

# Investigation into Elevated Nitrate Concentration at DWR Well 16N03E24M002M (24M2M)

PREPARED FOR: Roberta Firoved/California Rice Commission  
Tim Johnson/California Rice Commission

PREPARED BY: Jenny Krenz-Ruark/CH2M  
Lisa Porta/CH2M

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## Introduction

The California Rice Commission (CRC) submitted their *Annual Monitoring Report (AMR)* for Sacramento Valley Rice Growers in December 2017, as required by the Monitoring and Reporting Program under Order R5-2014-0032, General Waste Discharge Requirements for Sacramento Valley Rice Growers (Rice WDR Order). Central Valley Regional Water Quality Control Board (Regional Water Board) staff review of the AMR has questioned whether the single, elevated, groundwater nitrate concentration reported in the AMR meets the definition of a confirmed exceedance, as defined by the Rice WDR Order, triggering the requirement for development of a *Groundwater Quality Management Plan (GQMP)* or source identification study. The CRC is tasked with determining whether the elevated nitrate concentration is fact a confirmed exceedance, and reporting their findings to the Regional Water Board by March 26, 2018.

This technical memorandum (TM) evaluates historical monitoring results at this well and other surrounding wells to determine whether the single elevated nitrate concentration can be considered a confirmed exceedance.

## Background

2017 marked the start of the CRC's groundwater monitoring under the Rice WDR Order in accordance with the *Groundwater Quality Trend Monitoring Workplan (Trend Monitoring Workplan)* (CRC, 2016). Groundwater wells were sampled by USGS (Rice Wells Network), and by DWR (Yuba County wells) during this initial year of monitoring. In subsequent years, the USGS wells will be monitored by the CRC per the schedule established in the *Trend Monitoring Workplan*, and the DWR wells will continue to be monitored by DWR on their own schedule.

### USGS Rice Wells Network

The USGS Rice Wells Network is a collection of shallow (i.e., less than 50 feet deep) wells that were specifically installed and monitored by USGS to "assess shallow groundwater quality and determine if effects on water quality could be attributed to rice agriculture" (CRC, 2013). These wells are located in primary rice-growing areas in Butte, Colusa, Glenn, and Sutter counties. These wells are representative of shallow groundwater conditions in the rice farmlands where they are located (CRC, 2013), and were specifically designed to yield data that can be compared with historical and future data to evaluate long-term groundwater trends, per the Rice WDR Order. A total of 20 Rice Network Wells were selected to be monitored under the AMR, as described in the *Trend Monitoring Workplan*.

## Yuba County Wells

The rice growing areas of Yuba County are not represented in the Rice Wells Network, and this area was identified as a data gap in the *Rice-Specific Groundwater Assessment Report* (GAR) (CRC, 2013). Existing, DWR-monitored wells were chosen as the best-possible source of supplemental groundwater quality information for this area, as outlined in the *Trend Monitoring Workplan* (CRC, 2016). The DWR-monitored wells differ from the Rice Wells Network wells in that they are deeper (i.e., ranging between 86 and 185 feet deep) and are used for domestic or irrigation purposes. A zoomed-in version of AMR Figure 4-2 (attached) shows the location of these six wells relative to 2017 permitted rice lands.

## 2017 Groundwater Results

The 2017 CRC AMR reported groundwater monitoring results from the 20 USGS Rice Wells Network wells, which were sampled in July 2017, and a total of six wells sampled by DWR (two wells in August 2016, and four wells in September 2017). USGS reports nitrate results as “nitrate+nitrite as N,” with an applicable maximum contaminant level (MCL) of 10 milligrams per liter (mg/L), and DWR reports nitrate results as “dissolved nitrate,” with an applicable MCL of 45 mg/L. The different units represent agency preference. Section 5 of the GAR (CRC, 2013) explains forms of nitrogen in water in more detail, along with the different types of nitrate reporting.

All of the nitrate results from the USGS Rice Wells Network wells were below the MCL in 2017. The majority of the DWR-sampled Yuba County wells had nitrate results below the MCL, with the exception of Well 16N03E24M002M (Well 24M2M). The September 2017 sample from Well 24M2M showed a dissolved nitrate concentration of 46.6 mg/L, which is slightly above the dissolved nitrate MCL of 45 mg/L.

As a result, the Regional Water Board’s staff sent the CRC a letter on January 26, 2018 that asked the CRC to determine whether this elevated nitrate concentration should be considered a confirmed exceedance, stating that:

*“The CRC should determine if the elevated nitrate concentration in well 16N03E24M002M is a confirmed exceedance by 26 March 2018 and report their findings to the Central Valley Water Board.”*

The Rice WDR Order defines a confirmed exceedance, stating that “a confirmed exceedance means that the monitoring data are determined to be of the appropriate quality and quantity necessary to verify that an exceedance has occurred.” The Rice WDR Order outlines requirements for development of a GQMP if there is determination of a confirmed exceedance, as included below.

