WELL ASSET MANAGEMENT REPORT
El Macero Well #3
El Macero County Service Area
El Macero, California

Prepared for:
Yolo County, California

March 2019

Prepared by:
California Rural Water Association

March 8, 2019

Ms. Beth Gabor
Yolo County
625 Court Street,
Room 202
Woodland, CA 95695

VIA Email.

Re: Well Asset Management Report
El Macero Well #3, El Macero Country Club, Davis, CA

Dear Ms. Gabor:

California Rural Water Association is pleased to present this Well Asset Management Report for the El Macero Well #3 located at El Macero Country Club in Davis, California.

If you have any questions regarding this report, please call our Senior Hydrogeologist, Thomas Ballard, CHG, at (916) 761-3700 or Dan DeMoss at (916) 553-4900.

Sincerely,
California Rural Water Association

Dan DeMoss
Executive Director

Thomas Ballard
Senior Hydrogeologist

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Introduction and Background

The El Macero County Service Area (CSA) owns a groundwater well, designated as EM-3, which is located on a CSA-owned parcel of land that abuts the El Macero Country Club's (EMCC) golf course (**Figures 1 and 2**). EM-3 was constructed in 1991 at CSA expense and has since then been used continuously for the production of water for the CSA. EM-3 is connected to the EMCC supply lake on hole Number 12 of the EMCC golf course. Available documents indicate that EM-3 produces water from the same aquifer as the EMCC's Well 4 and that the quality of water from EM-3 and Well 4 are similar. The CSA now receives drinking water supply from the City of Davis and does not currently need to utilize EM-3 to supply the CSA's drinking water needs, therefore EM-3 is now operated as an agricultural well to supply water for the road medians in the CSA and to the EMCC per agreement. The CSA desires to develop a program to monitor key operating and water quality parameters for EM-3 and keep the well in sound operating condition should it be needed for other CSA purposes in the future. Well Use Agreement 16-184, dated November 22, 2016 (**Appendix A**) documents the formal arrangement for use and maintenance of EM-3 between the CSA and the EMCC.

Objective

Develop a recommended program for sampling and maintenance of Well EM-3. California Rural Water Association (CRWA) will develop estimated costs for replacement of the well and present recommendations and cost data in a Well Asset Management Report.

Reviewed Data

The following data was reviewed in the development of this report:

- Well Use Agreement between CSA and EMCC, dated November 22, 2016
- Water Level Data 1991-2016
- EM-3 production data for the year 2015
- Pumping Efficiency Test data for the years 2006, 2014 and 2015.
- Well analytical data for the years 2004, 2009, 2013 and 2014
- Driller's Well Log dated 5/24/91
- Well "As-Built" diagram dated March 4, 1991
- Site plan of the EM-3 location.
- Eaton Pumps annual costs and pump replacement estimate (May 13, 2016)
- Personal Communication with Dan Morris of Eaton Drilling, Inc. (March 7, 2019)

Well Construction

EM-3 was constructed between January 11 and January 22, 1991, and its construction is documented in a driller's log dated May 24, 1991, prepared by Layne-Western Company, Inc. and an "as-built" diagram dated March 4, 1991, prepared by Hydrologic Consultants, Inc. The driller's log and "as-built" diagram are included in **Appendix B** to this report. The driller's log only documents construction to 342 feet, including the upper two screen zones, so presumably there is a page missing from the driller's log documenting the rest of the well construction.

The well boring includes 40 feet of 32-inch surface casing in a 40-inch borehole and 470 feet of 18-inch production casing and screen in a 30-inch borehole for a total constructed well depth of 470 feet. Blank casing sections are constructed of a 0.313-inch wall mild steel and screen sections are documented as a #304 stainless steel wire-wrap screen with a 0.050-inch slot opening. The surface seal extends to 225 feet with a #21 Mix filter pack from 225 to 470 feet. Filter pack thickness, based on casing diameter and borehole size, is approximately 6-inches.

A 2-inch schedule 40 steel sounding tube extends from surface to approximately 310 feet within the production casing. Two 4-inch gravel fill pipes extending to approximately 225 feet are installed in the annular space to allow for adding filter pack as necessary as a result of settling.

There is no record of di-electric couplings between the mild steel casing and the stainless steel screen sections.

Approximate screen intervals are as follows:

- 238-258 feet
- 286-306 feet
- 342-362 feet
- 385-395 feet
- 400-416 feet
- 445-455 feet

There is no record of an elog being conducted during the well installation, so screen intervals may have been selected based on geology alone.

There is an approximate 15-foot "basement" section below the lowest screen interval.

EM-3 Well Characteristics

Based on water level data between 1991 and 2016 (**Appendix C**), the static water levels in EM-3 show a distinctly seasonal trend, as is common in the Central Valley of California. Dry summer conditions combined with increased agricultural pumping, cause the water table to decline significantly in the summer months, as reflected in the EM-3 records. The difference between summer and winter water levels can be as much as 80 feet in EM-3.

Water quality data (general minerals) was reviewed for the years 2004, 2009, 2013 and 2014. Most parameters within this time interval appear to remain relatively stabile with a slight upward trend in nitrate, which is still well below the applicable Maximum Contaminant Level (MCL) (**Appendix D**).

The only water use data was available for the year 2015, which showed modest use of EM-3 mainly during May, June and July.

A Pumping Efficiency Test conducted by the City of Davis in 2006 showed a drawdown of 88.7 feet at a pumping rate of 1030 gallons per minute, giving a specific capacity of 11.6. A Pumping Efficiency Test in 2014 indicated that the pump bowls were set at 156 feet, although this number has not been verified elsewhere. A Pumping Efficiency Test conducted by Pumping Efficiency Testing Services in 2015, showed a drawdown of 88 feet while pumping at 1100 gallons per minute, giving a specific capacity of 12.5. The similar numbers for specific capacity over a 9-year period indicate well plugging may be occurring at a relatively slow rate and that well rehabilitation may be required on a 5 year basis to maintain optimal well health. Pumping Efficiency Tests are included in **Appendix E**.

Recommendations and Costs

Annual Maintenance

CRWA concurs with Eaton Pumps' May 13, 2016 recommendations for annual maintenance with additional recommendations for assessing ongoing health of the well. Eaton's recommendations for annual maintenance are as follows:

1. Annual Ag Suitability Water Test
2. Annual Pump Efficiency Test
3. Exercise the Pump Every Two Weeks

Parameters for an Ag Suitability Test along with an explanation of their usefulness in evaluating agricultural water sources are included in **Appendix F**. The Ag Suitability Test, as its name implies, evaluates the chemical characteristics of a well to determine its suitability and any potential limitations for agricultural use, such as at the EMCC golf course. To return the EM-3 well to CSA service would require more extensive California Code of Regulations Title 22 testing and then routine sampling for drinking water constituents according to the Community Water System standards of Title 22.

An annual pump efficiency test is useful to compare pump efficiency and performance over time to help predict when the pump is in need of overhaul or replacement. In addition, well clogging due to incrustations and biofilm development can negatively affect pump performance. Calculated well efficiencies should be plotted on a spreadsheet and tracked over time to identify trends that may provide early indicators of pump issues.

As a well that is used primarily during summer months and that receives little use during the rest of the year, it is important to exercise the well/pump to maintain flow in the well, avoid development of total coliform issues and keep all pump motor bearing sets and turbine shaft components properly lubricated. In order to track well performance over time and provide an early indicator of any plugging issues, the pump should be run at a production rate (estimated at approximately 1100 gallons per minute) long enough to establish a stable drawdown in the well. In order to calculate drawdown, a static water level measurement should be collected prior to pumping. Drawdown and discharge rates should be recorded and used to calculate specific capacity of the well (gallons per foot of drawdown). Specific capacity should be recorded in a spreadsheet and plotted over time. Declines of 10-15% in specific capacity are indicative of well plugging and indicate a need for well rehabilitation.

Annual pumping costs are based on calendar year 2018 PG&E billing data for the EM-3 well. These costs reflect an increase in pumping of the well over 2015 usage data. Due to the pump and motor in use at the site, pumping costs run approximately twice what they would be with the installation of a new pump and motor regulated by a variable frequency drive (VFD). The current pump and motor set up is not capable of using a VFD, requiring the use of a gate valve to regulate flow, which in turn requires monitoring of back pressure on the pump to keep psi within an acceptable operating range.

Although the Well Use Agreement specifies the Ag Suitability Test as the sole analytical evaluation of the well on an annual basis, we recommend the following additional tests and/or data collection to evaluate ongoing well health and identify potential well problems. This is a subset of the suite of tests we normally recommend for Community Water System wells:

1. Annual analytical testing for Total Dissolved Solids (TDS), Ferrous Iron (Fe^{+2}), Total Coliform, E. coli and total bacteria count via ATP analysis.
2. Annual testing using the Biological Activity Reaction Test (BART) for Iron Related Bacteria (IRB), Sulfur Reducing Bacteria (SRB) and Slime-Forming Bacteria (SLYM).
3. Collecting discharge and water levels measurements during bi-weekly pump exercising to calculate and track specific capacity (as discussed above).
4. Track energy usage normalized to gallons produced per kilowatt hour

In addition to the Ag Suitability Test, CRWA recommends the following additional analytical testing to monitor well health parameters:

- Total Dissolved Solids is a measure of the content of dissolved solids, usually referred to as salts, in the well water. Generally, drinking water has less than 500 parts per million TDS, although higher TDS levels can be tolerated in agricultural uses. Generally, TDS is going to be relatively stable, but increases in TDS can result from contamination or even biological activity in the well.
- Ferrous Iron (Fe^{+2}), as distinct from the Total Iron analysis, is an indicator of potential corrosion in the well. Since EM-3 is constructed with mild steel casing and stainless steel screen, it likely has a higher than average potential for corrosion issues, therefore Ferrous Iron levels should be tracked over time as an indicator of the level of corrosion occurring in the well.
- Total Coliform is a bacteria test that encompasses a variety of coliform bacteria, including many harmless bacteria, but also fecal coliform and E. coli. Total Coliform levels tend to increase in wells that are stagnant for periods of time, such as in backup wells or wells that are only used intermittently. Total coliform levels are important to monitor well health conditions and are relevant should the well ever be returned to other uses.
- E. coli is a coliform bacteria that can cause illness when consumed in drinking water. Generally E. coli is indicative of septic system or sewer line contamination. Should the well ever need to be returned to other uses, E. coli levels will be critical. By monitoring E. coli levels, determinations may be made of any septic or fecal contamination issues in the area near the EM-3 well.
- Total Bacteria Count using the Adenosine Tri-Phosphate (ATP) methodology allows tracking of total biological activity in the well. This data is then plotted over time to determine if any biological issues are present in the well including development of biomass which can cause well plugging or increasing trends in bacteria to unhealthy levels. Naturally occurring bacteria are present in all wells at some level, but wells tend to provide an ideal setting for bacteria growth that can be harmful to the well through corrosion, biofouling and development of anaerobic conditions which are favorable environments for pathogens.

