICTIVE LAYER
- >60 INCHES TO RESTRICTIVE LAYER

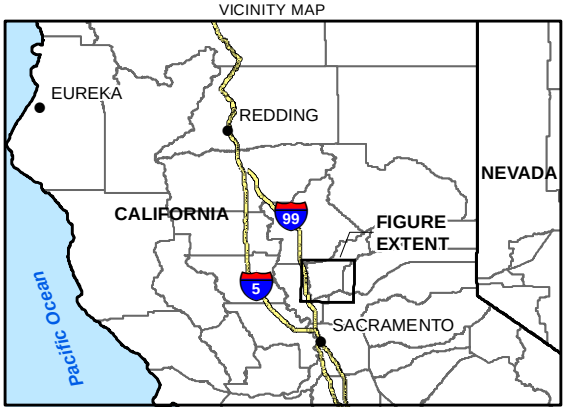
NRCS DRAINAGE CLASS WITHIN RICE LANDS

- POORLY DRAINED
- SOMEWHAT POORLY DRAINED
- MODERATELY WELL DRAINED
- WELL DRAINED
- SOMEWHAT EXCESSIVELY DRAINED
- EXCESSIVELY DRAINED
- WATER

NOTE:

DATA SOURCES: GROUNDWATER BASINS, RICE LANDS (CALIFORNIA DWR 2010); COUNTY (CAL FIRE) USGS RICE WELLS (USGS). NRCS SOILS (USDA; CH2M). HORIZONTAL DATUM IS NAD83.

VICINITY MAP

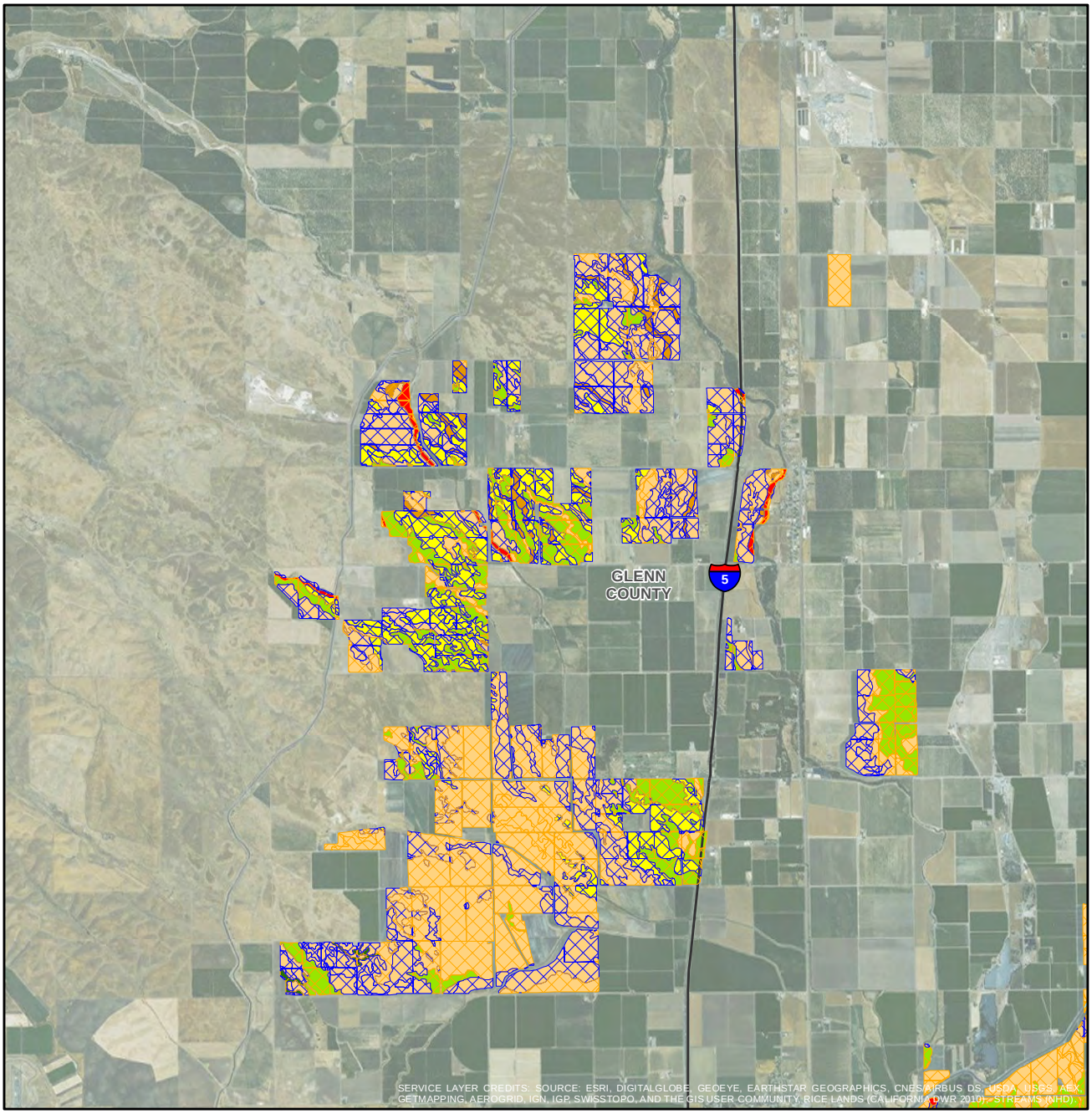


California Rice

0 4 8
Miles

N

FIGURE C-8
Soil Restrictive Layers in Yuba County Data Gap Area
Groundwater Trend Monitoring Workplan
California Rice Commission