## Rice WDR Order Language

The Rice WDR Order provides specific language regarding requirements for development of a GQMP if there is a confirmed exceedance, which is provided in part VIII.F.2 as follows:

### *VIII.F.2. Conditions Requiring Preparation of Groundwater Quality Management Plan (GQMP)*

*A GQMP shall be developed by the California Rice Commission where: (1) there is a confirmed exceedance (considering applicable averaging periods) of a water quality objective or applicable water quality trigger limit (trigger limits are described in section VII of the MRP) in a groundwater well and rice lands may cause or contribute to the exceedance; (2) the Basin Plan requires development of a groundwater quality management plan for a constituent or constituents discharged by rice lands; or (3) the Executive Officer determines that rice lands may*

*be causing or contributing to a trend of degradation of groundwater that may threaten applicable Basin Plan beneficial uses.*

### *3. SQMP/GQMP Not Required*

*At the request of the California Rice Commission or upon recommendation by Central Valley Water Board staff, the Executive Officer may determine the development of a SQMP/GQMP is not required. Such a determination may be issued if there is sufficient evidence indicating that the Growers discharging waste to the affected surface water or groundwater are meeting the receiving water limitations given in section III of this Order (e.g., evidence indicates that rice lands does not cause or contribute to the water quality problem).*

#### *Attachment A, VI.F. Groundwater Quality Management Plans*

*Under this Order, groundwater quality management plans (GQMPs) will be required where there are exceedances of water quality objectives, where there is a trend of degradation that threatens a beneficial use, as well as for high vulnerability groundwater areas if such areas are identified in the future. GQMPs will only be required if rice operations may cause or contribute to the groundwater quality problem.*

As discussed above, 2017 was the first year of groundwater monitoring under the Rice WDR Order. The *Trend Monitoring Workplan*, which provides the basis for groundwater monitoring under the Rice WDR Order, outlines a 3-year cycle for trend monitoring of groundwater quality data to allow for multiple years of data to be considered. This averaging period allows for consideration of fluctuations in quality parameters and allows for broader changes in water quality to be assessed. The Regional Water Board staff's comments reinforced this averaging period, outlining that "after the first 3 years of groundwater trend monitoring is completed, a statistical trend analysis will be included in the AMR." Therefore, the 3-year averaging period is a more reasonable approach than assessment of a single result for exceedance.

## Well-Specific Information and Results

Additional well-specific information helps inform the decision on whether the single elevated nitrate concentration is in fact a "confirmed exceedance" attributable to rice agriculture. The well with the elevated nitrate concentration and other, nearby, DWR-monitored wells are discussed below to provide context and a regional perspective.

### Well 16N03E24M002M (24M2M)

DWR Well 24M2M is the well reported as having an elevated dissolved nitrate concentration in its 2017 sample. Well 24M2M is a domestic well and is 105 feet deep, with a screened interval of 76 to 105 feet below ground surface (bgs). The well is located off Shell Road in Marysville in a field surrounded by orchard land use, with scattered residential properties nearby (Figure 1a).

INVESTIGATION INTO ELEVATED NITRATE CONCENTRATION  
AT DWR WELL 16N03E24M002M (24M2M)

