CHAPTER 7 CHICO PLANT ATTACHMENTS

Attachment - CH_62173 1 Attachment 1_HPC and Oil Lube Pumps

Attachment - CH_62173 2 Attachment 2_ New Cost Estimate

Attachment – CH 64812 1 Hydec Quote

Attachment – CH 64812 2 Permit

Attachment - CH_20515 1_ zone 350 PHD vs. Capacity Graph.pdf

Attachment – 63844 Reference Article

Attachment- CH 16952 1

Attachment- CH 16952 2

Attachment- CH 16041 3

Attachment- CH 16860 4

Attachment- CH 16952 5

Attachment- CH 16936 1

Attachment- CH 16936 2

AOC Associated With Oils for Lubricating Well Pumps

Dawn R. White and Mark W. LeChevallier

Several types of oil for lubricating well pumps were examined to assess their relative contribution to assimilable organic carbon (AOC) in groundwater. The objective of the study was to determine whether the use of an oil-lubricated well-pump system could contribute to the growth of bacteria in water distribution systems. A modified van der Kooij procedure was used to test the AOC concentration in sterile tap-water samples before and after the addition of various types of pump-lubricating oil. The results showed that certain lubricating oils could release substantial levels of bacterial nutrients (AOC) into the water. The choice of lubricating oil could be related to bacterial growth problems in some systems.

Oil-lubricated line-shaft well pumps are widely used in potable water wells in the United States. Oil-lubricated systems may be recognized by the oil storage tank and the adjustable-rate drip feeder. Systems without such equipment usually have water-lubricated column bearings. The main purpose of lubrication is to separate the moving parts and thus reduce friction, carry off heat, dampen shock, and reduce wear.

The western region of the American Water System has 17 operating oil-lubricated wells. Five of these wells are located at the Paradise Valley Water Company in Arizona. Testing of these wells in 1987, before the installation of chlorinators, showed unusually high levels of heterotrophic plate count (HPC) bacteria (Table 1). All wells are approximately 1,500 ft deep and located beneath two layers of impervious rock. The wells are not affected by recharge or runoff. Given that the wells were protected, plus the very old age of the water, such high bacterial levels would not be expected.

In the California–American Water Company's Los Angeles Division, sampling showed that HPC levels in oil-lubricated wells were, on average, almost four times higher than in water-lubricated wells (HPC levels of 270 cfu/mL compared with 70 cfu/mL, respectively). For two wells across the street from one another, the oil-lubricated well had plate counts averaging 260 cfu/mL, whereas the water-lubricated well averaged 64 cfu/mL. Several of these wells have also been subject to intermittent occurrences of coliform bacteria.

The higher incidence of elevated HPC and coliform bacterial counts in the oil-lubricated wells prompted examination of the possibility that the oil may be contributing to bacterial growth. Talley and Alexander[1] have previously suggested that oil used to lubricate shaft bearings could, if it entered into the distribution system, support the growth of opportunistic bacteria. van der Kooij and Hijnen[2] have reported that lubricants used in some pipe joints could promote growth of coliform organisms.

Trace levels of assimilable organic carbon (AOC) are becoming widely recognized as important for stimulation of bacterial growth in distribution networks.[2,3] Along with temperature, rainfall, and disinfectant residual, the concentration of AOC in water is an important parameter in regulating growth in distribution system biofilms.[3] Limiting the amount of available nutrients may be a more effective means of controlling bacterial

TABLE 1
Heterotrophic plate counts at the Paradise Valley Water Company from March to July 1987

Oil-Lubricated Well	HPC Bacteria *cfu/mL**	
	Average	Range
Well 11	1,600	10–5,000
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Well 13	8,000	10–16,000
Well 14	8,200	1,200–27,000
Well 15	5,800	10–28,000
Average in Distribution System	4,700	

*HPC bacteria were enumerated on *Standard Methods* plate count agar incubated at 35°C for 48 h. Values represent plate counts collected once a month from March 1987 to July 1987.

TABLE 2
*Effect of oil on AOC levels in water**

Parameter	AOC of Water	Tap Water Amended With Acetate	AOC of Tap Water and Oil	AOC due to Oil
Negative control	<1			
Tap water	46 ± 7			
Tap water + 50 µg acetate/L		88 ± 12		
Tap water + oil 1			60 ± 18	14
Tap water + oil 2			38 ± 7	–8
Tap water + oil 3			1,933 ± 284	1,887
Tap water + oil 4			117 ± 9	71

*All values are expressed as micrograms AOC per litre ± standard deviation.

*Obtained from D. van der Kooij, KIWA, the Netherlands growth than increasing disinfectant concentrations. van der Kooij and Hijnen[2] have suggested that AOC levels <10 µg/L will limit the growth of HPC bacteria in unchlorinated water systems. AOC levels >50–100 µg/L have been associated with growth of coliform bacteria in chlorinated water systems.[3]