LEGEND

- MAJOR RIVER
- COUNTY
- GROUNDWATER BASIN

DEPTH TO RESTRICTIVE LAYER

- <60 INCHES TO RESTRICTIVE LAYER
- >60 INCHES TO RESTRICTIVE LAYER

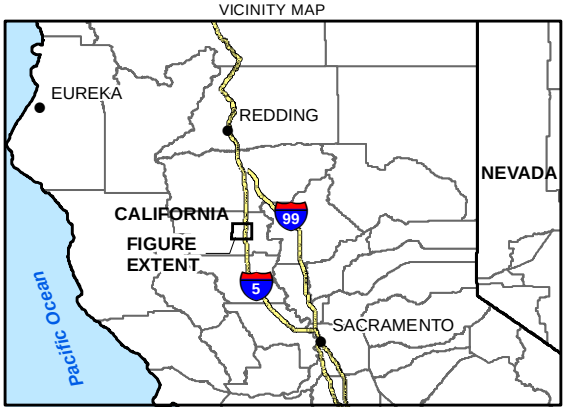
NRCS DRAINAGE CLASS WITHIN RICE LANDS

- POORLY DRAINED
- SOMEWHAT POORLY DRAINED
- MODERATELY WELL DRAINED
- WELL DRAINED
- SOMEWHAT EXCESSIVELY DRAINED
- EXCESSIVELY DRAINED
- WATER

NOTE:

DATA SOURCES: GROUNDWATER BASINS, RICE LANDS (CALIFORNIA DWR 2010); COUNTY (CAL FIRE) USGS RICE WELLS (USGS). NRCS SOILS (USDA; CH2M). HORIZONTAL DATUM IS NAD83.