In general, biofouling is responsible for at least 80% of all well plugging issues, therefore it is important to monitor for potential biofouling in production wells. CRWA recommends annual testing using Biological Activity Reaction Test (BART) tests for Iron-Related Bacteria (IRB), Sulfur-Reducing Bacteria (SRB) and Slime-Forming Bacteria (SLYM). The BART test simulates conditions inside the well and is specific to a particular bacteria group (i.e. iron-related bacteria). The IRB, SRB and SLYM BART tests are the most common for determining the potential for biofouling in a well. The BART test not only shows if these bacteria groups are present, but also gives an indication of how active and aggressive they are and are therefore a cost effective tool for assessing the potential for biofouling in a well.

Another recommended way to monitor well health is through a simple measurement of energy usage based on gallons produced per kilowatt hour and requires no additional costs to collect the data. To monitor energy usage in this manner, production of a well, in gallons, is divided by energy consumption, in kilowatt-hours, over the same period. A downward trend in gallons per kilowatt-hour is indicative of a loss of efficiency in the well, changes in dynamic head or pump issues. Well efficiency is a separate parameter than pump efficiency and reflects the efficiency of groundwater in the surrounding aquifer reaching the well and pump. Loss of well efficiency is generally an indicator of well plugging.

Table 1
Estimated Annual Operating and Maintenance Costs

Item	Description	Quantity	Units	Unit Cost	Annual Cost
	Materials				
1	Ag Suitability Test	1	LS	$ 160.00	$ 160.00
2	BART Tests (IRM, SRB, SLYM)	3	ea	$ 75.00	$ 225.00
3	Additional Analytical Costs	1	LS	$ 525.00	$ 525.00
				Subtotal	**$ 910.00**
	Energy				
	Energy Costs (based on 2015 pumping)	1	LS	$31,633.79	$ 31,633.79
				Subtotal	**$ 31,633.79**
	Labor				
4	Pump Efficiency Test	1	LS	$ 475.00	$ 475.00
5	Exercise Well, Collect Data (bi-weekly)	8	hrs/event	$ 100.00	$ 20,800.00
				Subtotal	**$ 21,275.00**
				Total Annual Costs	**$ 53,818.79**

Periodic Maintenance

Periodic maintenance refers to maintenance to maintain the well on a longer than annual timeframe. For instance, well rehabilitation is often conducted on 4-6 year time frames depending the condition of the individual well.

Video Log

A video log is an essential diagnostic tool that, at a minimum, should be run whenever the pump is pulled or every few years, in order to gauge biofouling, mineral incrustation development, corrosion issue and potential points of failure in the well. Well videos should be planned out in advance to optimize the data gained from the logging. In addition to the video itself, a short summary report should also be prepared to document any issues encountered with the well and which ones to target for remedial actions, if necessary. Well videos are also useful when compared over time and this can often be used to pinpoint recurring problem areas in the well. It appears that no well videos have been conducted of EM-3 and CRWA recommends that such a video log be completed as soon as possible to assess the current condition of the well. Costs for a well video logging are included in Table 2 and include the cost of pulling and reinstalling the pump. If the video logging can be scheduled with regular pump maintenance, then pulling the pump just for the well video is not necessary.

Well Rehabilitation

In general, the actual well rehabilitation approach is specific to the problems exhibited at the individual well. We have outlined a general approach with associated costs below and in Table 2, but well diagnostics may indicate the need for a different approach, based on well conditions. For maximum effectiveness, it is important to develop a well rehabilitation approach specific to the individual well.

Typically, a routine well rehabilitation will consist of utilizing a nylon brush sized to fit the well casing which is moved up and down or rotated to clean the inner part of the casing and screens. Brushing is not sufficient to unplug screens or clean any plugging going on in the gravel pack, but is a first step to provide as much access to the screens as possible. If significant biofouling or mineral incrustations are present, an acid and dispersant are typically used to clean out these deposits. Use of well rehabilitation chemicals requires the chemicals to be worked through the screens and into the gravel pack through the use of a single or double swab tool, that creates a back and forth surging action in the well as the swab tool is pushed down and pulled back up. If mineral incrustations are abundant in the well, multiple chemical applications may be necessary.

If substantial capacity is lost in the well due to plugging, even the best well rehabilitation techniques may not completely restore the well to full capacity. This is why it is important to conduct well rehabilitation on a regular basis as indicated by well health parameters that are being monitored and the results of video logging.

Other specialized well rehabilitation techniques are also available based on the issues in the well and their severity. Most often, well rehabilitation uses a combination of techniques for maximum effectiveness.

Table 2
Estimated Periodic Costs

Item	Description	Quantity	Units	Unit Cost	Cost
	Materials				
1	Chlorine	1	LS	$ 475.00	$ 475.00
2	Phosphoric Acid	1	LS	$14,000.00	$ 14,000.00
3	NuWell-310	1	LS	$15,000.00	$ 15,000.00
				Subtotal	**$ 29,475.00**
	Equipment				
4	Nylon Brush	16	hr	$ 325.00	$ 5,200.00
5	Swab and Airlift	24	hr	$ 450.00	$ 10,800.00
				Subtotal	**$ 16,000.00**
	Labor				
6	Remove and Install Pump	1	LS	$ 7,500.00	$ 7,500.00
7	Video Survey	1	LS	$ 1,500.00	$ 1,500.00
				Subtotal	**$ 9,000.00**
				Periodic Costs	**$ 54,475.00**
	Annual Cost Based on 5 Year Rehabilition Interval				**$ 10,895.00**

Replacement Costs

Based on the age of the EM-3 well and its construction, we estimate an approximate lifespan of 50-70 years from its construction date in 1991. No significant well diagnostics were reviewed and no well videos have apparently been conducted based on the records reviewed.

Well Replacement

EM-3, based on its construction of mild steel casing with stainless steel screen has a high likelihood for galvanic corrosion in the well – most likely affecting the casing. Estimate of well life, based on no other diagnostic information, is estimated at 50-70 years from 1991, but this estimate is subject to modification based on new data from water chemistry, video or other diagnostic techniques. If the 50-70 year lifespan holds, plans and budgets should be developed for well replacement between 2041 and 2061. Any new construction should consist of stainless steel casing and screen to avoid the potential corrosion issues that currently exist. Costs are included in Table 3 for well replacement.

Pump Replacement/Upgrade

The current pump is inefficient and is not capable of utilizing a VFD to control flow. Options are to replace pump with a unit that will handle a VFD or utilize a gate valve system, although the gate valve will put back pressure on the pump which could cause pre-mature wear. Replacing the pump is the best option, but when? When it becomes necessary to vary flow rates a fair amount or the next significant pump overhaul. Based on calculations performed by Eaton Pumps, a new pump would cost approximately $74,000 with a VFD, but would reduce pumping costs from $15.23 per hour to $7.61 per hour, based on 2016 rates – a reduction in pumping costs of almost 50%. Increases in electrical rates and greater use of the well since that time will make the cost savings greater. An estimated payback period of approximately 12 years was calculated based on 2015 usage rates, but this is likely to be under 10 years at current electrical rates and the increased well usage. Eaton Pumps proposes to replace the current inefficient 125-hp pump with a 75-hp pump that can accept a VFD, substantially improving its efficiency. Pump upgrade and replacement costs are included in Table 3.

Maintenance and Upgrades – Other Equipment

The EM-3 well has a fairly limited distribution system associated with it, mainly to move water to the golf course lake during summer months. Nevertheless, the gate valve, distribution piping and other surface completion features of the well should be planned to be replaced on a 20 year life cycle.

Table 3
Replacement Costs

Item	Description	Quantity	Units	Unit Cost	Cost
	Well Replacement (32 year life)				
1	Mobilization	1	LS	$ 15,000.00	$ 15,000.00
2	Test Hole Drilling	500	ft	$ 85.00	$ 42,500.00
3	Geophysics	1	LS	$ 5,000.00	$ 5,000.00
4	Zone Testing	1	LS	$ 40,000.00	$ 40,000.00
5	Ream Borehole	500	ft	$ 125.00	$ 62,500.00
6	Surface Casing - 40'	40	ft	$ 175.00	$ 7,000.00
7	Stainless Steel Casing - 18"	400	ft	$ 300.00	$ 120,000.00
8	Stainless Steel Wire-Wrap Screen	100	ft	$ 350.00	$ 35,000.00
9	Seal	225	ft	$ 95.00	$ 21,375.00
10	Gravel Pack	275	ft	$ 45.00	$ 12,375.00
11	Well Development	1	LS	$ 15,000.00	$ 15,000.00
12	Disinfection	1	LS	$ 2,500.00	$ 2,500.00
13	Complete Well Head	1	LS	$ 7,500.00	$ 7,500.00
14	Install Electrical Panel	1	LS	$ 4,500.00	$ 4,500.00
15	Install Pump and Motor	1	LS	$ 6,500.00	$ 6,500.00
16	Well Capacity Test	1	LS	$ 35,000.00	$ 35,000.00
17	Title 22 Water Quality Testing	1	LS	$ 2,500.00	$ 2,500.00
				Subtotal	**$ 434,250.00**
				Annual Cost Subtotal	**$ 13,570.31**
	Pump/Motor Replacement (20 year life)				
18	75 hp Hitachi Submersible 1800 rpm	1	LS	$ 36,775.87	$ 36,775.87
19	13" Two Stage Bowl, Design 1100 gpm	1	LS	$ 7,169.10	$ 7,169.10
20	Variable Frequency Drive	1	LS	$ 4,500.00	$ 4,500.00
21	10" x 20' column pipe	200	ft	$ 52.28	$ 10,456.00
22	#1/0 Submersible Drop Cable	210	ft	$ 12.70	$ 2,667.00
23	Splice kits, gaskets, sealants	1	LS	$ 363.64	$ 363.64
24	Fuses/Time clock for panel modfication	1	LS	$ 909.10	$ 909.10
25	Labor to remove and install pump	20	hr	$ 300.00	$ 6,000.00
26	Labor to Load/unload equipment	5	hr	$ 115.00	$ 575.00
27	Labor to modify electrical panel	5	hr	$ 130.00	$ 650.00
28	Taxes				$ 4,525.00
				Subtotal	**$ 74,590.71**
				Annual Cost Subtotal	**$ 3,729.54**
	Miscellaneous Replacements/Repairs				
29	Valves and Piping (20 year class)	1	LS	$ 12,000.00	$ 12,000.00
				Subtotal	**$ 12,000.00**
				Annual Cost Subtotal	**$ 600.00**
				Total	**$ 520,840.71**
				Total Annual Cost	**$ 17,899.85**

Costs and Budgeting

While some of the current uses of the well are specifically for the CSA and other specifically for the EMCC, regular operation of the well is required for the long-term health of the well. As such, all 448 property owners in the CSA (includes the EMCC) benefit equally from annual operation and maintenance, periodic maintenance and replacement.