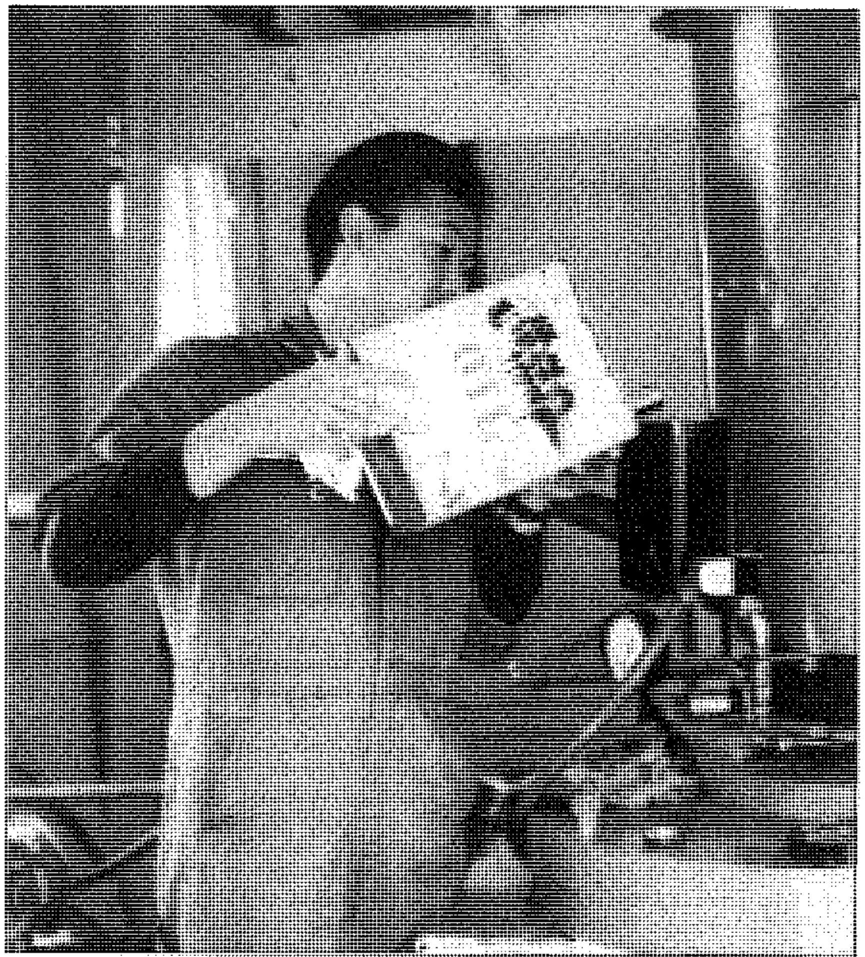
The objective of this project was to assess the effect of lubricating oil on the AOC content of well water. Several commonly used lubricating oils were examined to determine the appropriate choice for oil-lubricated wells.

Materials and methods

Glassware preparation. To remove all traces of growth-supporting compounds, glassware was washed in a 10 percent solution of potassium dichromate in concentrated sulfuric acid, rinsed in hot tap water followed by a rinse of 10 percent nitric acid solution, and then rinsed with hot tap water. Finally, glassware was baked overnight at 300°C. The only materials that were not acid-treated were the pipette tips used for making colony counts. The same type of sterilized pipette tips were used for both test and control bottles.

Inoculum. A culture of *Pseudomonas fluorescence*, strain P17,* was adapted to grow in tap water (low-nutrient conditions) by inoculating an isolated colony into sterile tap water containing 100 mg acetate carbon/L (sodium acetate), 1 mg nitrogen/L (ammonium chloride), and 1 mg potassium phosphate/L. Once the maximum concentration of organisms was reached, this solution was used to inoculate sterile tap water with no added nutrients. After incubation, the unamended tap water (containing adapted bacteria) was used as an inoculum in subsequent AOC assays.

Sample preparation. The tap water used for all samples was collected at one time and sterilized by autoclaving. Acid-washed 250-mL biochemical oxygen demand (BOD) bottles containing 100 mL of autoclaved tap water were inoculated with 1 mL of lubricating oil and 200–300 cfu/mL of the adapted *P. fluorescence* P17. The solution was mixed for 10 s using a vortexer. Four oil types,* as well as a growth control containing 50 µg/L additional acetate-carbon (sodium acetate), a blank containing sterilized tap water but no addition of carbon, and a negative control using AOC-free water† were tested. Three of the oil types chosen for this assay are being used by California–American Water Company's Monterey and Los Angeles divisions and by Paradise Valley Water Company. Oil 4, a totally synthetic lubricating oil, was chosen because it was being considered as a potential candidate for oil-lubricated wells. All of the oils are approved for use in food processing and in water and wastewater treatment plants.



Oil-lubricated well pumps are commonly used in the water industry, but certain lubricants could release bacterial nutrients into the water.

Analysis. All controls and samples were incubated statically at room temperature (22–23°C) until N_{max} (maximum cell concentration) was reached. The concentration of organisms in each culture was determined by performing triplicate plate counts from the first day after inoculation until the fifth day. Plate counts were performed using the spread plate method on R_2A agar. The plates were incubated at room temperature for about five days or until colonies were clearly visible. The plate count results for each test culture can be plotted against time and the N_{max} can be determined easily as the high point on the growth curve. The maximum growth for each sample and standard was expressed as colony forming units per litre and divided by the empirically derived yield factor of 4.1×10^6 cfu/µg of acetate carbon (AOC) to produce results in micrograms AOC per litre.[4]

Statistics. Statistical comparisons were performed by the unpaired *t*-test using a statistics program.‡

Results

The results of the oil-amended tap-water samples along with the negative, blank, and growth controls are shown in Table 2. The negative control (AOC-free water) contained less than 1 µg/L AOC, indicating insignificant nutrient contamination from glassware or pipette tips. The average AOC concentration in the unamended tap water (blank sample) was 46±7 µg/L. When 50 µg/L of acetate carbon was added to the tap water, an AOC value of 88±12 µg/L was obtained. The difference between the unamended-tap and acetate-amended water was 42 µg/L, not statistically significant (p = 0.137) from the expected value of 50 µg/L.