VICINITY MAP

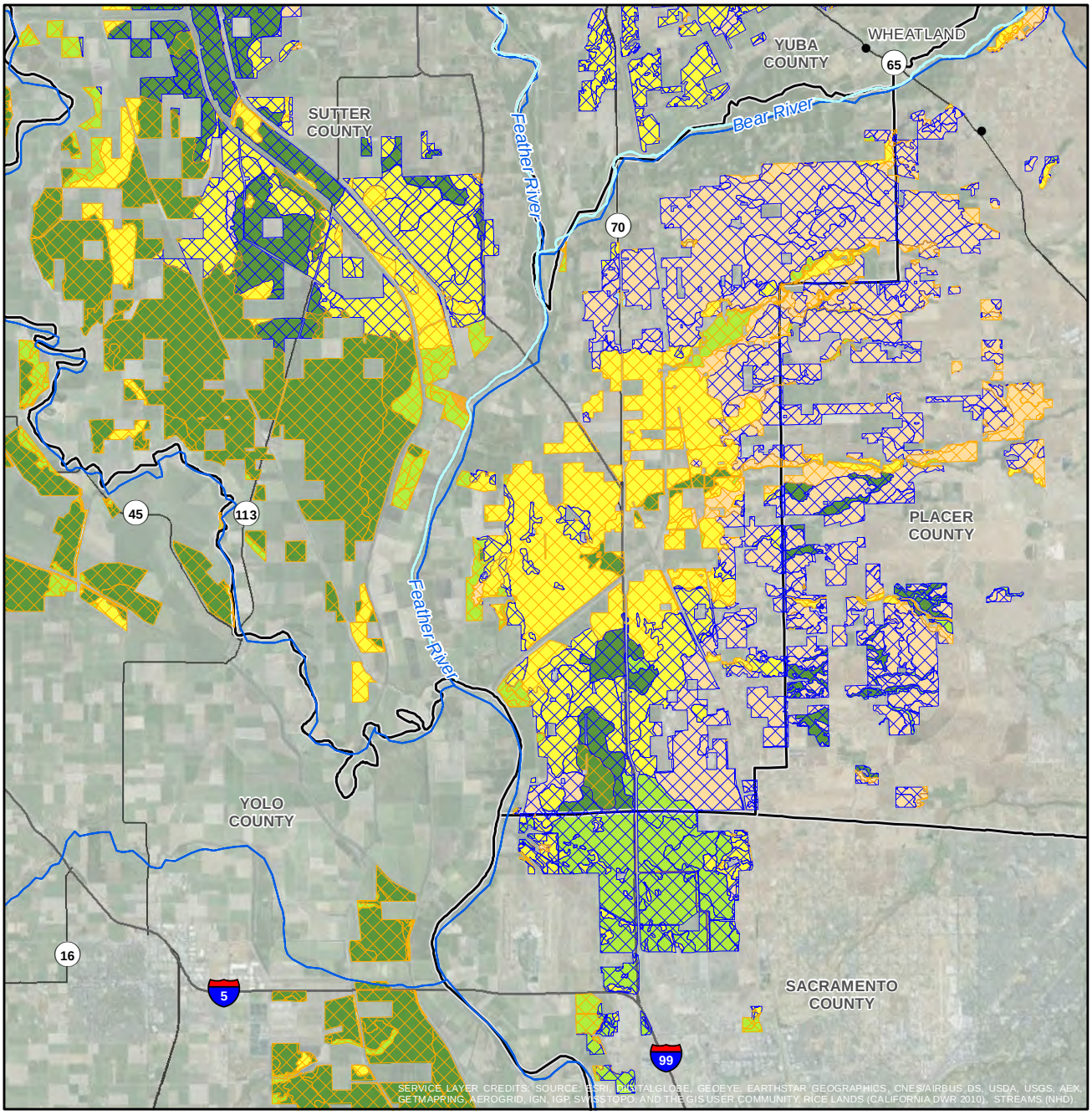


California Rice

0 1.5 3
Miles

N

FIGURE C-9
Soil Restrictive Layers in Glenn County Data Gap Area
Groundwater Trend Monitoring Workplan
California Rice Commission



LEGEND

- MAJOR RIVER
- GROUNDWATER BASIN
- COUNTY

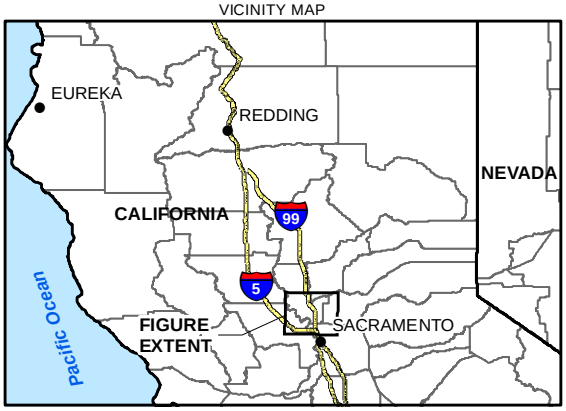
DEPTH TO RESTRICTIVE LAYER

- <60 INCHES TO RESTRICTIVE LAYER
- >60 INCHES TO RESTRICTIVE LAYER

NRCS DRAINAGE CLASS WITHIN RICE LANDS

- POORLY DRAINED
- SOMEWHAT POORLY DRAINED
- MODERATELY WELL DRAINED
- WELL DRAINED
- SOMEWHAT EXCESSIVELY DRAINED
- EXCESSIVELY DRAINED
- WATER

VICINITY MAP



NOTE:

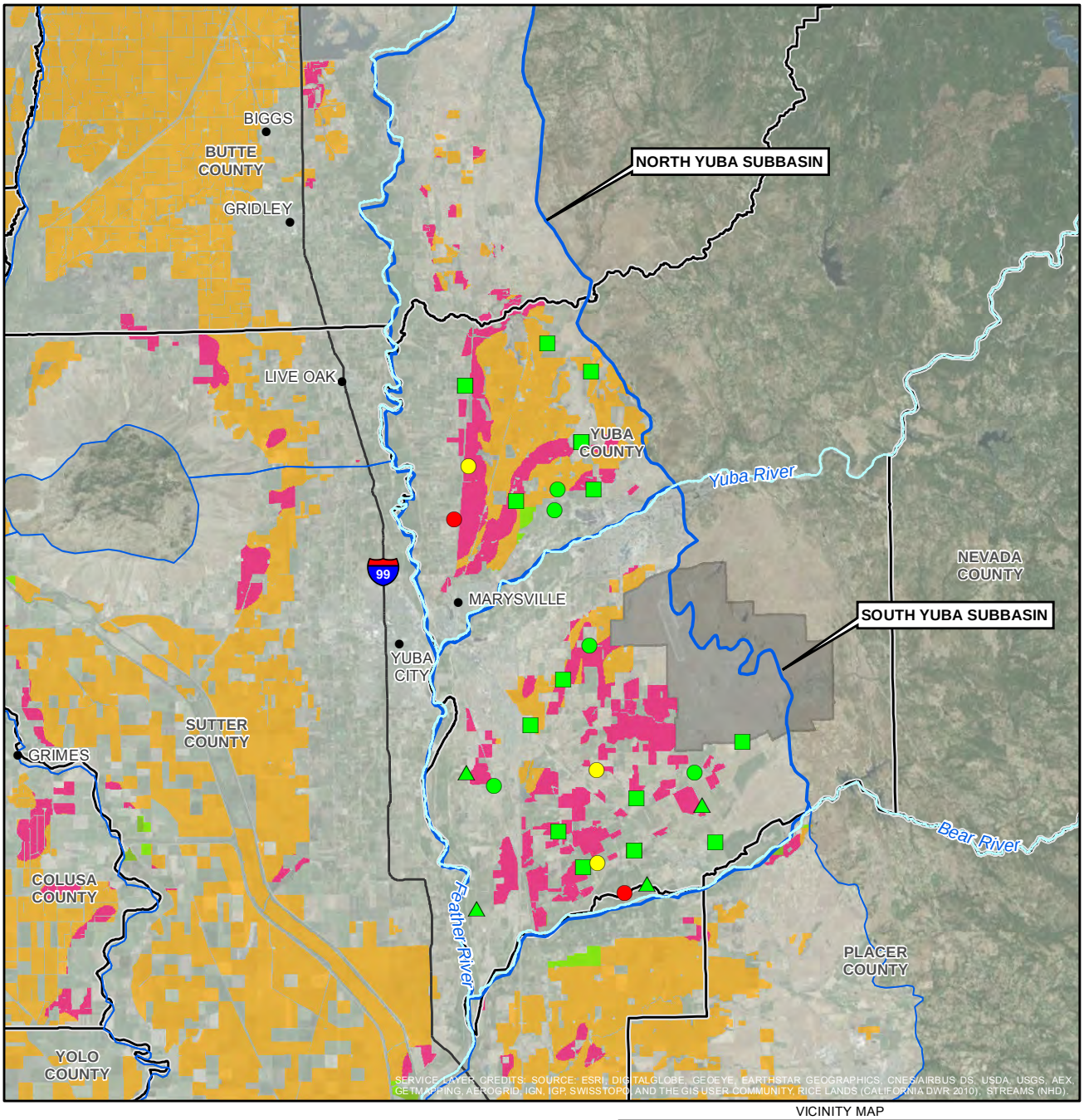
DATA SOURCES: GROUNDWATER BASINS, RICE LANDS (CALIFORNIA DWR 2010); COUNTY (CAL FIRE) USGS RICE WELLS (USGS). NRCS SOILS (USDA; CH2M). HORIZONTAL DATUM IS NAD83.