Table 4 below shows the annual costs summarized from Tables 1, 2 and 3 and is broken out on a per unit basis.

Table 4
El Macero Well #3 Cost

Item	Total Est		Source
	Annual Cost		
Estimated Annual Operating and Maintenance Costs			
El Macero Well #3			
Total	$ 53,818.79		Table 1
Per Unit (448 Units)	$ 120.13		
Estimated Annualized Periodic Costs			
El Macero Well #3			
Total	$ 10,895.00		Table 2
Per Unit (448 Units)	$ 24.32		
Annual Capital Replacement Cost			
El Macero Well #3			
Total	$ 17,899.85		Table 3
Per Unit (448 Units)	$ 39.96		
Total El Macero Well #3 Annual Cost	$ 82,613.64		
Total Per Unit	$ 184.41		

Summary and Conclusions

EM-3 is constructed of mild steel casing and stainless steel screens. The combination of dissimilar metals with no di-electric couplings indicates the well lifespan is likely to be much shorter than an all stainless steel construction. We estimate a 50-70 year well life from the time of its construction in 1991, but no diagnostics exist to assess the level of corrosion or well plugging that is ongoing.

The current pump and motor are being used in an inefficient manner due to the fact the current configuration cannot accept a VFD. Eaton Pumps has recommended an alternative pump and motor configuration that would drop energy usage by almost 50 percent. CRWA strongly recommends evaluating this option which has an approximate 12-year payback based on current usage.

The well is mainly used during summer months and is idle most of the rest of the year. Wells that are idle for significant periods of time should be exercised on a regular basis to maintain all equipment in good working order.

Currently, because its use as a golf course water supply, the well water is only tested using an Ag Suitability Test. CRWA recommends additional testing for TDS, Fe^{+2}, Total Coliform, E. coli and Total Bacteria to assess the health of the well on an ongoing basis.

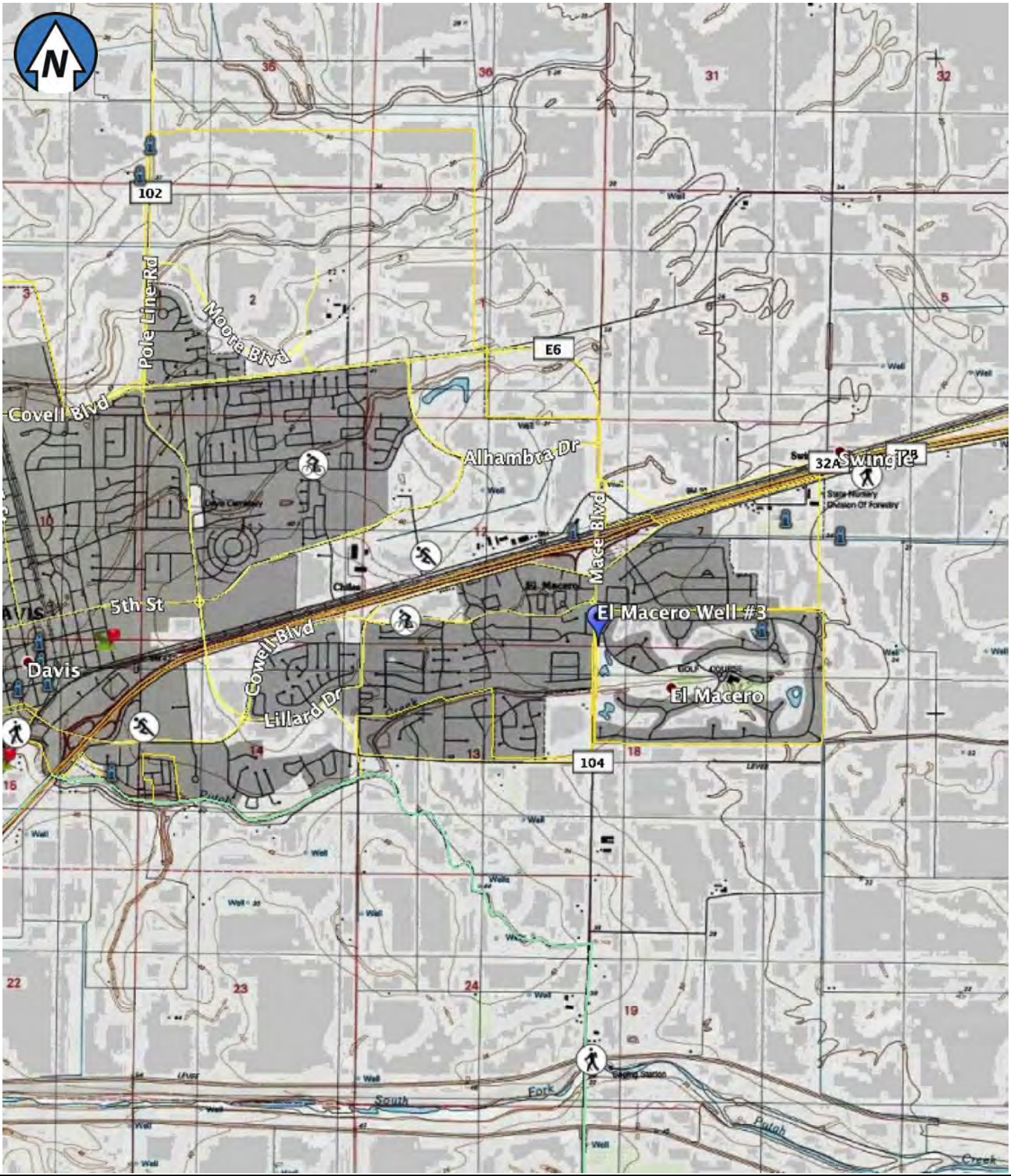
Biofouling is one of the most consistent causes of well plugging and CRWA recommends conducting tests at least once per year using the BART tests for iron-related bacteria, sulfur-reducing bacteria and slime-forming bacteria – the most common bacteria types involved in well biofouling.

Additional tracking should be conducted of specific capacity, which can be collected during well exercising and energy usage (gallons per kilowatt-hour) to monitor well performance over time and to determine when it is time to rehabilitate the well.

Based on very limited information, a 4-6 year schedule for well rehabilitation is likely appropriate, but CRWA recommends conducting a video survey of EM-3 as soon as practical to get a baseline for the well condition and help diagnose any issues with corrosion, well plugging and any other issues that may be discerned using visual methodologies.

It is recommended that any replacement well be constructed with both stainless steel casing and screen to avoid any galvanic corrosion issues.

FIGURES



Feet

0 2,000 4,000

Figure 1
Site Location Map

California Rural Water Association

Notes:
All locations are approximate.
Source: *USGS Topographic Map; Davis Quadrangle; 1:24,000; 2018*

El Macero Well #3
El Macero Country Club
Davis, Yolo County, California

Feet

0 50 100

Notes:

All locations are approximate

Aerial Source: *Google Earth, 16 August 2018*

California Rural Water Association

Figure 2
Site Map

El Macero Well #3
El Macero Country Club
Davis, Yolo County, California

Appendix A
Well Use Agreement

WELL USE AGREEMENT No. 16-184

This Well Use Agreement ("Agreement") is made this 22nd day of November, 2016, by and between the County of Yolo, a political subdivision of the State of California, on behalf of and for the benefit of the El Macero County Service Area, ("CSA"), and the El Macero Country Club, a California non-profit, mutual benefit corporation, ("EMCC").

RECITALS

1. CSA owns a groundwater well, referred to as EM3 and more fully described below, which is located on a CSA-owned parcel of land that abuts EMCC's golf course.
2. EM3 was constructed in 1991 at CSA expense and has since then been used continuously for the production of water for CSA.
3. EM3 is connected to the EMCC supply lake on hole Number 12.
4. Available documents indicate that EM3 produces water from the same aquifer as EMCC's Well 4 and that the quality of water from EM3 and Well 4 are similar.
5. CSA now receives water from the City of Davis and does not currently need water from EM3.
6. CSA desires to make available certain well capacity to EMCC and to have EMCC maintain and regularly operate EM3 in order to keep it in good condition for possible future CSA Purposes.
7. EMCC represents that it has the ability and the desire to operate and maintain EM3 for Club Purposes in exchange for water use.

Now, therefore, the parties agree that:

DEFINITIONS

1. "EM3" shall mean CSA's groundwater production well located on Mace Boulevard on a CSA-owned parcel abutting the northwest corner of the EMCC golf course, as shown on Attachment A, including all appurtenant on-site equipment and facilities, which include but are not limited to pipes, valves, turnouts, meter, electrical and/or other power source(s).
2. "Well 4" shall mean the groundwater production well owned and operated by EMCC for Club Purposes.
3. "Club Purposes" shall mean the irrigation of EMCC's fairways, tees, greens, landscaping and other vegetation, the maintenance of lakes or ponds on EMCC properties and other miscellaneous purposes associated with golf course operations.