Addition of the lubricating oil was shown to have a significant effect on AOC levels in certain circumstances. Oils 1 and 2 had a statistically insignificant effect on AOC levels (p ranged between 0.342 and 0.15). Oils 3 and 4, however, did significantly contribute to the AOC of the tap water (p = <0.001 and 0.002, respectively). Oil 4 added an average of 71 µg AOC/L to the tap water. For oil 3, AOC

*Oil 1—Chevron GST68; oil 2—Texaco Regal R&O 46; oil 3—Chevron FM32X; oil 4—Husky 15A14 (Husk-itt Corp, Signal Hill, Calif.)
†HPLC-grade water, J.T. Baker Co., Phillipsburg, N.J.
‡Stat-Pac, Northwest Analytical, Portland, Ore.

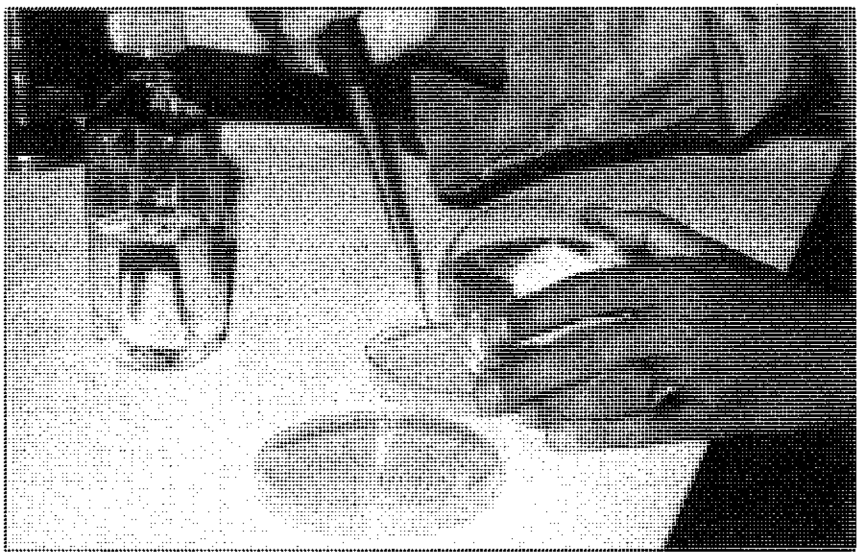


Plate counts showed that levels of heterotrophic bacteria were higher in oil-lubricated well pumps than they were in water-lubricated well pumps.

levels were increased an average of 1,887 μg AOC/L, more than 40 times higher than the background level.

Discussion

Given the growing concern about ever more stringent microbiological drinking water standards, all materials in contact with drinking water need to be examined for their potential to stimulate bacterial regrowth. The results of this study show that certain pump-lubricating oils can, under laboratory conditions, contribute AOC to the water. Not all of the oils available on the market were tested, and to truly evaluate the total effect of these oils on distribution system water, it would be necessary to determine the exact fate of the oil throughout the pipe network. The results do show, on a comparative basis, that certain oils may be better suited for use in drinking water systems.

In an oil-lubricated well, oil is typically added on a continuous basis and accumulates on top of the water column. Although there is obviously some contact between oil and water, this was historically thought to be minimal. During periods of nonuse, however, enough contact may exist to produce initial discharges with elevated concentrations of AOC. Because oil is added continuously, over the years it would be expected that oil levels would accumulate to a great height. For example, approximately 130 L of oil were used in 1990 to lubricate a single pump in the California–American Water Company's Los Angeles Division. This amount would, in one year, create a 7-ft column of oil. When last serviced, only 10 ft of oil was found, despite the fact that the oil had been added for the previous seven years. The conclusion is that some of the oil does mix with water and enters the distribution system. In this case, approximately 730 L of oil has entered the system from one well during the past seven years. Although the volume of oil compared with the volume of water leaving the well is small (estimated at 1–2 μL/L), it could have a significant effect, particularly if it accumulated in sections of the distribution system.

Although all the oils tested were labeled as "food-grade" and approved for use in food-processing and water and wastewater plants, experience has shown that some oil-lubricated wells can experience high HPC bacteria and sporadic coliform counts. Oil 3, for example, had previously been used in the Paradise Valley Water Company wells (Table 1). Some manufacturers even advertise the biodegradability of their product as an advantage. Given that high HPC counts can lead to violations of the maximum contaminant level specified in the Total Coliform Rule, it is recommended that certain precautions be taken by systems served by oil-lubricated wells to limit the effect of the oil on distribution system water quality.

- Select a food-grade lubricating oil with minimal effect on AOC. If manufacturers cannot provide this information, the utility can perform the test outlined in the "Materials and methods" section.
- Monitor the oil consumption of each well. Inspect and service wells with unusually high consumption levels.
- When possible, operate oil-lubricated wells constantly to prevent high levels of AOC from entering the distribution system. It is thought that repeated startups may help mix the oil into the water column. Future research should evaluate the optimum operation to limit passage of oil into the distribution system.
- An aggressive and systematic flushing program should be scheduled to eliminate accumulated oil in the distribution system. Reservoirs and storage tanks should be inspected for oil films.
- Routine microbiological and chemical monitoring of each well can spot problem situations before contamination of the distribution system. Future research should evaluate the effect of oil droplets on disinfection efficiency.