California Rice

0 4 8
Miles

N

FIGURE C-10
Soil Restrictive Layers in Placer and Sutter County Data Gap Area
Groundwater Trend Monitoring Workplan
California Rice Commission



LEGEND

MAX NITRATE MEASURED (mg/L-N)

- <MCL*0.5
- ">MCL*0.5 and <MCL
- >MCL

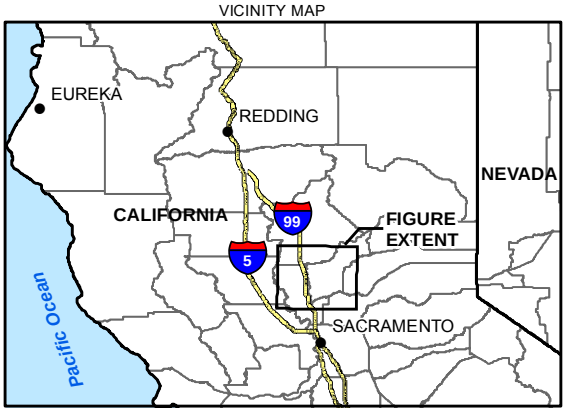
MONITORING ENTITY

- DWR
- YCWA PMW
- YCWA CASGEM

- MAJOR RIVER
- GROUNDWATER BASIN
- COUNTY
- RICE WITHIN DPR LEACHING AREA
- RICE WITHIN INITIAL SWRCB HVA
- RICE LAND
- BEALE AIR FORCE BASE

NOTE:

DATA SOURCES: GROUNDWATER BASINS, RICE LANDS, URBAN AREAS, BEALE AFB (CALIFORNIA DWR); COUNTY (CAL FIRE); MONITORING WELLS (YUBA COUNTY WATER AGENCY); HVA (SWRCB). HORIZONTAL DATUM IS NAD83



California Rice

0 6 12
Miles

N

FIGURE C-11
Maximum Nitrate Concentrations in Yuba County Monitoring Wells
Groundwater Trend Monitoring Workplan
California Rice Commission

Attachment C1
Yuba County DWR Wells Driller Logs

Drilling Log
DWR Well ID: 13N04E02A002M

ORIGINAL
File Original, Duplicate and Triplicate with the
DIVISION OF WATER RESOURCES
P. O. BOX 1079
SACRAMENTO 5, CALIFORNIA

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

58-009 52

Do Not Fill In 2A2
State Well No. 13N/4E-2A1
Other Well No.
Region 5

WATER WELL DRILLERS REPORT

(Sections 7076, 7077, 7078, Water Code)

32

Y N

(1) Driller:
Name FRANK L. CORNWELL & SON
Address 422 2nd Street
Marysville
License No. 99159 Classification C-57

(2) Proposed use or uses (check):
Domestic ☐ Municipal ☐
Irrigation ☐ Industrial ☐
Domestic and Irrigation ☑ Test well ☐
Other

(3) Equipment used (check):
Rotary ☐
Cable ☑
Dug well ☐
Other

Owner:
Name [redacted]
Address

(4) Type of work (check):
New well ☑ Reconditioning of well ☐
Deepening existing well ☐

(5) Well log:
Total depth of well 185 ft.