Club Purposes shall also include the operation of a well on a periodic basis to insure proper maintenance of the pump in question.

4. “CSA Purposes” shall mean the use of water within CSA for purposes other than Club Purposes.

5. “Major Replacements” are defined as any equipment maintenance, repair and replacement expenditures that are not Minor Replacements.

6. “Minor Replacements” are defined as equipment maintenance, repair and replacement expenditures not exceeding $2,500 per expenditure/incident.

TERMS AND CONDITIONS

1. Water Usage. Non-exclusive of CSA’s right to use water from EM3 for CSA Purposes, EMCC may use water from EM3 for Club Purposes. Water from EM3 should not be used to increase total water consumption for Club Purposes and the total amount of water used for Club Purposes from all sources combined shall not significantly exceed the amount that would have been used absent receipt of water from EM3 under this Agreement.

2. Security. At CSA’s sole discretion, CSA may establish and maintain such physical or electronic security measures as CSA, in its sole and exclusive discretion, deems appropriate for EM3 and if so, will provide EMCC the reasonable access required by EMCC personnel in order to carry out EMCC’s rights and duties under this Agreement.

3. Operations and Maintenance. During the term of this Agreement, EMCC will operate and maintain EM3 in accordance with the Operations and Maintenance Plan attached as Attachment B, as amended from time-to-time upon mutual consent of the parties. EMCC shall be responsible for the cost of electricity used at EM3 provided that CSA shall separately meter EM3 and shall submit a quarterly invoice not less than 30 days following the end of the quarter in question. Upon receipt of a timely invoice from CSA, EMCC shall pay such invoice within not more than 14 days.

4. Minor Replacements. EMCC shall be solely responsible for the cost of Minor Replacements. Subject to the expense limitation, EMCC is responsible for proper care and maintenance of the equipment including both routine and unexpected (even if inevitable), episodic maintenance, repair and replacements, when needed.

5. Major Replacements. In the event of the need for a Major Replacement, EMCC will promptly notify CSA. CSA may, at CSA’s sole discretion, choose to (i) have the Major Replacement made in which case CSA must pay the cost or (ii) terminate this Agreement in lieu of making the Major Replacement.

6. Connection to EMCC's Irrigation System. EMCC is solely responsible for the cost of connecting EMCC's irrigation system to EM3, for all future connections and for maintaining existing and future physical connections, which connections shall not be considered either a Major Replacement or Minor Replacement. Additional appurtenant facilities may be necessary to make water available from EM3 to EMCC. Such facilities may include, but are not limited to, valves, discharge piping, one or more meters, and other facilities deemed necessary or appropriate by EMCC. Any such facilities shall be designed, constructed and maintained in accordance with EMCC specifications at EMCC's sole cost and expense at a location and manner to be agreed upon by the parties. EMCC shall be solely responsible for any damage to the EMCC irrigation system resulting from the existing or future physical connections with EM3.

7. Annual Reporting. EMCC will maintain and annually provide to CSA a maintenance log reflecting any and all maintenance and monitoring performed on EM3 while under EMCC operation as detailed in Attachment B. 95

8. Water Rights. All groundwater used for Club Purposes pursuant to this Agreement is deemed by the parties to have been used in furtherance of the exercise of EMCC's groundwater rights. All groundwater used for CSA Purposes pursuant to this Agreement will be deemed by the parties to have been used in furtherance of CSA's groundwater rights.

9. No Warranty. CSA makes no warranty, express or implied, with respect to the quality or quantity of water produced from EM3 and EMCC takes and utilizes such water at EMCC's sole risk and subject to the terms of this Agreement, and EMCC shall indemnify, hold harmless, and defend CSA with respect to any and all claims, demands, or lawsuits regarding water produced by EMCC from EM3, other than water used for CSA Purposes.

10. Mutual Indemnity. With the exceptions listed below in this Section, each party shall indemnify, defend, protect, hold harmless and release the other party, its elected bodies, officers, agents and employees from and against any and all claims, liability, losses, proceedings, damages, causes of action, liability, costs or expense (including attorneys' fees and witness costs) arising from or in connection with, or caused by any negligent act or omission or willful misconduct of the indemnifying party. This indemnification obligation shall not be limited in any way by any limitation on the amount or type of damages or compensation payable to or for the indemnifying party under workers' compensation acts, disability benefit acts, or other employee benefit acts. Notwithstanding the foregoing, EMCC shall not be liable for any Major Replacement or for a complete well failure not caused by a negligent act or omission or the willful misconduct of EMCC and the provisions of Section 5 of this Agreement shall govern.

11. Assignment or Transfer. EMCC may not assign or transfer this Agreement, including to a successor-in-interest of all or a majority of EMCC's assets, without the prior written consent of CSA, which consent shall not be unreasonably withheld.

12. Term of Agreement. This Agreement shall remain in effect until the earliest to occur of:

   a. Written notice of termination by either party if CSA does not initiate a Major Replacement within 60 days after EMCC notifies CSA of the need for such Major Replacement, effective as of the date of the notice;

   b. Termination by either party for any reason or no reason upon 180 days' advance notice to the other party;

   c. Termination by mutual consent of the parties;

   d. Written notice of termination by either party if EM3 becomes inoperable, effective as of the date of the notice.

13. Compliance with Law. EMCC shall comply with all federal, state and local laws and regulations applicable to EMCC's use, operation and maintenance of EM3. CSA shall comply with all federal, state and local laws and regulations applicable to CSA's ownership and control of EM3.

14. Independent Contractor. EMCC is an independent contractor and not an agent, officer or employee of CSA. The parties mutually understand that this Agreement is by and between two independent contractors and is not intended to and shall not be construed to create the relationship of agent, servant, employee, partnership, joint venture or association.

15. Survival. The Mutual Indemnity provision of this Agreement shall survive the termination of the Agreement.

16. Notice
   a. Any notice provided in connection with this Agreement shall be given in writing by personal delivery, by any commercially accepted overnight delivery service or by prepaid first-class mail addressed as follows:

      El Macero County Service Area
      County of Yolo, County Administrator's Office
      625 Court Street, Room 202
      Woodland, CA 95695

      El Macero County Country Club
      44571 Clubhouse Drive

      El Macero, CA 95618

b. If notice is given by personal delivery, notice is effective as of the date of personal delivery. If notice is given by mail or by overnight delivery service, notice is effective as of the day following the date of mailing or the date of delivery reflected upon a return receipt, whichever occurs first.

17. Choice of Law. The parties have executed and delivered this Agreement in the County of Yolo, State of California. The laws of the State of California shall govern the validity, enforceability or interpretation of this Agreement. Yolo County shall be the venue for any action or proceeding, in law or equity that may be brought in connection with this Agreement.

18. Entire Agreement. This Agreement and the Water Use Agreement of the same date, including any attachments referenced, constitute the entire agreement between the parties and there are no inducements, promises, terms, conditions or obligations made or entered into by CSA or EMCC other than those contained in this Agreement.

EMCC	**COUNTY OF YOLO**
By:______________________________	By: ______________________________
_	_ Jim Provenza, Chair Board of Supervisors
	Attest: Julie Dachtler, Deputy Clerk Board of Supervisors
	By: ______________________________
	_ Deputy (Seal)
	Approved as to Form: Philip J. Pogledich, County Counsel
	By: ______________________________
	_ Carrie Scarlata, Assistant County Counsel

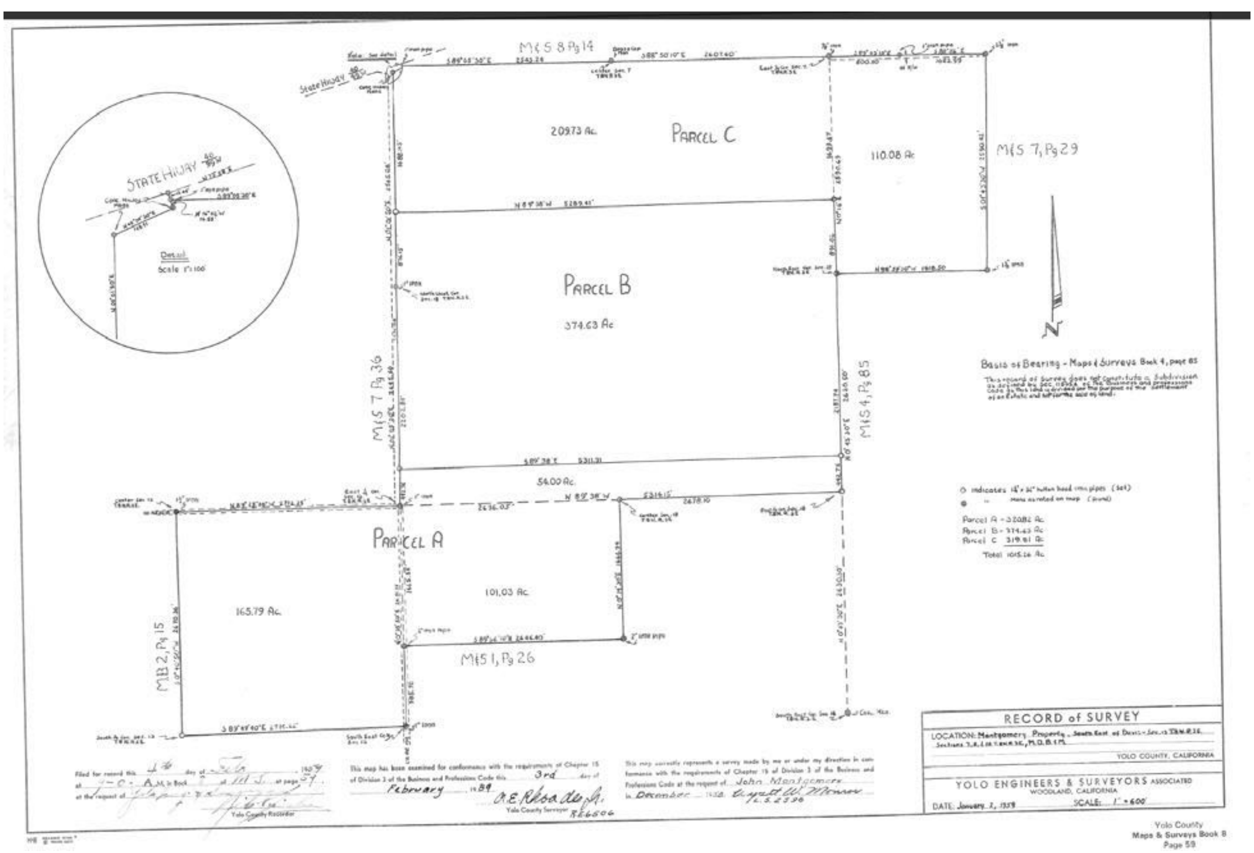
ATTACHMENT A

[Map/legal description]