In some situations it may be advisable to change from oil lubrication to water lubrication whenever a pump needs to be replaced. This may not be applicable in all situations, however. Use of a water-lubricated system for deep thermal wells, for example, would shorten equipment life. Knowing that differences exist between oils allows the alternative solution of changing oil types to minimize the effect on water quality. Most important is the awareness that substances used in day-to-day operations can affect water quality.

Acknowledgment

The authors acknowledge the support of Andrew A. Krueger, manager of California–American Water Company, as well as assistance from California–American's production department personnel. The authors thank James McVeigh, water quality director, American Water Works Service Co. Inc. This study was funded by the California–American Water Company.

References

1. TALLEY, M.W. & ALEXANDER, M.R. Preventing Potential Health Threats of Stagnation in Potable Internal Distribution Systems. Proc. 1989 AWWA Ann. Conf., Los Angeles, Calif.
2. VAN DER KOOIJ, D. & HIJNEN, W.A.M. Measuring the Concentration of Easily Assimilable Organic Carbon in Water Treatment as a Tool for Limiting Regrowth of Bacteria in Distribution Systems. Proc. 1985 WQTC, Houston, Texas.
3. LECHEVALLIER, M.W.; SCHULTZ, W.; & LEE, R.G. Bacterial Nutrients in Drinking Water. *Appl. & Environ. Microbiol.*, 57:3:857 (1991).
4. VAN DER KOOIJ, D.; VISSER, A.; & HIJNEN, W.A.M. Determining the Concentration of Easily Assimilable Organic Carbon in Drinking Water. *Jour. AWWA*, 74:10:540 (Oct. 1982).

About the authors: *Dawn White is the water quality supervisor for the California–American Water Company, Los Angeles Division. A member of AWWA, she originally presented this work at the 1991 Annual Conference and Exposition. Mark W. LeChevallier* is the assistant director for research, American Water Works Service Co. Inc., 1025 Laurel Oak Rd., Voorhees, NJ 08043.*

*To whom correspondence should be addressed

CH 62173 2

Work Order Estimates

Work Order: 00062173
Company: California Water Service Comp
Revision: 1

CH20-01

Additions

3240 - PUMPING EQUIPMENT [270]

Equip Number: Est In-Service: 12/31/2015

Est Chg Type	Business Segment	Sub. Acct.	Property Group	Asset Location	Unit Description	Quantity	Amount	
Contractor Cost	Water - Regulated	3240	PUMPS	STA. 020-01-BRYANT N/O VALLOMBROSA <CHICO>	~~Miscellaneous pumping parts/equipment~~	1.00	~~$8,000.00~~	
Contractor Cost	Water - Regulated	3240	PUMPS	STA. 020-01-BRYANT N/O VALLOMBROSA <CHICO>	60 HP VHS Motor	1.00	$8,000.00	
Contractor Cost	Water - Regulated	3240	PUMPS	STA. 020-01-BRYANT N/O VALLOMBROSA <CHICO>	~~Deep-well turbine pump~~	1.00	~~$13,000.00~~	
Contractor Cost	Water - Regulated	3240	PUMPS	STA. 020-01-BRYANT N/O VALLOMBROSA <CHICO>	W/L Column assembly PULL/INSTALL	1.00	~~$22,000.00~~	$12,800 5,000
Labor	Water - Regulated	3240	PUMPS	STA. 020-01-BRYANT N/O VALLOMBROSA <CHICO>	EMT and ENGR time and labor	1.00	$2,000.00	
Other	Water - Regulated	3240	PUMPS	STA. 020-01-BRYANT N/O VALLOMBROSA <CHICO>	10% Contingency	1.00	~~$5,300.00~~	$2,280
Other	Water - Regulated	3240	PUMPS	STA. 020-01-BRYANT N/O VALLOMBROSA <CHICO>	12% Escalation	1.00	~~$6,996.00~~	2,736
Other	Water - Regulated	3240	PUMPS	STA. 020-01-BRYANT N/O VALLOMBROSA <CHICO>	6% Cap Interest	1.00	~~$3,917.76~~	$1,368
Overhead	Water - Regulated	3240	PUMPS	STA. 020-01-BRYANT N/O VALLOMBROSA <CHICO>		0.00	~~$13,842.75~~	4,836
					Total Act/Ret	8.00	~~$83,056.51~~	
					Total Additions	8.00	~~$83,056.51~~	37,020

Retirements

3240 - PUMPING EQUIPMENT [270]

Equip Number: Est In-Service: 12/31/2015

Est Chg Type	Business Segment	Sub. Acct.	Property Group	Asset Location	Unit Description	Quantity	Amount	
Contractor Cost	Water - Regulated	3240	PUMPS	STA. 020-01-BRYANT N/O VALLOMBROSA <CHICO>	~~Pump and~~ Column	1.00	~~$2,500.00~~	$1500
Contractor Cost	Water - Regulated	3240	PUMPS	STA. 020-01-BRYANT N/O VALLOMBROSA <CHICO>	60 HP VHS motor	1.00	$1,000.00	
Overhead	Water - Regulated	3240	PUMPS	STA. 020-01-BRYANT N/O VALLOMBROSA <CHICO>		0.00	$700.00	
					Total Act/Ret	2.00	~~$4,200.00~~	
					Total Retirements	2.00	~~$4,200.00~~	3,200
					Work Order Total	10.00	~~$87,256.51~~	$40,220

556

03/27/2013, 14:57:39

From:	Paul Gasta
To:	Francis, Maurice
Subject:	Re: Need a New Quote - Budgetary
Date:	Wednesday, March 06, 2013 2:46:11 PM
Attachments:	030613 CHICO VA.pdf

Attached per your request. Sales tax is approximately $350.00, freight estimate is $225.00.