Give details of formations penetrated, such as silt, peat, muck, sand, gravel, clay, shale, sandstone, hardpan, rock. Include size of gravel (diameter) and sand (fine, medium, coarse), color of material, structure (loose, packed, cemented, soft, hard, brittle).

Depth From Ground Surface		Depth To Ground Surface		Formation	Thickness
0	ft. to	9	ft.	Top Soil	9
9	" "	40	"	Clay	31
40	" "	80	"	Brown Clay	40
80	" "	105	"	Brittle Clay	25
105	" "	107	"	Sand	20
107	" "	120	"	Brittle Clay	13
120	" "	143	"	Soft Clay	23
143	" "	153	"	Packed Sand	10
153	" "	185	"	Brown Clay	32

Plotted and Coded As Well 13N/4E-2A2

FOR OFFICIAL USE ONLY

If additional space is required, continue on DWR Form No. 246—Supplement, and attach to respective report copies.

(6) Casing left in well:

LENGTH FT.	DIAMETER INCHES	SINGLE, DOUBLE, WELDED, OTHER	LBS. PER FOOT OR GAGE OF CASING	SEATING BELOW GROUND SURFACE, FT.
75	10	Welded	1290	75

Type and size of shoe or well ring 4X5 Welded joints—☑ Yes ☐ No

D.W.R. FORM NO. 246 REGIONAL WATER POLLUTION CONTROL BOARD COPY

File Original, Duplicate and Triplicate with the
DIVISION OF WATER RESOURCES
P. O. BOX 1079
SACRAMENTO 5, CALIFORNIA

SHEET 2

58-009

WATER WELL DRILLERS REPORT

(Sections 7076, 7077, 7078, Water Code)

Do Not Fill In

State Well No. 13N/4E-[illegible]

Other Well No. /

Region 5

(7) Perforations: None

Type of perforator used

Perforated	ft. to	ft.	Hole size	No. of holes
"	" "	"	"	"
"	" "	"	"	"
"	" "	"	"	"
"	" "	"	"	"
"	" "	"	"	"
"	" "	"	"	"
"	" "	"	"	"
"	" "	"	"	"
"	" "	"	"	"

(8) Water levels:

Depth at which water first encountered Standing 37 ft.

Depth to water before perforating ft.

Depth to water after perforating ft.

Note any change in water level while drilling

(9) Well pumping test: No Test

Date of test By whom

Depth to water when test started ft.

G.P.M. at beginning of test

Drawdown from standing level ft.

G.P.M. at completion of test

Drawdown at completion of test ft.

Length of time tested

Temperature of water

Was gas present in water? ☐ Yes ☐ No

(10) General:

Was well gravel packed? No Size of rock Thickness of pack

Was a surface sanitary seal provided?

Were any strata sealed against pollution? ☑ Yes ☐ No If yes, attach detailed description.

Strata sealed Top Cased 0'

Was analysis made of water? ☐ Yes ☑ No If yes, attach copy.

Was electric log made of well? ☐ Yes ☑ No If yes, attach copy.

FOR OFFICIAL USE ONLY

If well abandoned, was it plugged and sealed?

Method of plugging and sealing

(11) Location:

Plumas x School

Morrisons Crossing

[redacted]

North

1 MILE

Section No. 2

Township Wheatland T13N

Range R4E

Base & Meridian Mt Diablo

Show location of well in Section, thus (X)

Distances to section lines from well, N or S 1000 N ft. and E or W 400 E ft.

Show location of nearest known well, thus (O)

Distance to nearest known well ft.

(12) Time of work:

Work started date 9-12-50 Completed date 9-14-50

Date of this report 9-27-50

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

[SIGNED] FRANK L. CORNWELL & SON

By Louis L. Cornwell

License No. 99159 Classification C-57

Dated , 19

D.W.R. FORM NO. 246

REGIONAL WATER POLLUTION CONTROL BOARD COPY

23972 3-50 40M GUIN SPO

Drilling Log
DWR Well ID: 14N04E14J002M

ORIGINAL
File Original, Duplicate and Triplicate with the REGIONAL WATER POLLUTION CONTROL BOARD No. 5
(Insert appropriate number)

WATER WELL DRILLERS REPORT
(Sections 7076, 7077, 7078, Water Code)

STATE OF CALIFORNIA 273

LOCATION NOT CHECKED
Do Not Fill In
No 8639
State Well No. 14N/4E-2
Other Well No. 14N-4E-2

(1) OWNER:
[redacted]

(2) LOCATION OF WELL:
County Yuba Owner's number, if any—
R. F. D. or Street No.
1 mile East of 99E on Virginia Rd.
50 yds. West of Virginia Rd.