All that real property situated in the State of California, County of Yolo, described in the County of Yolo Official Book of Records 1514, Page 279, as:

A portion of Parcel “B” as same appears of record in Maps and Surveys Book 8, pg. 59. Yolo County Records, also being a portion of the Southwest quarter of Section 7, T8N, R3E, M.D.B.&M., described as:

Beginning at a point on the West line of said Parcel “B” and said Section 7 that is distant North 1°01’ 50” East 38.33 feet from the Southwest corner of said Section 7, said point of beginning also being the Northwest Corner of that certain parcel of land conveyed to the El Macero Country Club by deed recorded in Official Records Book 1320, Page 249, Parcel 2: thence continuing along said West line of said Parcel “b” and said Section 7, North 1° 01’ 50” East 40.00 feet; thence at right angles thereto, parallel with the North line of said El Macero Country Club Parcel, South 88° 58’ 10” East 70.00 feet: thence at right angles thereto, parallel with said West line South 1° 01’ 50” West 40.00 feet to said North line of said El Macero Country Club parcel: thence along said North line North 88° 58’ 10” West 70.00 feet to the point of the beginning.



ATTACHMENT B
Operation, Maintenance, Records and Reporting

I. Operation

EMCC may use EM3 as needed to supply water to lakes on EMCC property and, at a minimum, shall exercise the pumping equipment once every two weeks for at least 15 minutes.

EMCC may, at its discretion, partially close the above ground gate valve on the pump discharge line in order to protect golf course piping.

II. Maintenance

EMCC shall maintain EM3 in good working order in accordance with the recommendations of the May 13, 2016, letter from Dan Morris, Eaton Pumps Sales and Service, to Michael Facciuto, EMCC (attached), including any necessary repairs and minor replacements.

Annually, EMCC shall have the efficiency of EM3 tested and shall obtain a chemical analysis of water produced from EM3 in order to monitor its continued suitability for irrigation ("Ag Suitability" water test).

III. Records

EMCC shall maintain a record of pumpage from EM3, including dates, run times, gallons pumped and energy usage.

EMCC shall maintain a record of maintenance and minor repairs and replacements at EM3.

IV. Reporting

EMCC shall submit an annual report to the CSA, covering the prior Water Year (October 1 through September 30) by not later than November 1 transmitting (a) the results of pump efficiency tests and water quality analyses, (b) pumpage, including dates, run times, gallons pumped and energy usage and (c) a summary of the maintenance completed and any repairs or replacements made.

Annual operation and maintenance report for EM3 shall be provided to:

El Macero County Service Area
County of Yolo, County Administrator's Office
625 Court Street, Room 202
Woodland, CA 95695

Annually, EMCC shall obtain, at EMCC's expense, an inspection of EM3 by an appropriate independent third party and promptly submit a copy of the inspection report to CSA.

Appendix B
Well Log and As Built Diagram

EM-3

TRIPLICATE
Owner's Copy

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 428868

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Page ___ of ___
Owner's Well No. ___
Date Work Began 1-14-91, Ended 1-22-91
Local Permit Agency Yolo County Environmental Health
Permit No. ___ Permit Date ___

GEOLOGIC LOG

ORIENTATION (✓) ___ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION (Describe material, grain size, color, etc.)
0	1	top soil
1	15	brown clay
15	45	yellow stickycclay
45	50	brown sticky clay
50	100	yellow sticky clay
100	135	fine to medium and coarse sands
115	125	gravel - coarse to 1/2" X 1" rocks
125	180	yellow soft clay
180	190	medium and coarse sand to med. gravel
190	250	yellow soft clay
250	286	gravel coarse to 1/2" rocks
286	290	yellow sticky clay
290	306	gravel 1/4" to 3/4" rocks
306	346	blue soft clay
346	365	gravel coarse to 1/4" rocks
365	380	brown clay
380	386	dine to medium sand
385	500	brown clay with fine sand stringers

TOTAL DEPTH OF BORING 400 (Feet)
TOTAL DEPTH OF COMPLETED WELL 470 (Feet)

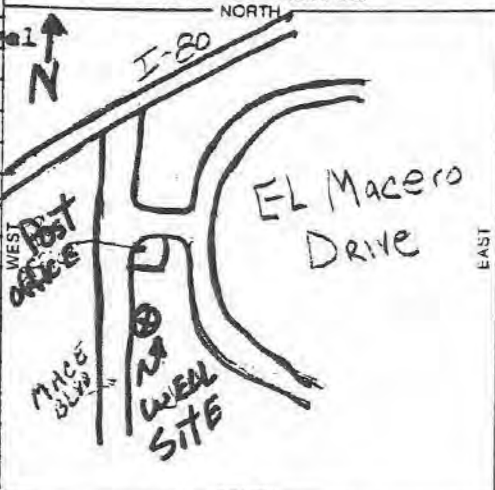
WELL OWNER

Name El Macero Country Club — WRONG
Mailing Address El Macero Drive
Davis, CA 95616
CITY STATE ZIP

WELL LOCATION

Address Mace and El Macero Drive
City Davis
County Yolo
APN Book ___ Page ___ Parcel ___
Township 8N Range 2E Section 12
Latitude ___ NORTH Longitude ___ WEST
DEG. MIN. SEC.

LOCATION SKETCH



Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USE(S) (✓)

___ MONITORING

WATER SUPPLY
___ Domestic
X Public
___ Irrigation
___ Industrial
___ "TEST WELL"
___ CATHODIC PROTECTION
___ OTHER (Specify)

DRILLING METHOD Reverse Rotary FLUID Water

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 42 (Ft.) & DATE MEASURED 2-9-91
ESTIMATED YIELD* 2800 (GPM) & TEST TYPE pump
TEST LENGTH 24 (Hrs.) TOTAL DRAWDOWN 101.1 (Ft.)
* *May not be representative of a well's long-term yield.*

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL/GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	40	36			✓		Steel	31.5	.25	
0	238	30	✓				Steel	17.38	.313	
238	258			✓			304ss		DoubleX	.050
258	286		✓				Steel		.313	
286	306			✓			304ss		DoubleX	.050
306	342		✓				Steel		.313	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	225	X			
225	470				#21 Mix

ATTACHMENTS (✓)

___ Geologic Log
X Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

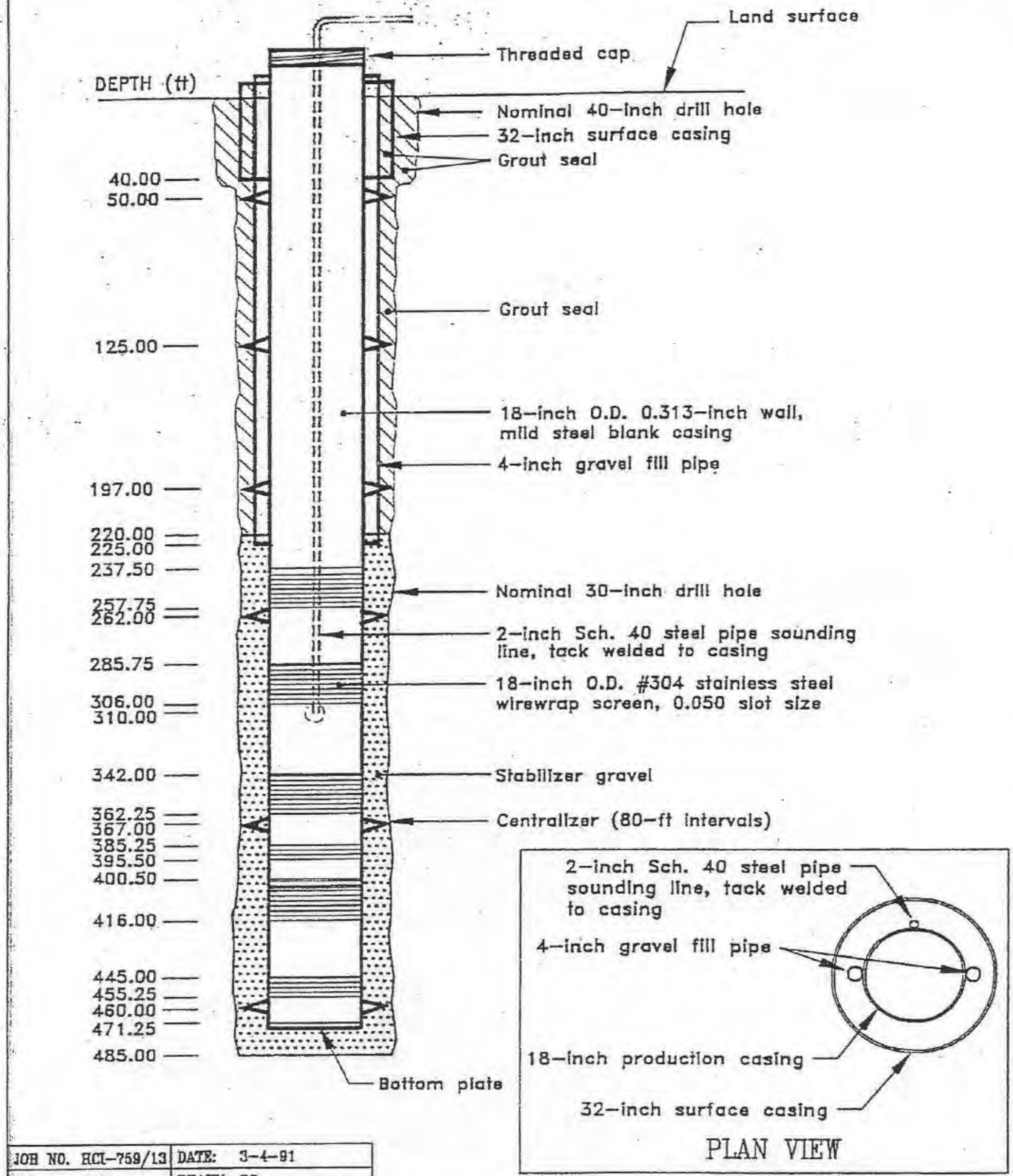
NAME Layne-Western Company, Inc.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P. O. Box 1326 - Woodland, CA 95695
ADDRESS CITY STATE ZIP

Signed [signature] 5-24-91 510011
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM



JOB NO. HCI-759/13	DATE: 3-4-91
BY: TMH	DRAWN: SC
CHKD: LCA	REV:

HCI HYDROLOGIC CONSULTANTS, INC.