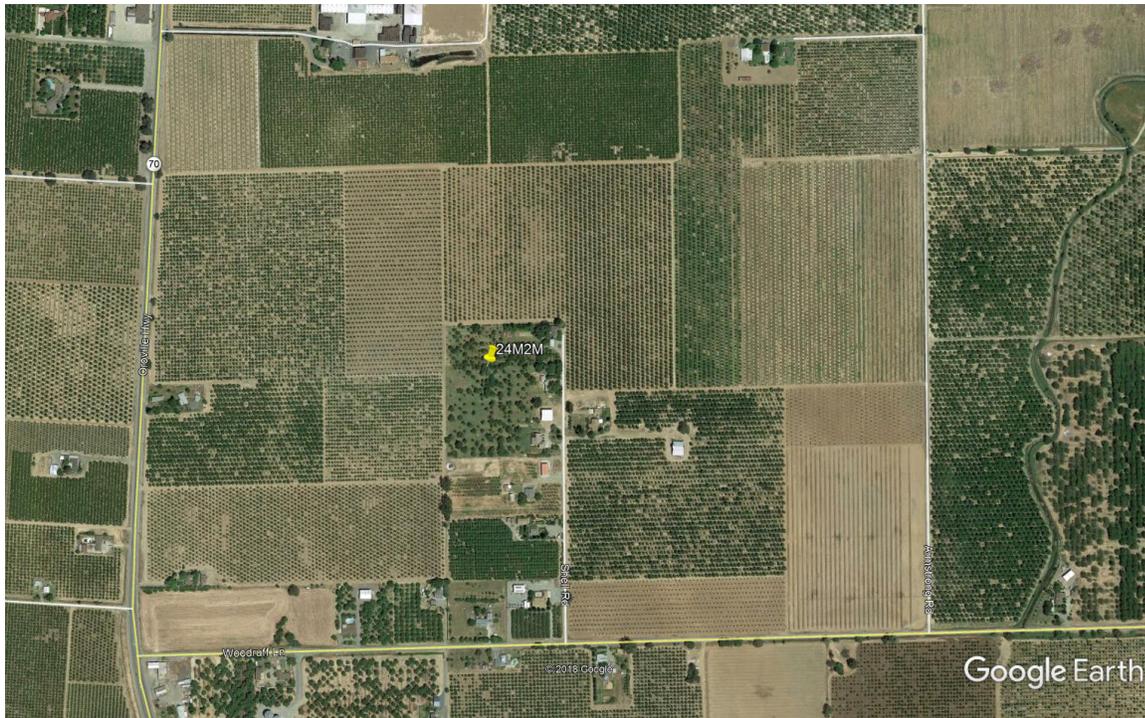


Figure 1a. Google Earth Location of Well 24M2M

Well 24M2M was initially chosen as an edge-of-field well to fulfill the Yuba County data gap identified in the GAR. The map presented in the *Trend Monitoring Workplan* showed an incorrect location for this well, which placed it within rice land use (Figure 1b). The reason behind the incorrect location is explained below.



Figure 1b. Google Earth Snapshot Showing the Old and Revised Locations of Well 24M2M

DWR records for well locations are confirmed and updated during each sampling event. The well location information for Well 24M2M was updated by DWR during 2017 sampling, and showed a change to the GPS location from the location reported in the Trend Monitoring Workplan (which used information from the 2013 sampling event). The updated GPS location places the well in an area with orchard land use, as shown in Figure 1b. Note that the well was not moved; only GPS readings were updated after the last sampling event.

Table 1 details the location and well information for Well 24M2M.

Table 1. Well Information for DWR Well 24M2M

Well Type	DWR State Well Number	Mapping ID	Latitude	Longitude	Well Depth (ft)	Top and Bottom Perforation Depths (ft bgs)	Well Use	Date Installed
DWR	16N03E24M002M	24M2M	39°13'24.96"N	121°35'39.84"W	105	76-105	Domestic	3/4/1968

Well 24M2M has been sampled by DWR since 1970, with a biannual sampling schedule since 2001 (two samples were missing during that period, one in 2009 and the other in 2015). Recent nitrate data for Well 24M2M show concentrations fluctuating between approximately 20 and 45 mg/L (Table 2, Figure 2). The September 2017 sample of 46.6 mg/L has the highest nitrate concentration measured at this well. It is difficult to determine from one sample whether the higher value is part of a trend of increasing concentration, or is part of natural fluctuations potentially made more severe by the recent drought. The average dissolved nitrate concentration at this well over the period of record is 30.6 mg/L, which is below the MCL. Figure 2 further shows variability in nitrate concentration over that period.

Table 2. DWR Monitoring Results for Well 24M2M

Station Number	Analyte	Sampling Date	Dissolved Nitrate (mg/L)	Units
16N03E24M002M	Dissolved Nitrate	8/17/1970	22.0	mg/L
16N03E24M002M	Dissolved Nitrate	7/1/1980	17.0	mg/L
16N03E24M002M	Dissolved Nitrate	8/28/2001	42.6	mg/L
16N03E24M002M	Dissolved Nitrate	9/17/2003	39.4	mg/L
16N03E24M002M	Dissolved Nitrate	8/22/2005	27.3	mg/L
16N03E24M002M	Dissolved Nitrate	9/18/2007	32.4	mg/L
16N03E24M002M	Dissolved Nitrate	8/31/2011	30.0	mg/L
16N03E24M002M	Dissolved Nitrate	8/22/2013	18.2	mg/L
16N03E24M002M	Dissolved Nitrate	9/20/2017	46.6	mg/L
<i>Average</i>			<i>30.6</i>	<i>mg/L</i>

Note: this well was also scheduled to be sampled in 2015, but DWR did not sample it. We do not know the reason why. Since this is a private domestic well, access could have been an issue.