(3) TYPE OF WORK (check):
New well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) EQUIPMENT:
Rotary ☐
Cable ☒
Dug Well ☐

(6) CASING INSTALLED:
SINGLE ☒ DOUBLE ☐

From	ft. to	Diam.	Gage or Wall
0	84	8"	10

Type and size of shoe or well ring 8x4x⅛
Describe joint Elec. Weld

If gravel packed

Diameter of Bore	from ft.	to ft.

Size of gravel:

(7) PERFORATIONS: None
Type of perforator used
Size of perforations in., length, by in.

From ft.	to ft.	Perf. per row	Rows per ft.

(8) CONSTRUCTION:
Was a surface sanitary seal provided? ☐ Yes ☒ No To what depth ft.
Were any strata sealed against pollution? ☐ Yes ☒ No If yes, note depth of strata

From ft.	to ft.

Method of Sealing RECEIVED

(9) WATER LEVELS:
Depth at which water was first found JAN 6 1955 54 ft.
Standing level before perforating CONTROL BOARD ft.
Standing level after perforating ft.

(10) WELL TESTS:
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. draw down after hrs.
Temperature of water Was a chemical analysis made? ☐ Yes ☐ No
Was electric log made of well? ☐ Yes ☒ No

(11) WELL LOG:
Total depth 162 ft. Depth of completed well 162 ft.
Formations: *Describe by color, character, size of material, and structure.*

0 ft. to	2 ft.	Topsoil	5
2 "	4 "	red clay	3
4 "	10 "	brown sandy clay	5
10 "	25 "	sand & gravel	20 15
25 "	64 "	sand, gravel & cobbles	
64 "	72 "	sand	20
72 "	85 "	Cemented sand	10
85 "	124 "	brown sandy clay	5
124 "	125 "	gravel	20
125 "	157 "	brown sandy clay	10
157 "	162 "	sand & gravel	20

CONFIDENTIAL
Section 7076.1, Water Code

Plotted

Work started 8/7/54 19 . Completed 8/11/54 19

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Star Well Drilling & Pump Co.
(Person, firm, or corporation) (Typed or printed)
Address P.O. Box 689
Yuba City, Calif.
[SIGNED] Glenn R. Morey
Well Driller
License No. 121868 Dated 7/1/54, 19

95699 3-54 SOM QUIN © SPO

DWR FORM NO. 246 (REV. 3-54)

Drilling Log
DWR Well ID: 15N04E23Q001M

ORIGINAL
File Original, Duplicate and Triplicate with the
DIVISION OF WATER RESOURCES
P. O. BOX 1079
SACRAMENTO 5, CALIFORNIA

WATER WELL DRILLERS REPORT

(Sections 7076, 7077, 7078, Water Code)

STATE OF CALIFORNIA—DEPARTMENT OF PUBLIC WORKS

DIVISION OF WATER RESOURCES

10768

LOCATION NOT CHECKED Do Not Fill In

State Well No. 15N/4E-23Q1

Other Well No. 15N/4E-21

58-268

(1) DRILLER: (person, firm, or corporation)

Name Armstrong Bros.

Address P.O. Box 721

Marysville, Calif.

[redacted]

(2) Proposed Use (Check)

Domestic	☒	Industrial	☐
Irrigation	☐	Test Well	☐
Municipal	☐	Other	☐

Equipment

Rotary	☐
Cable	☒
Dug Well	☐
Other	☐

(3) CASING:

84 ft. of 12 in. 10 ga. casing left in well

Type and size of shoe or well ring 12 X 4 X 12

(4) PERFORATIONS:

Type of perforator used None

Perforated	ft. to	ft.	holes per	in.

Diameter of perforations in., length in.

(5) WATER LEVELS:

Was electric log made of well? ☐ Yes ☐ No If yes, attach copy.

Depth at which water was first found 97 ft. ft.

Standing level before perforating ft.

Standing level after perforating ft.

Note your observation of any change in water level while drilling

Was a surface sanitary seal provided?

(6) WELL PUMPING TEST:

Capacity gal./min. ft. draw down

Was well gravel packed?

Were any strata sealed against pollution?

Temperature Was a chemical analysis made? Attach copy

If abandoned was well capped?

(7) TYPE OF WORK (check):

New well ☒ Reconditioning of well ☐

Deepening existing well ☐

(8) LOCATION OF WELL

County (Yuba)

R. F. D. or Street No.

See map.

(9) WELL LOG:

Total depth of well 120 ft.