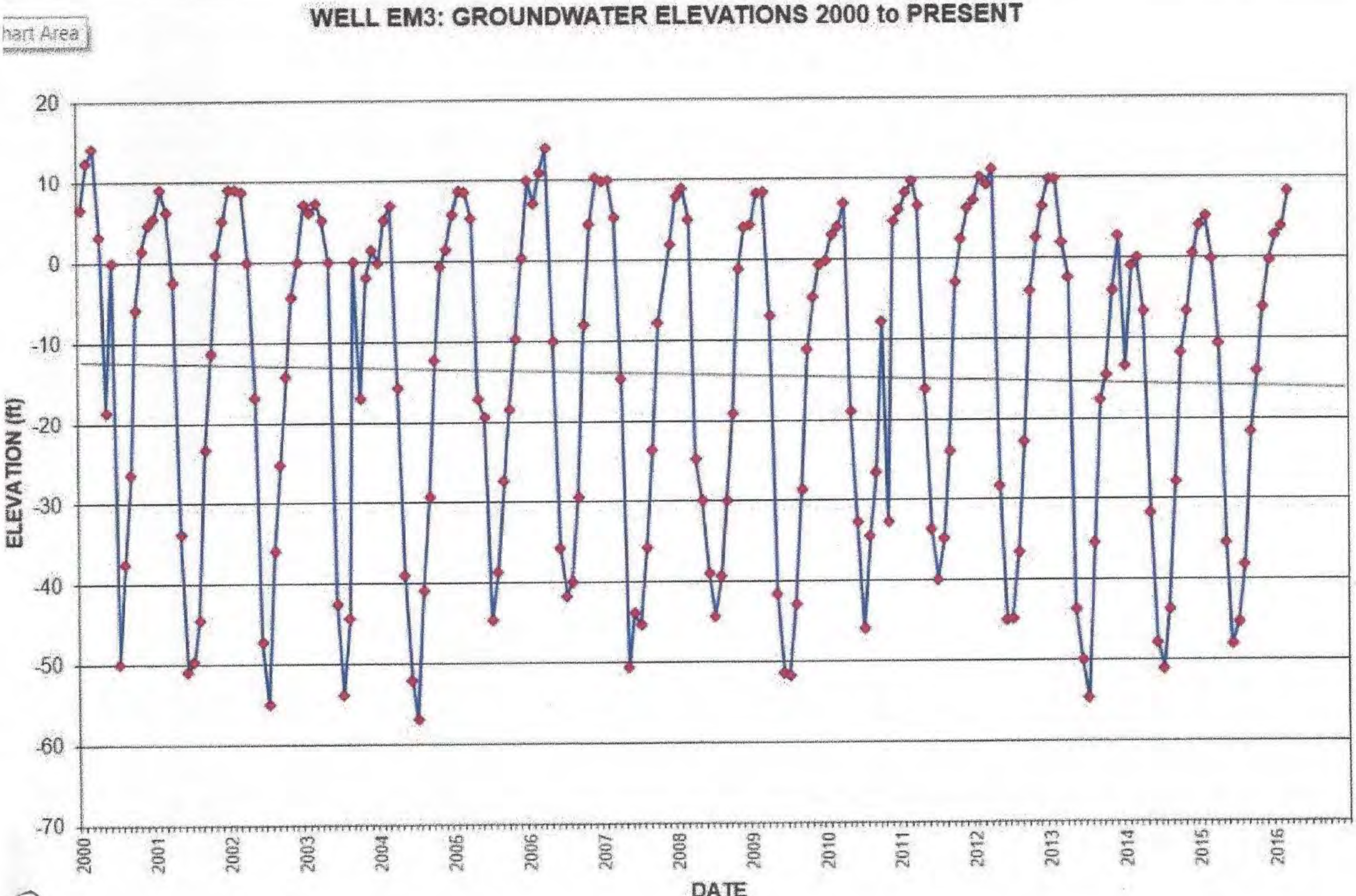
As-Built Diagram of El Macero Well No. 3

EM3

FIGURE 3

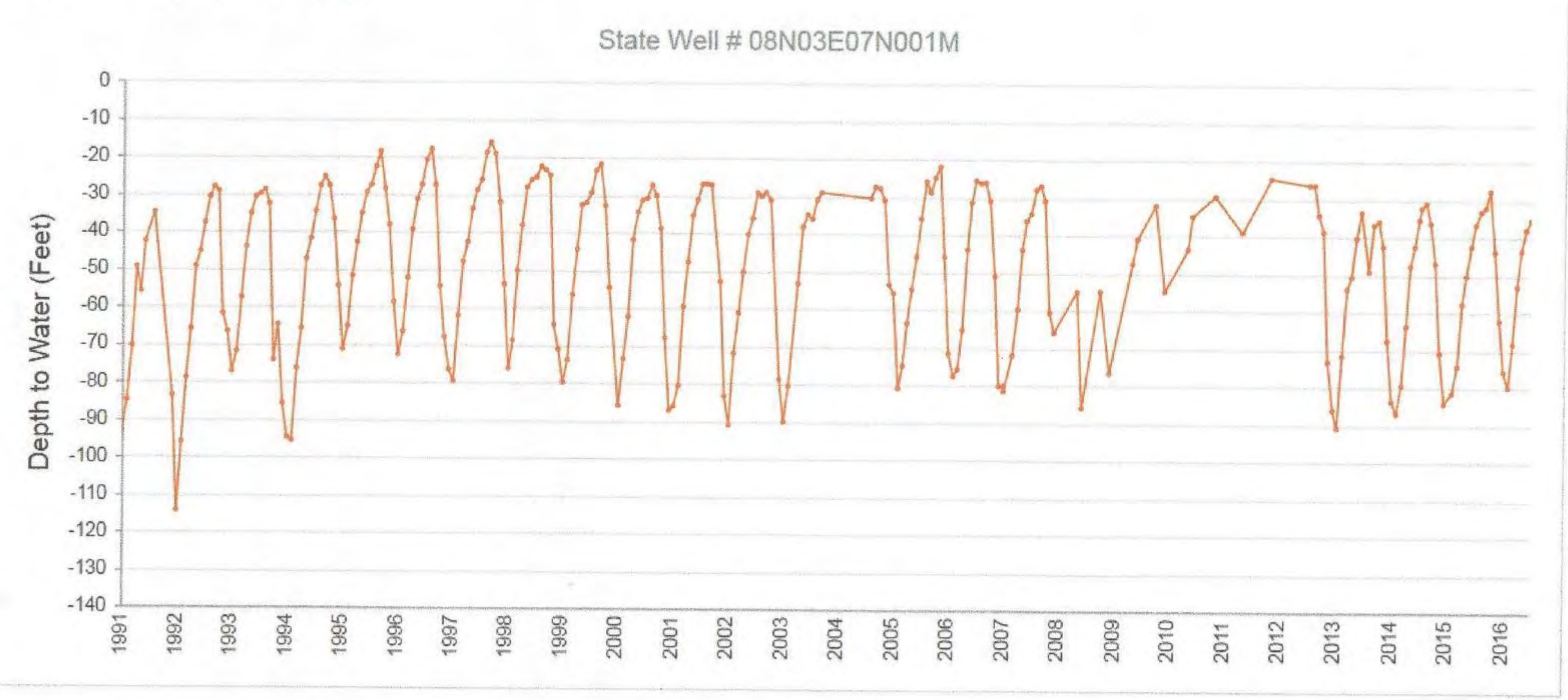
Appendix C
Water Level Data

WELL EM3: GROUNDWATER ELEVATIONS 2000 to PRESENT



(8)

EM-3



State Well # 08N03E07N001M
Depth to Water (Feet)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

(6)

EM 3 Depth to Water, Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991							93.1	84.9	70.4	49.4	55.9	42.6
1992		34.9				35.9		96.0	78.9	65.9	49.3	45.2
1993	37.7	30.8	28.1	29.2	61.8	66.6	77.2	71.9	57.5	44.1	35.2	30.7
1994	29.9	28.8	32.6	74.2	64.7	85.8	94.7	95.6	76.4	65.8	47.3	41.9
1995	34.6	27.8	25.4	27.7	36.6	54.4	71.3	65.2	51.7	42.8	35.1	29.5
1996	27.5	22.7	18.6	28.5	38.1	58.7	72.7	66.5	52.3	39.4	31.3	27.5
1997	20.8	18.0	27.5	54.4	68.0	76.6	79.7	62.2	47.8	42.6	33.8	28.8
1998	26.1	18.8	16.1	19.2	32.0	53.9	76.2	68.7	50.3	38.1	28.1	26.1
1999	25.4	22.5	23.4	24.9	64.6	71.1	79.9	73.9	56.6	44.5	32.6	32.0
2000	29.4	23.5	21.8	32.8	54.6	N/A	86.0	73.5	62.3	41.8	34.5	31.3
2001	30.8	27.3	30	38.8	67.9	87.2	86	80.7	59.6	47.7	35.3	31.2
2002	27	27	27.2	N/A	52.9	83.3	91.0	71.9	61.2	50.3	40.3	36
2003	29.2	30.1	29.1	31.2	N/A	78.8	90.1	80.6	N/A	53.3	38.2	34.9
2004	36.1	30.9	29.0	51.7	75.0	88.0	93.0	77.0	65.3	48.3	36.6	34.5
2005	30.5	27.5	27.8	31	53.5	55.7	81	75	63.6	54.7	46	35.9
2006	26	28.9	25	22	46	71.7	77.7	75.9	65.4	44	31.5	25.7
2007	26.4	26.2	31	51.1	80.3	80.2	81.6	72.1	59.9	44	36.3	34.4
2008	28	27.1	31	60.7	66	74.9	80.3	75.3	65.9	55.1	37.1	31.9
2009	31.9	28.1	27.9	43.3	76.7	87.8	88.0	79.1	64.9	47.5	41.0	37.0
2010	36.2	32.9	32.0	29.0	54.9	68.6	82.0	70.5	62.6	43.7	N/A	N/A
2011	30.2	28.1	26.6	29.6	49.7	70	76.2	71	60.2	39.2	33.9	30
2012	28.7	25.8	26.8	24.8	64.3	81	80.8	72.6	58.8	40	33.43	29.5
2013	26.5	26.5	34.4	38.8	73.4	86.2	91	71.8	54	50.8	40.4	33.6
2014	49.4	36.9	36	42.6	67.7	83.8	87.1	79.6	63.8	47.8	42.6	35.5
2015	32.3	31.1	36.4	47	71	84.4						