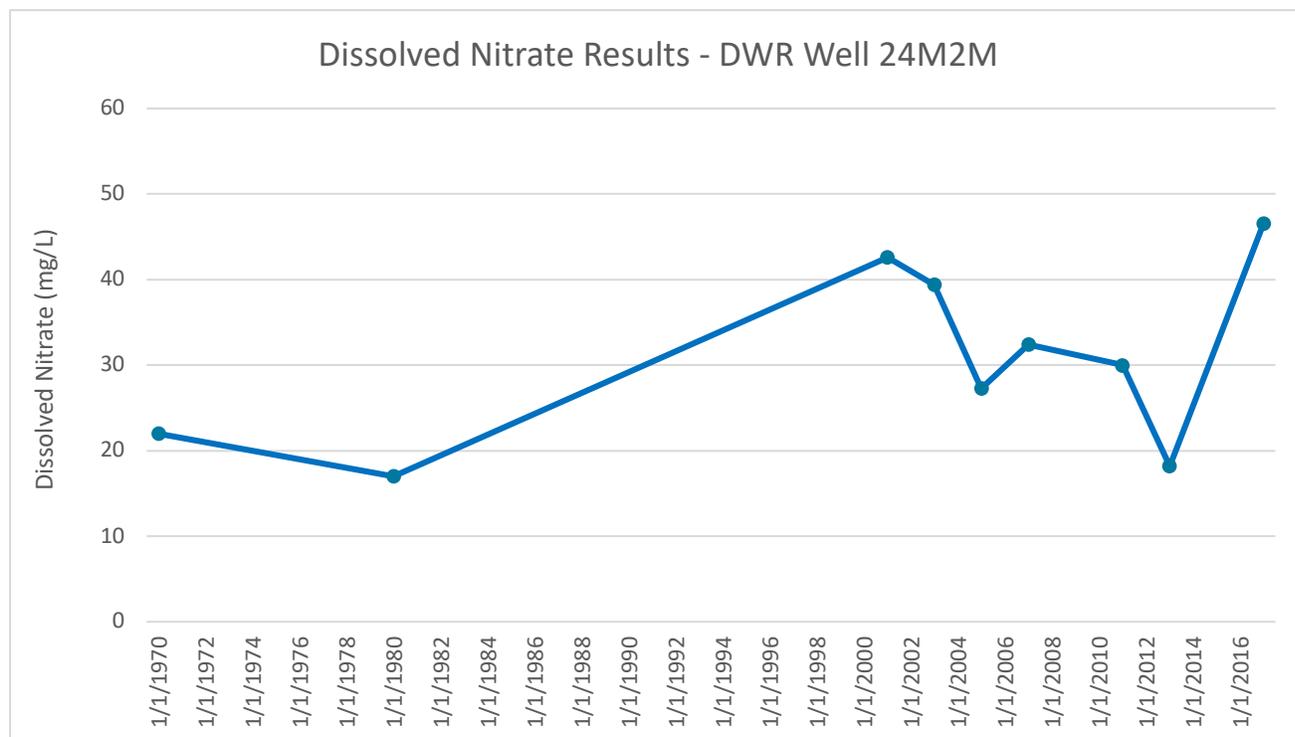


Figure 2. Dissolved Nitrate Results for DWR Well 24M2M

### Other Nearby Wells Monitored by DWR

As shown on AMR Figure 4-2 (attached), there are two other DWR-monitored wells located near Well 24M2M in the northern portion of Yuba County rice land areas. One well, Well 16N03E36E002M (Well 36E2M), is located downgradient of rice lands, south of Well 24M2M, within orchard land use. The other well, Well 16N04E27F002M (Well 27F2M), is located further upgradient, directly within a large area of rice land use. A comparison of nitrate results for these two wells to Well 24M2M gives a geographic understanding of water quality in this rice-growing area.

Table 2 details the location and well information for Well 36E2M and Well 27F2M.

Table 2. Well Information for DWR Wells 36E2M and 27F2M

Well Type	DWR State Well Number	Mapping ID	Latitude	Longitude	Well Depth (ft)	Top and Bottom Perforation Depths (ft bgs)	Well Use	Date Installed
DWR	16N03E36E002M	36E2M	39°11'59.64"N	121°35'15.72"W	86	80-86	Domestic	12/19/1963
DWR	16N04E27F002M	27F2M	39°13'1.91"N	121°30'52.20"W	105	56-105	Domestic	12/23/1954

### Well 16N03E36E002M (36E2M)

Well 36E2M is a domestic well (86 feet deep) that is located in an area of land use similar to Well 24M2M. Specifically, Well 36E2M is downgradient from rice lands, but is surrounded by orchard land use (Figure 3).