Formation: Mention size of water gravel—

0	ft. to	2	ft.	Topsoil 5
2	"	5	"	Hardpan
5	"	12	"	Yellow Clay 3
12	"	24	"	Cobbles + Sand 15
24	"	71	"	Yellow Clay 3
71	"	80	"	Cobbles + Sand 15
80	"	115	"	Blue Clay 3
115	"	120	"	Sand + Gravel 20

"CONFIDENTIAL"
Section 7076.1, Water Code

Plotted and Coded
As Well 15N04E 23Q01

Work started 12-12 1952. Completed Dec 16 1952

Date of Report 3/16/53, 19

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

[SIGNED] Armstrong Bros.
Well Driller

By Joe L. Armstrong

License No. 12911 Classification C-57

Dated 3/16/53, 19

40970 7-51 30M QUIN ① SPO

Drilling Log
DWR Well ID: 16N03E24M002M

APR 30 1968

ORIGINAL
File with DWR

WATER WELL DRILLERS REPORT
(Sections 7079, 7080, 7081, 7082, Water Code)

THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

940

Do Not Fill In

No 43261

State Well No. 16N/3E-24M2

Other Well No. 16/3-24

[redacted]

(2) LOCATION OF WELL:

County Yuba Owner's number, if any

Township, Range, and Section

Distance from cities, roads, railroads, etc.

(3) TYPE OF WORK (check):

New Well ☑ Deepening ☐ Reconditioning ☐ Destroying ☐

If destruction, describe material and procedure in Item 11.

(4) PROPOSED USE (check):

Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) EQUIPMENT:

Rotary ☐
Cable ☑
Other ☐

(6) CASING INSTALLED:

STEEL: ☑ OTHER: ☐
SINGLE ☑ DOUBLE ☐

If gravel packed

From ft.	To ft.	Diam.	Gage or Wall	Diameter of Bore	From ft.	To ft.
0	76	8"	Bgk			

Size of shoe or well ring: 3 1/4 x 8" Size of gravel:

Describe joint BTW

(7) PERFORATIONS OR SCREEN:

Type of perforation or name of screen

From ft.	To ft.	Perf. per row	Rows per ft.	Size in. x in.

(8) CONSTRUCTION:

Was a surface sanitary seal provided? Yes ☑ No ☐ To what depth ft.

Were any strata sealed against pollution? Yes ☐ No ☐ If yes, note depth of strata

From 0 ft. to 76 ft.

From ft. to ft.

Method of sealing Clay

(9) WATER LEVELS:

Depth at which water was first found, if known 20 ft.

Standing level before perforating, if known ft.

Standing level after perforating and developing 16 ft.

(10) WELL TESTS:

Pump test made? Yes ☐ No ☑ If yes, by whom?

gal./min. with ft. drawdown after hrs.

Temperature of water Was a chemical analysis made? Yes ☐ No ☑

Was electric log made of well? Yes ☐ No ☑ If yes, attach copy

(11) WELL LOG:

Total depth 105 ft. Depth of completed well 105 ft.

Formation: *Describe by color, character, size of material, and structure*

0 ft. to	16	Top Soil	5 ft.
16	35	Sandy Clay	5
35	60	Sand	20
60	73	Gravel	20
73	95	Hard Sand + Clay	5
95	100	Black Sand	10
100	105	Small Gravel	20

This Well is located north of Marysville on Cal-Hi to Shell Rd Right on Shell Rd appx ¼ mi.

Logged and Coded As Well 16N03E24M02

FOR OFFICIAL USE ONLY

Work started 3/1 19 68 Completed 3/4 19 68

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Beaman & Son Pump Co.
(Person, firm, or corporation) (Type or print)

Address 470 E. Gen. Wash. Blvd.
Yuba City Calif.

[SIGNED] J. M. Beaman
(Well Driller)

License No. 196093 Dated 4/25- 19 68

SKETCH LOCATION OF WELL ON REVERSE SIDE

86391-860 10-65 50M TRIP ① △ OSP

Drilling Log
DWR Well ID: 16N03E36E002M

LOCATION NOT CHECKED

ORIGINAL
File Original, Duplicate and Triplicate with the
REGIONAL WATER POLLUTION
CONTROL BOARD No. 5
(If appropriate number)

WATER WELL DRILLERS REPORT
(Sections 7076, 7077, 7078, Water Code)

STATE OF CALIFORNIA

5-48

Do Not Fill In
No 79700
State Well No. 16N/3E-36E2
Other Well No. [illegible]

[redacted]

(2) LOCATION OF WELL:
County SUTTER YUBA Owner's number, if any— NONE
R. F. D. or Street No. ON OROVILLE ROAD IN DIST 10 MARYSVILLE CAL - 500 FEET NORTH EAST OF OROVILLE ROAD AND ELLIS ROAD 100 FT EAST OF OROVILLE ROAD - 30 FT SOUTH EAST CORNER OF GARAGE

(3) TYPE OF WORK (check):
New well [X] Deepening [ ] Reconditioning [ ] Abandon [ ]
If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (check):
Domestic [X] Industrial [ ] Municipal [ ]
Irrigation [ ] Test Well [ ] Other [ ]

(5) EQUIPMENT:
Rotary [ ]
Cable [X]
Dug Well [ ]

(6) CASING INSTALLED:
SINGLE [X] DOUBLE [ ]
From 0 ft. to 80 ft. Diam. 12 Gage or Wall

Type and size of shoe or well ring 8"X10"X4
Describe joint BUTT WELDED

If gravel packed
Diameter of Bore | from ft. | to ft.
NONE

Size of gravel:

(7) PERFORATIONS:
Type of perforator used NONE
Size of perforations — in., length, by — in.
From — ft. to — ft. | Perf. per row | Rows per ft.