1993 - 2014	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	20.8	18	16.1	19.2	32	53.9	71.3	62.2	47.8	38.1	28.1	25.7
Average	30.5	27.3	28.0	37.8	60.0	74.9	82.9	74.1	60.0	46.6	36.7	32.3
Maximum	49.4	36.9	36.4	74.2	80.3	88	94.7	95.6	76.4	65.8	47.3	41.9

Appendix D
Analytical Data

CHEMICAL ANALYSES OF WATER FROM EM3
General Mineral

Constituent	Common Name	Units	March 2004	November 2009	August 2013	August 2014
Hardness	CaCO3	mg/L	380	490	450	460
Calcium	Ca	mg/L	44	53	49	49
Magnesium	Mg	mg/L	67	86	80	81
Sodium	Na	mg/L	73	74	72	73
Potassium	K	mg/L	<2.0	<2.0	1.6	1.6
Alkalinity	CaCO3	mg/L	350	390	410	380
Hydroxide	OH	mg/L	<1.0	<1.0	<3.0	ND
Carbonate	CO3	mg/L	<1.0	<1.0	0.59	ND
Bicarbonate	HCO3	mg/L	350	390	410	380
Sulfate	SO4	mg/L	94	100	88	90
Chloride	Cl	mg/L	65	82	78	80
Nitrate	NO3	mg/L	12	24	27	26
Fluoride	F	mg/L	0.3	0.25	0.21	0.18
pH			8.3	8.2	8.3	8.2
Specific Conductance	E.C.	µmhos/cm	960	1200	1100	1100
Total Filterable Residue	TDS	mg/L	600	660	640	640

NOTES:
mg/L = milligrams per liter = parts per million (ppm)
µmhos/cm = micromhos/centimeter

Appendix E
Pumping Efficiency Tests

EM-3

CITY OF DAVIS PUMP EFFICIENCY TEST : WELL EM3

TEST DATE : OCTOBER 17, 2006

Collins Tube Average Reading : 4.05

4.05	4.60	4.10
4.00	4.55	4.05

Discharge ID :	10"	SWL	51.4
gpm/ft/sec :	245	PWL	140.1
Equidistance	3 & 9/16	Discharge Level	147.1
HP	125	Total Lift	287.2
Motor Efficiency	91.3	psi	63.7
Center Point	12.5"	Meter gpm	1030
		Measured gpm	992

Horsepower Input	124.2	
Kilowatt Input	92.7	
% Motor Load	90.7%	
WHP	72.0%	
Plant Efficiency	58.0%	
Capacity	11.2	(Measured)
Capacity	11.6	(Observed)

Discharge Level	2.31 * psi
Total Lift	DL + PWL
HPI	Kh * 4.83 * Revolutions * (Constant/sec)
KWI	HPI * .746 ([(40*4.83*1*4.8)]/2.78
% Motor Load	HPI * Motor Eff/ Rated HP=HPI * 91.3/125
Working Horsepower	GPM (Measured) * (Total Lift/3960)
OPE	WHP/HPI
Constant	40
Kh	1.8
Meter Rev	1
Time	2.8
	4.83

Pumping Efficiency Testing Services, PETS

Serving you with accuracy and efficiency

498 Water Trough Road
Sebastopol, CA 95472

(866) 774-4812 voice / fax
pumpingefficiency1@pacbell.net

CONFIDENTIAL AND PROPRIETARY INFORMATION PUMPING COST ANALYSIS FROM: Pumping Efficiency Testing Services

MARIE GRAHAM
CITY OF DAVIS
1717 5TH STREET
DAVIS, CA 95616

Test Date: 6/30/2014
Pump: EM3
Nameplate HP: 100.0
Our Pump Test Number: 108221

This is a water well used for Municipal and assumed to be operated 1000 hours/year.

The current OPE is high enough that little or no cost savings are estimated from a retrofit/repair.

*NOTE: * denotes a value that was Assumed or Provided by Customer*	**Measured Pump Condition**	**Assumed Condition After Retrofit**	**Notes**
1. Overall pumping efficiency:	71 %	71 %	
2. Nameplate Horsepower:	100.0 hp	100.0 hp	
3. Motor Efficiency:	91 %	91 %	
4. Actual Motor Input Horsepower:	108.4 hp	108.4 hp	
5. Motor loaded at:	99 %	99 %	
6. Flow rate (gpm):	1,025 gpm	1,025 gpm	
7. Pumping Level (ft):	159 ft	159 ft	
8. Discharge Pressure (psi):	59 psi	59 psi	
9. Total Dynamic Head (feet):	296 ft	296 ft	*Rounded TDH = line 7. + (2.31 x line 8.)*
10. Million Gallons Pumped/Year:	61.34 mg/Yr*	61.34 mg/Yr*	*Same mg/yr AFTER!*
11. Average Cost per kWh:	$0.170 /kWh*	$0.170 /kWh*	*Same $/kWh AFTER*
			Estimated Savings from Retrofit
12. Estimated Total kWh per Year:	80,900 kWh/yr	80,889 kWh/yr	11 kWh/yr
13. Hours of Operation/yr:	1,000 hr/yr*	1,000 hr/yr	0 hr/yr
14. Kilowatt-Hours per mill gal:	1,315 kWh/mg	1,315 kWh/mg	0 kWh/mg
15. Average Cost Per mill gal:	$223.61 $/mg	$223.58 $/mg	$0.03/mg = 0.01%

- Estimated savings = $0.03/mg = 0.01% of energy costs
- If pumping 61.34 mg/year this equals about $2 annual savings

Analysis Remarks:

It is sincerely hoped that this information will prove helpful to you, and that your concerns over maintaining optimum pumping efficiency will continue. If you have any questions, please contact Bob

Regards,

Bob Fraker

Pumping Efficiency Testing Services, PETS

Serving you with accuracy and efficiency

498 Water Trough Road
Sebastopol, CA 95472

Voice/Fax (866) 774-4812
pumpingefficiency1@pacbell.net

PUMPING EFFICIENCY TEST REPORT

Pump/Location: EM3/800 Mace
GPS Coord.: Long -121.6944 **Lat** 38.54607

Analysis Date - 5/2/2015
Pump Test Reference Number: 0202142-1

Utility: PG & E
Meter Number: 1003872635

Motor Make: No Name Plate
HP: ~~100~~ 125
Voltage: **Amps:**
Serial Number:

Pump Make: No Name Plate
Type: Submersible

Customer Addr: City of Davis
1717 5th Street
Davis, CA 95616

Contact: Marie Grahm
Phone: (530) 757-5686
Fax: (530) 758-4738
Cell: (530) 681-8743

Test Date: 4/28/2015 **Site Test #:** 3 **Tester:** Bob Fraker

Run Number 1 is used for cost analysis:	1
1. Pumping Water Level (Ft):	141
2. Standing Water Level (Ft):	53
3. Draw Down (Ft):	88
4. Recovered Water Level (Ft):	53
5. Discharge Pressure at Gauge (PSI):	54
6. Total Lift (Ft):	265
7. Flow Velocity (Ft/Sec):	4.5
8. Measured Flow Rate (GPM):	**1,100**
9. Customer Flow Rate (GPM):	1,117
10. Specific Capacity (GPM/Ft draw):	12.5
11. Acre Feet per 24 Hr:	4.9
12. Million Gallons per 24	1.584
13. Cubic Feet per Second (CFS):	2.5
14. Horsepower Input to Motor:	113
15. Percent of Rated Motor Load (%):	103
16. Kilowatt Input to Motor:	84
17. Kilowatt Hours per Mill Gal:	415
18. Cost to Pump a Million Gal:	$70.59
19. Energy Cost ($/Hour):	$14.30
20. Base Cost per kWh:	$0.170
21. NamePlate RPM:	0
22. RPM at Gear Head:	0
23. Overall Pumping Efficiency (%):	**65**

All results are based on conditions during the time of the test. If these conditions vary from the normal operation of your pump, the results shown may not describe the pump's normal performance.

Overall efficiency of this plant is considered to be good assuming this run represents plant's normal operating condition.

Drawdown Min: (5) 139.3' (10) 140.4' (15) 140.4' (20) 140.4' (25) 140.8' (30) 141.2'

Recovered Water Level Min: (1) 61.8' (2) 60' (3) 58.6' (4) 57.6' (5) 56.9'

Meter Hours: 32663

Estimated savings of 27 kWh/AF and $2,736.13 annual energy costs from a retrofit

Current OPE of 65% and estimated potential OPE of 70%

Appendix F
Ag Suitability Test Parameters

DELLAVALLE Laboratory, Inc.
Chemists and Consultants

1910 W McKinley Suite 110 • Fresno CA 93728-1298
559 233-6129 or 800 228-9896

www.dellavallelab.com

AGRICULTURAL WATER INTERPRETATION GUIDE

EC mmhos/cm

ELECTRICAL CONDUCTIVITY - This is an estimate of the concentration of soluble salts. The interpretation of EC assumes that 10-20% of the total water applied passes through and below the root zone. In most cases deep percolation losses, due to inefficiency of irrigation practices, will satisfy the leaching requirement for the usual crops.