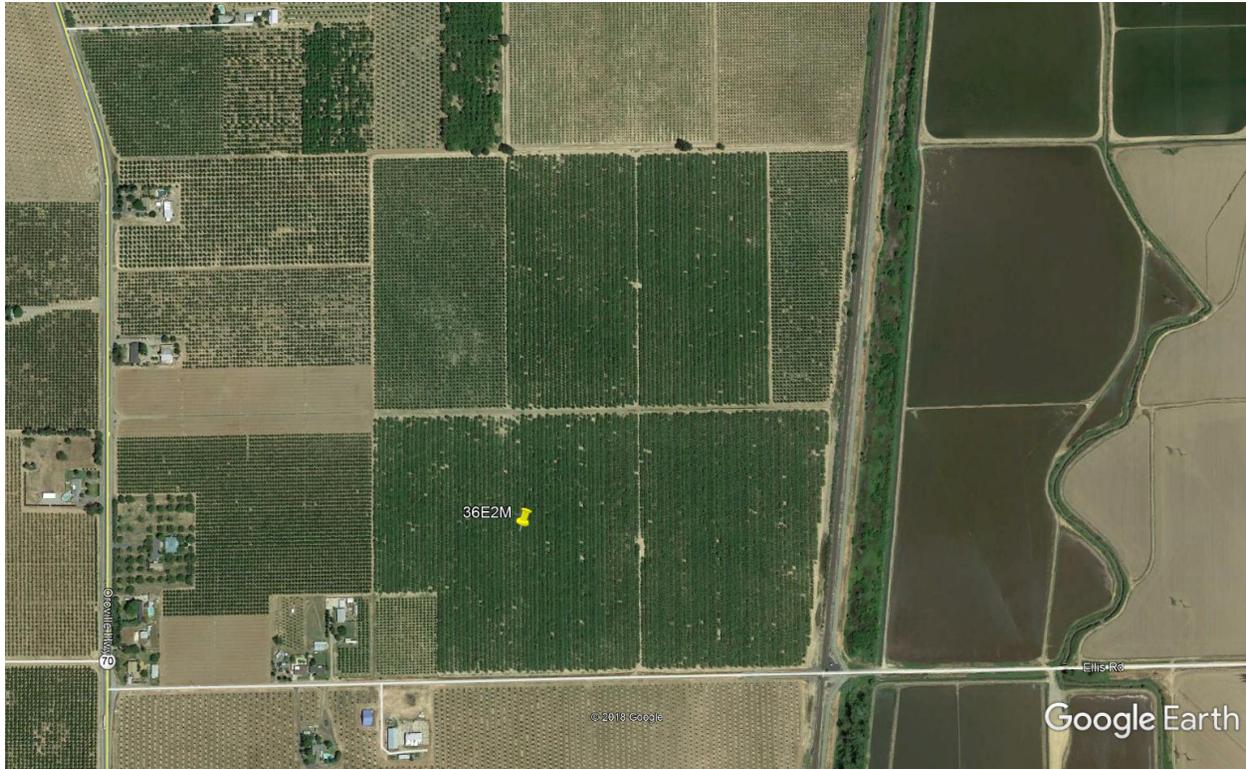


Figure 3. Google Earth Location of Well 36E2M

Well 36E2M was sampled during 2017 DWR monitoring, and had a dissolved nitrate concentration of 28.6 mg/L, which is below the MCL of 45 mg/L for dissolved nitrate. This well has also experienced dissolved nitrate concentrations above the MCL, though concentrations appear to have peaked, and have been decreasing over the last 10 years (Table 3, Figure 4).

Table 3. DWR Monitoring Results for Well 36E2M

Station Number	Analyte	Collection Date	Dissolved Nitrate (mg/L)	Units
16N03E36E002M	Dissolved Nitrate	4/12/1965	14.0	mg/L
16N03E36E002M	Dissolved Nitrate	6/16/1969	14.0	mg/L
16N03E36E002M	Dissolved Nitrate	6/5/1975	18.0	mg/L
16N03E36E002M	Dissolved Nitrate	7/23/1985	30.0	mg/L
16N03E36E002M	Dissolved Nitrate	8/28/2001	45.6	mg/L
16N03E36E002M	Dissolved Nitrate	9/17/2003	47.3	mg/L
16N03E36E002M	Dissolved Nitrate	8/22/2005	47.4	mg/L
16N03E36E002M	Dissolved Nitrate	9/18/2007	56.3	mg/L
16N03E36E002M	Dissolved Nitrate	8/22/2013	35.0	mg/L
16N03E36E002M	Dissolved Nitrate	7/20/2015	30.4	mg/L
16N03E36E002M	Dissolved Nitrate	9/20/2017	28.6	mg/L
		<i>Average</i>	33.3	<i>mg/L</i>