Paul Gasta

From: Francis, Maurice
Sent: Wednesday, March 06, 2013 1:47 PM
To: paulg@covad.net
Subject: RE: Need a New Quote - Budgetary

Hi Paul,

This is for budgetary purposes. Can you please submit a revised quote for same unit, to be installed in Chico, CA though.

Please include estimated taxes and shipping cost as well.

Thanks.

Maurice S. Francis
Engineering Dept. | California Water Service Company
1720 North First Street | San Jose | CA 95112-4598
Tel: (408) 367-8246 | Fax: (408) 367-8427
✉ mailto:calwater.comemfrancis@calwater.com

Think before you print Always Recycle.

HyDEC CORP., 6450 TRINITY CT., DUBLIN, CA. 94568 PH.925-803-4646, FX 925-829-5264

HyDEC CORPORATION QUOTATION

Date: 3/6/2013
Job Name: CHICO REDUCING VALVE
Job Number: 030613 CHICO

Company: CALIFORNIA WATER SERVICE CO.
Location: SAN JOSE, CA.
Attn: MAURICE FRANCIS

WRITTEN SPECIFICATIONS SUPPLIED WERE NOT SPECIFIC. MATERIAL REQUIREMENTS SHOULD BE CONFIRMED BEFORE ORDERING

FX #:

TERMS	EARLIEST SHIP	FOB	SHIP VIA	SALESPERSON
NET 30 DAYS		NEWPORT BEACH, CA.	TO BE DETERMINED	PAUL GASTA

ITEM NO.	QTY	DESCRIPTION	UNIT	NET PRICE EACH	TOTAL NET PRICE
1	1	6" #92G-01BCKCX. DI BODY, SS INTERNAL TRIM, CLASS 150 FLGD., FUSION EPOXY L&C, 20-200 CRL, 30-300 CRD, W/X105 LCW, X=SS CAP SCREWS.	EA	$3,846.96	$3,846.96
				Subtotal	**$3,846.96**
				Freight	
		Tax rate: ________			**$0.00**
				Total	**$3,846.96**

PRODUCTS AND QUANTITIES SHOWN ABOVE ARE FOR ESTIMATING PURPOSES ONLY. NO GUARANTEE IS MADE AS TO THE ACCURACY OF QUANTITY OR THE INTERPRETATION OF SPECIFICATION. ALL ABOVE PRICES ARE NET EACH. QUOTATION EFFECTIVE 30 DAYS FROM ABOVE DATE. **PRICE DOES NOT INCLUDE START UP SERVICES CALL FOR QUOTE**

CALIFORNIA WATER SERVICE COMPANY
1720 NORTH FIRST STREET • SAN JOSE, CA 95112-4598
(408) 367-8200

February 3, 2012

Jerry Kotysan
Plan Check Engineer
City of Chico Building and Development Services
411 Main Street
Chico, CA 95927

SUBJECT: Chico Station 81- Site Development for 1.5 MG Storage Tank (Phase II)

Dear Mr. Kotysan;

Attached, please find three sets of above submittal package for your required review and approval.

The project includes the addition of a new 1.5 million gallon welded steel storage tank, a booster pump facility, an electrical panel board, a 5,000 gallon pressure tank, proposed landscaping and site grading works per AR-10 Chico Municipal Code criteria and AB 1881 water efficiency requirements. All documentation and plans have been saved in PDF format (see enclosed CD).

Dwg No:	Description
CH - 5212 R5	Site Plan
CH - 5213 R3	Piping Plan (4 Shts)
CH - 5219 R3	Plot Plan & Elevation
CH - 5253 R2	Grading Plan
CH - 5281 R1	Single Line Diagram
CH - 5282	Electrical Schematic
CH - 5283	RTU Wiring
CH - 5284	Outdoor Panelboard
CH - 5285	Conduit & Hydraulic Layout
CH - 5286	Hydenc
CH - 5288	Panelboard Foundation
CH - 5290	Pressure Tank Foundation

CW-876R8 Stilling Well & Air Control Installation for Pressure Tank
CWS-990 Cal Water Standard Electrical
CW-863R5 & CWDWGS (2 shts) Cal Water Standard Specifications

Construction is tentatively scheduled to commence in mid March 2012. The new storage tank is expected to go in service by end of August 2012.

For additional information, please contact Maurice Francis at (408) 367-8246.
Thank you for your assistance in completing this important project.

Sincerely,

Erin McCauley, P.E.
Manager of Design

Cc: Greg Redeker - City of Chico Planning Services
Michael Mares - Construction Superintendent
Michael Pembroke - District Manager

CALIFORNIA WATER SERVICE COMPANY
1720 NORTH FIRST STREET • SAN JOSE, CA 95112-4598
(408) 367-8200

May 18, 2011

Jerry Kotysan
Plan Check Engineer
City of Chico Building and Development Services
411 Main Street
Chico, CA 95927

SUBJECT: Chico Station 81 - New 1.5 Million Gallon Storage Tank (2nd Resubmittal)

Dear Mr. Kotysan;

Attached, please find our re-submittal package for your required review and approval.