(8) CONSTRUCTION:
Was a surface sanitary seal provided? [X] Yes [ ] No To what depth 2 FT. ft.
Were any strata sealed against pollution? [X] Yes [ ] No If yes, note depth of strata 80 FT.
From 0 ft. to 80 ft.

Method of Sealing CASING DRIVEN IN CLAY

(9) WATER LEVELS:
Depth at which water was first found 22 FT. ft.
Standing level before perforating NONE ft.
Standing level after perforating NONE ft.

(10) WELL TESTS:
Was a pump test made? [ ] Yes [X] No If yes, by whom? —
Yield: — gal./min. with — ft. draw down after — hrs.
Temperature of water — Was a chemical analysis made? [ ] Yes [X] No

Was electric log made of well? [ ] Yes [X] No

(11) WELL LOG:
Total depth 86 ft. Depth of completed well 85 ft.
Formation: Describe by color, character, size of material, and structure.

ft. to	ft.		
0	4	TOP SOIL	4
4	7	HARD PAN	3
7	20	SOFT BROWN CLAY	3
20	23	BROWN SAND	20
23	32	SOFT BLUE CLAY	3
36	51	HARD BROWN CLAY	3
51	69	GRAY CLAY	3
69	73	GRAY LOOSE SAND	20
73	82	HARD BROWN CLAY	3
82	86	BLACK SAND & GRAVEL	20

Plotted ded
As Well 16N03E 36E02

Work started DEC. 18 1963. Completed DEC 19 1963

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME SUTTER PUMP WORKS
(Person, firm, or corporation) (Typed or printed)
Address 909 S. WALTON
YUBA CITY CALIF.

[SIGNED] Earl L Lamm
Well Driller

License No. 154299 Dated JAN 18, 1964

97028 6-62 BOM QUIN △ SPO

DWR 188 (REV. 9-54)

Drilling Log
DWR Well ID: 16N04E27F002M

LOCATION NOT CHECKED

ORIGINAL
File Original, Duplicate and Triplicate with the REGIONAL WATER POLLUTION CONTROL BOARD No.____
(Insert appropriate number)

WATER WELL DRILLERS REPORT
(Sections 7076, 7077, 7078, Water Code)

STATE OF CALIFORNIA 27.5'

Do Not Fill In
No. 31767
State Well No. 16N/4E-27F2
Other Well No. 16N/4E-27

(1) OWNER:
Name [redacted]
Address

(2) LOCATION OF WELL:
County Yuba Owner's number, if any---
R. F. D. or Street No.
See map
@ JUNCTION OF LOMA RICA & HWY 20 N. SIDE OF HWY 20 & W. SIDE OF LOMA RICA RD.

(3) TYPE OF WORK (*check*):
New well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (*check*):
Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) EQUIPMENT:
Rotary ☐
Cable ☑
Dug Well ☐

(6) CASING INSTALLED:
SINGLE ☑ DOUBLE ☐
From 0 ft. to 56 ft. Diam. 12 Gage or Wall

If gravel packed
Diameter of Bore | from ft. | to ft.

Type and size of shoe or well ring 12 X 4 X 8"
Size of gravel:
Describe joint Butt joints welded & solid

(7) PERFORATIONS:
Type of perforator used
Size of perforations in., length, by in.
From ft. to ft. Perf. per row Rows per ft.

(8) CONSTRUCTION:
Was a surface sanitary seal provided? ☐ Yes ☐ No To what depth ft.
Were any strata sealed against pollution? ☐ Yes ☐ No If yes, note depth of strata
From ft. to ft.
Method of Sealing

(9) WATER LEVELS:
Depth at which water was first found ft.
Standing level before perforating ft.
Standing level after perforating ft.

(10) WELL TESTS:
Was a pump test made? ☐ Yes ☐ No If yes, by whom?
Yield: gal./min. with ft. draw down after hrs.
Temperature of water Was a chemical analysis made? ☐ Yes ☐ No
Was electric log made of well? ☐ Yes ☐ No

(11) WELL LOG:
Total depth 105 ft. Depth of completed well 105 ft.
Formations: *Describe by color, character, size of material, and structure.*
0 ft. to 4 ft. Topsoil
4 " 12 " yellow clays
12 " 52 " dry sand & gravel
52 " 105 " gray & yellow clay mixed

CONFIDENTIAL
Section 7076.1, Water Code

Work started Dec 21 1954. Completed Dec. 23 1954

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME ARMSTRONG BROS.
(Person, firm, or corporation) (Typed or printed)
Address P.O. Box 721
MARYSVILLE, CALIF.
[SIGNED] Joe L. Armstrong
Well Driller
License No. 122911 Dated Dec. 28, 1954

95688 3-54 50M QUIN @ SPO

DWR FORM NO. 246 (REV. 3-

31767

LOCATION NOT CHECKED