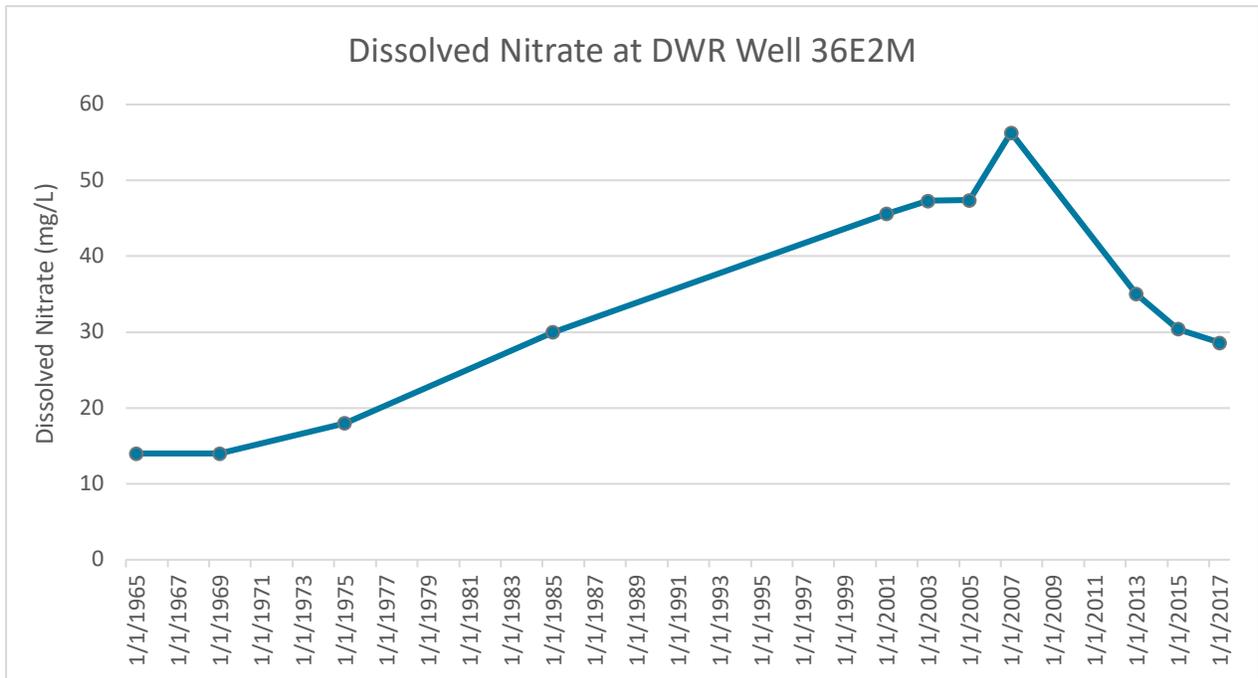


Figure 4. Dissolved Nitrate Results for DWR Well 36E2M

**Well 16N04E27F002M (27F2M)**

Well 27F2M is a domestic well (105 feet depth) located upgradient from the two wells discussed previously, within rice lands (Figure 5). The dissolved nitrate concentration at this well is below 5 mg/L, and has stayed consistently low across the period of sampling (i.e., 1970 to present).

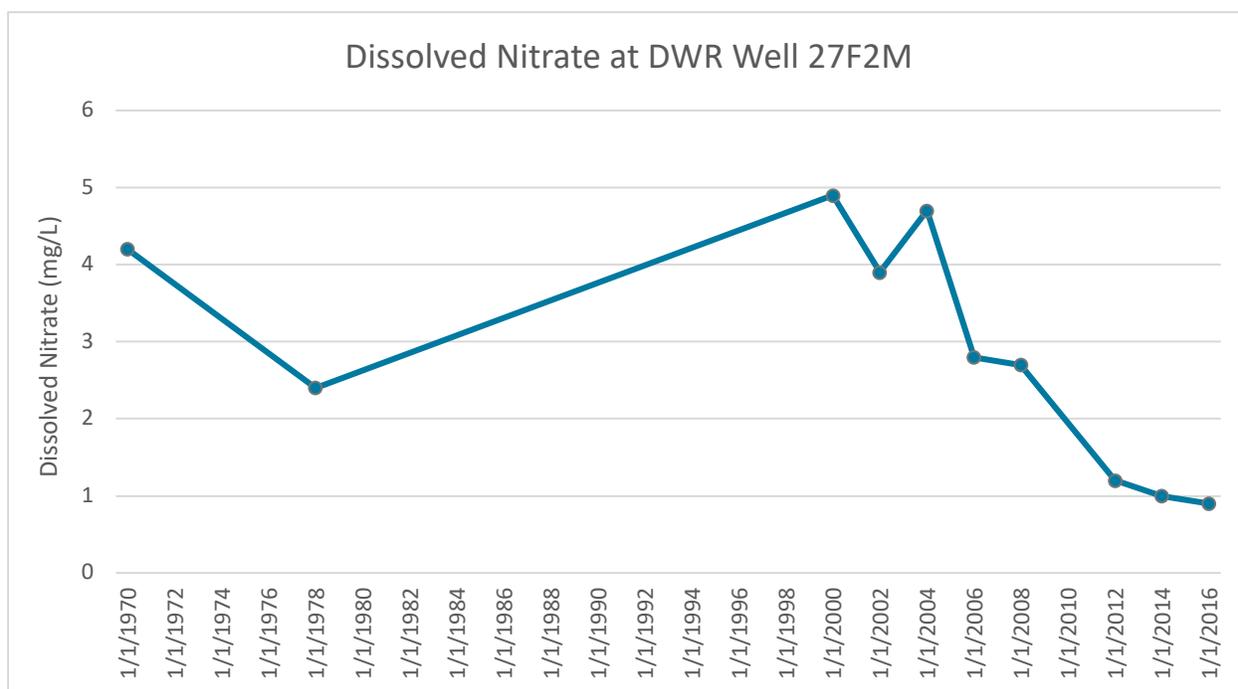


Figure 5. Google Earth Location of Well 27F2M

Well 27F2M was sampled during 2016 DWR monitoring, and had a dissolved nitrate concentration of 0.9 mg/L. Historical nitrate monitoring events by DWR at this well have all had low nitrate concentrations (Table 4, Figure 5).