Comments received from 1st Resubmittal review for architectural, planning, building and fire division have been incorporated (copy attached).

As requested, please find three sets of revised drawing plans (wet stamped and signed). No revisions were made to earlier submitted documents for tank foundation calculations, storage tank shop drawings or geotechnical soils report.

All documentation and revised plans have been saved in PDF format (see enclosed 2 CD's).

Dwg No:	Description
CH 5212 R3	Site Plan
CH 5213	Piping Plan (4 sheets)
CH 5219 R2	Plot Plan & Elevation
CH 5253	Grading Plan
CH 5281	Single Line Diagram
CH 5288	Panelboard Foundation (to be submitted at a later date)
CH 5289	Generator Foundation (to be submitted at a later date)
CH 5290	Pressure Tank Foundation (to be submitted at a later date)

Per Planning Division Plan Check comment - item 2. A landscaping plan will be submitted as a supplementary plan check item within 90 days after issuance of tank building permit. The landscaping plan to comply with Chico Municipal Code criteria and AB 1881 water efficiency requirements.

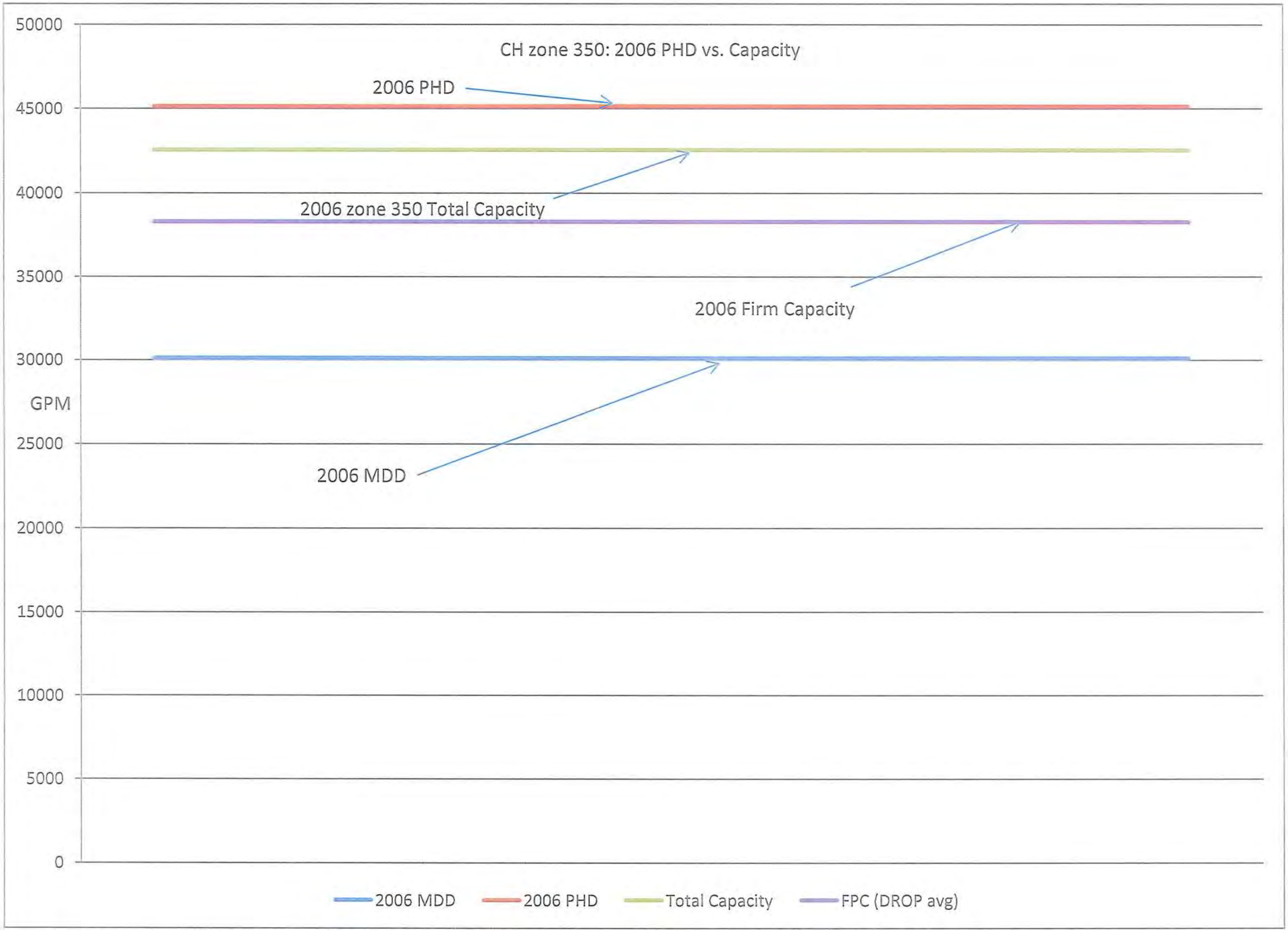
For additional information, please contact Maurice Francis at (408) 367-8246.
Thank you for your assistance in completing this important project.