Below 0.5	Depending on soil texture, water penetration problems may occur due to low salt content.
Below 0.75	Low salinity hazard - can be used for most crops.
0.75 - 1.5	Medium salinity hazard - can be used for moderately salt tolerant crops.
1.5 - 3.0	High salinity hazard - can be used for highly salt tolerant crops.
Above 3.0	Very high salinity hazard - generally not suitable for continual use except under most favorable conditions. Leaching is necessary.

The EC (mmhos/cm) multiplied by 640 is approximately equal to the concentration of total dissolved solids (TDS) in ppms.

Ca, Mg, Na meq/l

CALCIUM, MAGNESIUM, SODIUM - Major cations found in most waters. Solid calcium and magnesium carbonates ($CaCO_3$ and $MgCO_3$) form when the concentrations of these constituents are sufficiently high. For drip systems, preventative maintenance is necessary to avoid emitter clogging from formation of $CaCO_3$ and $MgCO_3$. Sodium is a problem when it is the dominant ion. Calcium, magnesium and sodium are used to calculate SAR.

SAR

SODIUM ADSORPTION RATIO - A calculated value used to *estimate* the exchangeable sodium percentage, ESP, of a soil after long-term use of water.

SAR_{adj}

SODIUM ADSORPTION RATIO ADJUSTED - This ratio takes into consideration the calcium precipitation from carbonates and bicarbonates. Permeability problems are more probable at a given SAR_{adj} with waters of low salinity than at high salinity. The relationship between irrigation water SAR_{adj} and soil ESP (exchangeable sodium percentage) is:

SAR_{adj}	ESP	
Below 6	Below 10	No soil permeability problem expected due to sodium.
7 - 9	10 - 15	Possible permeability problems with fine texture soils. (Saturation percentage above 50)
Above 9	Above 15	Permeability problems likely on all mineral soils, with possible exceptions of very coarse textured soils. (Saturation percentage below 20)

Cl meq/l

CHLORIDE - Fruit crops and many woody ornamentals are chloride sensitive.

Below 2	Satisfactory for all crops.
2 - 10	Range associated with leaf burn on chloride sensitive crops.
Above 10	Generally unsatisfactory for chloride sensitive crops.

CO_3, HCO_3 meq/l — CARBONATE PLUS BICARBONATE - These two major anions are related to the alkalinity of waters and are involved in the formation of $CaCO_3$ and $MgCO_3$. Waters relatively high in carbonate or bicarbonate may present special problems.

B ppm — BORON - Small amounts are required and large amounts are toxic to plants.

Below 0.5	Satisfactory for all crops.
0.5 - 1.0	Satisfactory for most crops. Sensitive crops may show injury, however yields may not be affected.
1.0 - 2.0	Satisfactory for semi-tolerant crops. Sensitive crops are usually reduced in yield and vigor.
2.0 - 4.0	Only tolerant crops produce satisfactory yields.
Above 4.0	Generally unsatisfactory for continued use.

NO_3-N ppm — NITRATE NITROGEN - All or part of the crop's needs can be supplied. This formula is helpful for calculating fertilizer needs: NO_3-N x 2.72 = N in lbs/ac. ft. of water.

Fe, Mn ppm — IRON, MANGANESE - Of concern in drip systems as emitter clogging may occur due to the formation of iron and manganese oxides, ochers (oxides mixed with sand, silt and clay) and hydroxides. Water containing more than 3.5 ppm iron or manganese should probably not be used for drip irrigation. If the iron level is between 1.5 and 3.5 ppm, the pH should be below 6.5 in order to avoid iron deposits.

LI — LANGELIER INDEX (Corrosivity) - The corrosiveness of water, expressed as Langelier Index, is a function of alkalinity, calcium concentration, EC, water temperature and pH. The Index values normally range from -0.5 to +0.8. A negative value indicates corrosive water; a positive value indicates a tendency to precipitate calcium carbonate ($CaCO_3$).

pH — Degee of ACIDITY or ALKALINITY - Normal range for western irrigation waters is from pH 6.5 to 8.4.

SUMMARY

PROBLEM	DEGREE OF PROBLEM		
	None	Increasing	Severe
Salinity:			
EC, mmhos/cm	0.75	0.75 - 3.0	3.0
Permeability:			
Caused by low salt: EC, mmhos/cm	>0.5	<0.5	---
Caused by sodium: SAR_{adj}	6	6 - 9	9
Toxicity, from root absorption:			
Sodium, SAR_{adj}	3	3 - 9	9
Chloride, meq/1	4	4 - 10	10
Boron, ppm	0.5	0.5 - 2	2
Toxicity, from leaf absorption (sprinklers):			
Sodium, meq/1	3	3	
Chloride, meq/1	3	3	
Excess nutrient: Nitrate-nitrogen, ppm	5	5 - 30	30
"Whitewashing": Calcium or bicarbonate, meq/1, each	<1.5	>1.5	

To obtain interpretation for specific crops or objectives, please call Dellavalle Laboratory, Inc.

References: Water Quality for Irrigation, L. K. Stromberg; 1975 and 1980
Water Quality for Agriculture, F.A.O. 1976

Appendix G
Pump Replacement/Upgrade Documentation

SUBMERSIBLE MOTOR PERFORMANCE GUIDELINES FOR USE ON VARIABLE FREQUENCY DRIVES

The Hitachi motor has been used extensively with variable frequency drives. As with any modified application, there are considerations to evaluate when using an inverter, or Variable Frequency Drive (VFD), to operate a submersible motor. To ensure reliable operation, the following guidelines must be followed when using the Hitachi submersible motor with a VFD with the exception (see notes) of the 100 HP and 125 HP, 1800 RPM, 10" Hitachi.

1. **Proper, class 10, quick trip, overload protection must be used at all times.**
2. **A minimum of 3 times full load current should be available to initially start the motor at the maximum ramp-up time if needed.**
3. **Maximum Ramp-up Time: 1.0 seconds to reach 30 hz, 4.0 seconds to reach current limit and rated speed at 60 hertz.**
4. **Maximum Ramp down time: from minimum frequency to power shutoff shall be 4.0 seconds.**
5. **Minimum operating frequency/speed (after initial ramp-up) is:**
   a. **30 hertz or 1,700 rpm, whichever occurs first, for 6" and 8", 2 pole motors.**
   b. **42 hertz or 2,400 rpm, whichever occurs first, for 10" and larger 2 pole motors.**
   c. **42 hertz or 1,070 rpm, whichever occurs first, for 4 pole motors.**

NOTE: Minimum frequency for the 100-125 HP, 4 pole, 10" Hitachi is 55 Hz.

7. **Maximum Speed: 1.00 x Full Load Speed**
8. **At the minimum operating speed (see #4), one-half foot per second water velocity, at rated temperature must be maintained past the motor. Velocity in excess of 10 feet per second is not recommended without consultation.**
9. **The VFD must maintain a constant volts to Hertz ratio. The controls must be rated the same as motor nameplate.**
10. **The VFD carrier frequency must be set to the lowest frequency for the desired functions of the VFD. A carrier frequency above 4 kHz is not recommended. Contact factory for other desired carrier frequencies.**
11. **The output of the VFD must have a filtering or line conditioning device installed to eliminate voltage waveform phenomenon that might adversely affect motor components and elements. Power at the motor leads must be clean, free of high voltage transients, harmonics, and within the voltage range of the motor (1000V peak at more than .1 microsecond rise time)**
12. **All other requirements and restrictions for the Hitachi submersible motor apply (see F1 manual).**

These are general guidelines for the operation of the Hitachi submersible motor on AC Inverters incorporating IGBT type switching devices and starting from zero rotation with a limited, immediate, hydraulic load.

EATON PUMPS SALES & SERVICE
CONTRACTOR'S LICENSE #133783 C57 A C61/D21
10 W. KENTUCKY AVE. • WOODLAND, CA 95695
(530) 661-6737 • FAX (530) 661-6747

Eaton Pumps Construction and Project Costs
El Macero Country Club - EM3 New 75HP Sub Pump Est.

May 16, 2016
This Estimate prepared by:
Dan Morris

Item Number	Description	Amount	Unit Price	Total
	Construction Materials			
1.)	New 75Hp Hitachi Submersible 1800rpm Motor	1	$ 36,775.87	$ 36,775.87
2.)	New 13" 2 Stage Bowl, Design (1100 gpm @ 150' TDH)	1	$ 7,169.10	$ 7,169.10
3.)	New 10" x 20' Column Pipe	200	$ 52.28	$ 10,456.00
4.)	New Size #1/0 Submersible Drop Cable	210	$ 12.70	$ 2,667.00
5.)	Miscellaneous Splice Kits-Gaskets-Sealant	1	$ 363.64	$ 363.64
6.)	Miscellaneous Fuses-Time Clock -For Panel Modifications	1	$ 909.10	$ 909.10
7.)	Note: This is Based on Complete Column/Drop Electrical Cable	0	$ -	$ -
8.)	Replacement. Some Of The Equipment May Be Reusable After	0	$ -	$ -
9.)	Removal And Inspection.	0	$ -	$ -
Estimated Construction Material Costs (Items 1 through 9)				$ 58,340.71
			+7.75% Tax	$ 4,521.41
	Labor			
10.)	Labor to Remove And Install Pumping Equipment	20	$ 300.00	$ 6,000.00
11.)	Loading/Unloading Equipment And Materials	5	$ 115.00	$ 575.00
12.)	Labor To Modify Electrical Panel	5	$ 130.00	$ 650.00
Estimated Labor Costs (Items 10 through 12)				$ 7,225.00
	Equipment and Rentals			
13.)	Equipment	0	$ -	$ -
Estimated Equipment and Rental Costs (Items 13 through 13)				$ -
Total Project Costs (Items 1 through 13)(Tax included)				$ 70,087.12

All Material Costs Are Estimates And Subject To State And Local Taxes
Prices Subject To Change After 30 Days