**Table 4. DWR Monitoring Results for Well 27F2M**

Station Number	Analyte	Collection Date	Result	Units
16N04E27F002M	Dissolved Nitrate	8/17/1970	4.2	mg/L
16N04E27F002M	Dissolved Nitrate	8/15/1978	2.4	mg/L
16N04E27F002M	Dissolved Nitrate	8/8/2000	4.9	mg/L
16N04E27F002M	Dissolved Nitrate	8/20/2002	3.9	mg/L
16N04E27F002M	Dissolved Nitrate	8/17/2004	4.7	mg/L
16N04E27F002M	Dissolved Nitrate	9/25/2006	2.8	mg/L
16N04E27F002M	Dissolved Nitrate	9/23/2008	2.7	mg/L
16N04E27F002M	Dissolved Nitrate	10/31/2012	1.2	mg/L
16N04E27F002M	Dissolved Nitrate	7/18/2014	1.0	mg/L
16N04E27F002M	Dissolved Nitrate	8/25/2016	0.9	mg/L
	<i>Average</i>		<i>2.9</i>	<i>mg/L</i>



**Figure 5. Dissolved Nitrate Results for DWR Well 27F2M**

## Conclusions and Recommendations

Results presented above for three DWR-monitored domestic wells in northern Yuba County show that the two wells located downgradient of rice fields, but located within orchards, have higher dissolved nitrate concentrations than a similar domestic well located within rice fields. These findings are consistent with the data and information provided in the CRC GAR and in monitoring results from the USGS Rice Network Wells. Based on the totality of the evidence provided in the GAR as well as the information provided in this TM, rice-related agricultural practices are unlikely to have caused elevated nitrate in the two wells located within orchards. This finding is further supported by the data and studies presented in the GAR, data gap analysis performed on soils within Yuba County rice lands, and the fact that USGS Rice Network Wells continue to show low nitrate concentration in shallow groundwater directly beneath rice lands.

Based on the information and data provided above, the conclusions are as follows:

- As demonstrated in the GAR analysis, low nitrate would be expected for a rice-growing environment due to the chemically reducing conditions produced in the flooded root zone, which cause denitrification. Nitrate detections in this area are more likely from the deeper parts of the screen interval with sampled groundwater that is not affected by rice farming.
- Well 24M2M is a domestic well and 105 feet deep. Samples collected from this deeper portion of the aquifer includes water recharged from a wider area than that represented by the USGS Rice Well Network, which are shallower wells (i.e., less than 50 feet deep) and are more representative of the shallow groundwater beneath rice fields. In general, these deeper domestic wells are not as accurate in measuring groundwater quality beneath rice fields as the shallow USGS Rice Network Wells.
- The 2017 dissolved nitrate result at Well 24M2M does not appear to be a confirmed exceedance due to rice agriculture; in other words, rice operations are unlikely to be causing or contributing to the groundwater quality problem; therefore, preparation of a GQMP is not required per the Rice WDR Order.
- The single elevated dissolved nitrate concentration does not constitute a trend of degradation.
- The data review provided above should eliminate rice lands as a potential source of nitrate to Well 24M2M.
- In addition, Well 24M2M may no longer be considered an adequate groundwater monitoring well representative of rice land use because of its corrected location. Although the corrected location shows the well downgradient of rice land use, it is also downgradient of and in the middle of orchard land use.
- Although it is confirmed that this DWR-monitored domestic well had an exceedance of the dissolved nitrate MCL, this well does not represent rice land use, nor is it likely that rice operations contributed to the exceedance due to other land use immediately surrounding the well.
- As a result, the need for a GQMP is not triggered by the one nitrate exceedance at this specific well.