Sincerely,

Erin McCauley, P.E.
Manager of Design

Cc: Michael Pembroke - District Manager

CH 20515 1



CH zone 350: 2006 PHD vs. Capacity
2006 PHD
2006 zone 350 Total Capacity
2006 Firm Capacity
2006 MDD
GPM
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
2006 MDD
2006 PHD
Total Capacity
FPC (DROP avg)

AOC Associated With Oils for Lubricating Well Pumps

Dawn R. White and Mark W. LeChevallier

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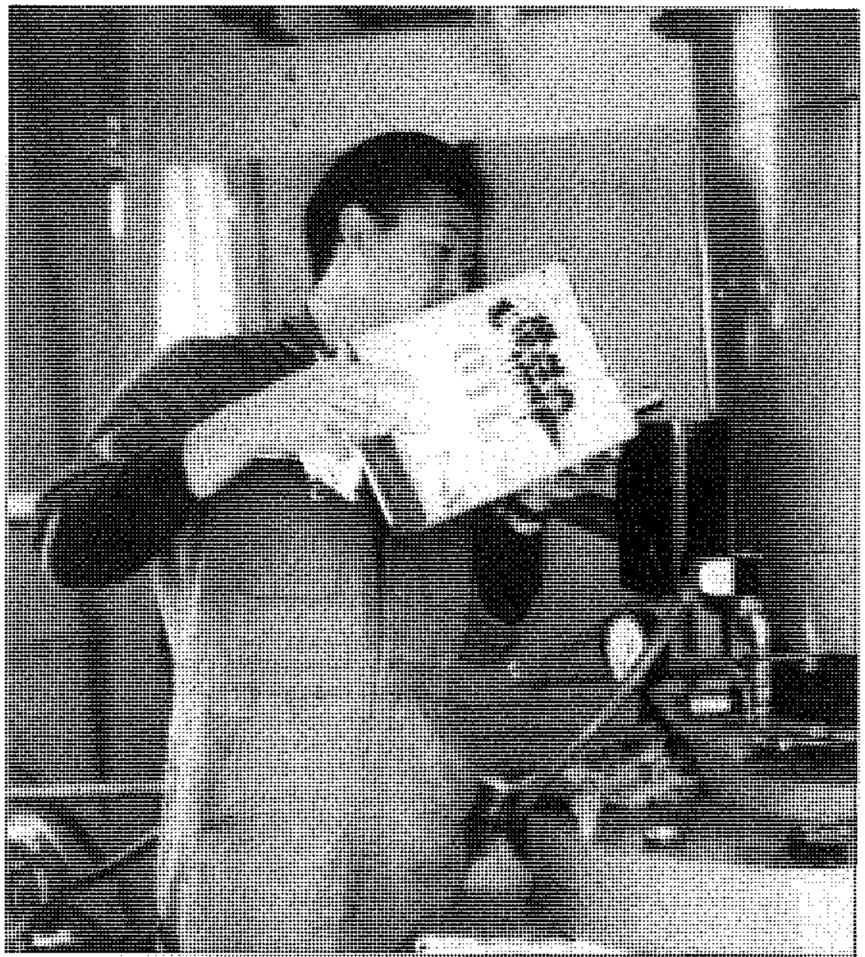
*Obtained from D. van der Kooij, KIWA, the Netherlands growth than increasing disinfectant concentrations. van der Kooij and Hijnen[2] have suggested that AOC levels <10 µg/L will limit the growth of HPC bacteria in unchlorinated water systems. AOC levels >50–100 µg/L have been associated with growth of coliform bacteria in chlorinated water systems.[3]

The objective of this project was to assess the effect of lubricating oil on the AOC content of well water. Several commonly used lubricating oils were examined to determine the appropriate choice for oil-lubricated wells.



Oil-lubricated well pumps are commonly used in the water industry, but certain lubricants could release bacterial nutrients into the water.

Materials and methods

Glassware preparation. To remove all traces of growth-supporting compounds, glassware was washed in a 10 percent solution of potassium dichromate in concentrated sulfuric acid, rinsed in hot tap water followed by a rinse of 10 percent nitric acid solution, and then rinsed with hot tap water. Finally, glassware was baked overnight at 300°C. The only materials that were not acid-treated were the pipette tips used for making colony counts. The same type of sterilized pipette tips were used for both test and control bottles.

Inoculum. A culture of *Pseudomonas fluorescence*, strain P17,* was adapted to grow in tap water (low-nutrient conditions) by inoculating an isolated colony into sterile tap water containing 100 mg acetate carbon/L (sodium acetate), 1 mg nitrogen/L (ammonium chloride), and 1 mg potassium phosphate/L. Once the maximum concentration of organisms was reached, this solution was used to inoculate sterile tap water with no added nutrients. After incubation, the unamended tap water (containing adapted bacteria) was used as an inoculum in subsequent AOC assays.

Sample preparation. The tap water used for all samples was collected at one time and sterilized by autoclaving. Acid-washed 250-mL biochemical oxygen demand (BOD) bottles containing 100 mL of autoclaved tap water were inoculated with 1 mL of lubricating oil and 200–300 cfu/mL of the adapted *P. fluorescence* P17. The solution was mixed for 10 s using a vortexer. Four oil types,* as well as a growth control containing 50 µg/L additional acetate-carbon (sodium acetate), a blank containing sterilized tap water but no addition of carbon, and a negative control using AOC-free water† were tested. Three of the oil types chosen for this assay are being used by California–American Water Company's Monterey and Los Angeles divisions and by Paradise Valley Water Company. Oil 4, a totally synthetic lubricating oil, was chosen because it was being considered as a potential candidate for oil-lubricated wells. All of the oils are approved for use in food processing and in water and wastewater treatment plants.