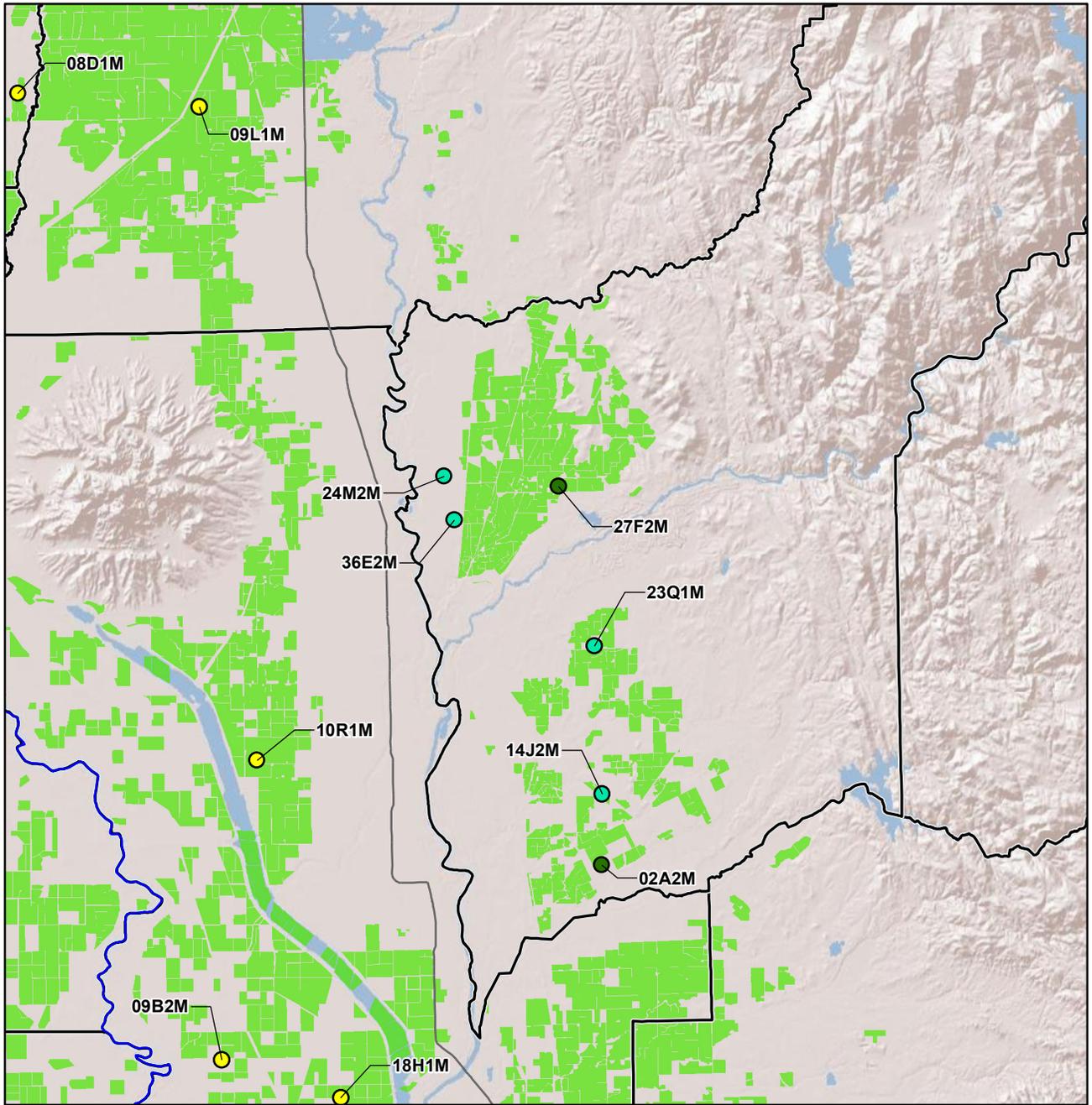
## Referenced Documents

California Rice Commission (CRC). 2013. *Rice-Specific Groundwater Assessment Report*. Submitted to the Central Valley Regional Water Quality Control Board. July.

California Rice Commission (CRC). 2016. *Groundwater Trend Monitoring Workplan and Data Gap Assessment Plan*. Submitted to the Central Valley Regional Water Quality Control Board. March.

California Rice Commission (CRC). 2017. *Waste Discharge Requirements for Sacramento Valley Rice Growers 2017 Annual Monitoring Report*. Submitted to the Central Valley Regional Water Quality Control Board. December.

Central Valley Regional Water Quality Control Board (CVRWQCB). 2014. Waste Discharge Requirements Order R5-2014-0032. Available at: [http://www.waterboards.ca.gov/centralvalley/board\\_decisions/adopted\\_orders/general\\_orders/r5-2014-0032.pdf](http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2014-0032.pdf). Verified October March 7, 2018.



VICINITY MAP

**LEGEND**

- City
- County
- Rice Land 2017 Permit Area

**Well Location**

- USGS wells – sampled July 2017
- DWR Wells – sampled August 2016
- DWR Wells – sampled September 2017

DATUM: NAD 1983.  
 SOURCES: BASEMAP (COPYRIGHT:© 2014 ESRI); RICE LANDS (CAL AG PERMIT, 2015);  
 COUNTY (CAL FIRE 2007) ; HYDROLOGY (NHD ACCESSED JAN 2016).  
 USGS RICE WELLS (USGS 2017). DWR MONITORING WELLS (DWR 2017)



**FIGURE 4-2**  
**Groundwater Sampling Wells**  
 2017 Annual Monitoring Report  
 California Rice Commission