Analysis. All controls and samples were incubated statically at room temperature (22–23°C) until N_{max} (maximum cell concentration) was reached. The concentration of organisms in each culture was determined by performing triplicate plate counts from the first day after inoculation until the fifth day. Plate counts were performed using the spread plate method on R_2A agar. The plates were incubated at room temperature for about five days or until colonies were clearly visible. The plate count results for each test culture can be plotted against time and the N_{max} can be determined easily as the high point on the growth curve. The maximum growth for each sample and standard was expressed as colony forming units per litre and divided by the empirically derived yield factor of 4.1×10^6 cfu/µg of acetate carbon (AOC) to produce results in micrograms AOC per litre.[4]

Statistics. Statistical comparisons were performed by the unpaired *t*-test using a statistics program.‡

Results

The results of the oil-amended tap-water samples along with the negative, blank, and growth controls are shown in Table 2. The negative control (AOC-free water) contained less than 1 µg/L AOC, indicating insignificant nutrient contamination from glassware or pipette tips. The average AOC concentration in the unamended tap water (blank sample) was 46±7 µg/L. When 50 µg/L of acetate carbon was added to the tap water, an AOC value of 88±12 µg/L was obtained. The difference between the unamended-tap and acetate-amended water was 42 µg/L, not statistically significant ($p = 0.137$) from the expected value of 50 µg/L.

Addition of the lubricating oil was shown to have a significant effect on AOC levels in certain circumstances. Oils 1 and 2 had a statistically insignificant effect on AOC levels (p ranged between 0.342 and 0.15). Oils 3 and 4, however, did significantly contribute to the AOC of the tap water (p = <0.001 and 0.002, respectively). Oil 4 added an average of 71 µg AOC/L to the tap water. For oil 3, AOC

*Oil 1—Chevron GST68; oil 2—Texaco Regal R&O 46; oil 3—Chevron FM32X; oil 4—Husky 15A14 (Husk-itt Corp, Signal Hill, Calif.)
†HPLC-grade water, J.T. Baker Co., Phillipsburg, N.J.
‡Stat-Pac, Northwest Analytical, Portland, Ore.

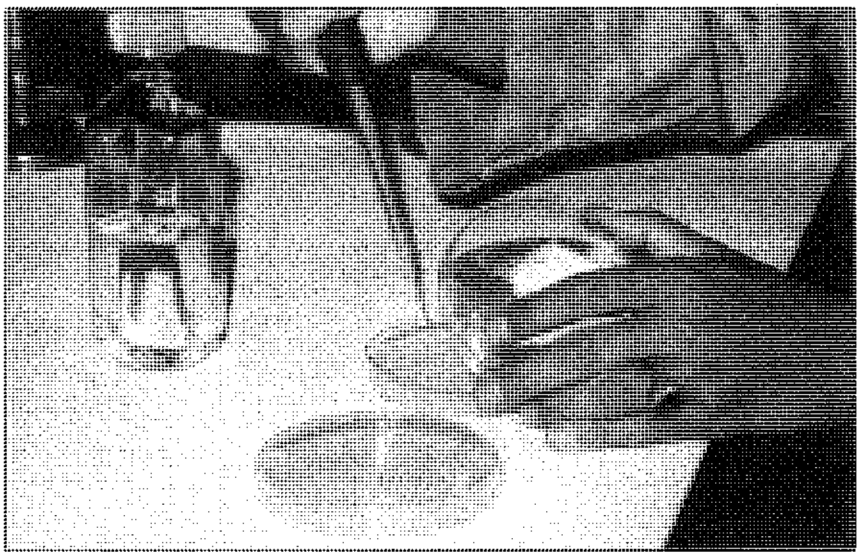


Plate counts showed that levels of heterotrophic bacteria were higher in oil-lubricated well pumps than they were in water-lubricated well pumps.

levels were increased an average of 1,887 μg AOC/L, more than 40 times higher than the background level.

Discussion

Given the growing concern about ever more stringent microbiological drinking water standards, all materials in contact with drinking water need to be examined for their potential to stimulate bacterial regrowth. The results of this study show that certain pump-lubricating oils can, under laboratory conditions, contribute AOC to the water. Not all of the oils available on the market were tested, and to truly evaluate the total effect of these oils on distribution system water, it would be necessary to determine the exact fate of the oil throughout the pipe network. The results do show, on a comparative basis, that certain oils may be better suited for use in drinking water systems.

In an oil-lubricated well, oil is typically added on a continuous basis and accumulates on top of the water column. Although there is obviously some contact between oil and water, this was historically thought to be minimal. During periods of nonuse, however, enough contact may exist to produce initial discharges with elevated concentrations of AOC. Because oil is added continuously, over the years it would be expected that oil levels would accumulate to a great height. For example, approximately 130 L of oil were used in 1990 to lubricate a single pump in the California–American Water Company's Los Angeles Division. This amount would, in one year, create a 7-ft column of oil. When last serviced, only 10 ft of oil was found, despite the fact that the oil had been added for the previous seven years. The conclusion is that some of the oil does mix with water and enters the distribution system. In this case, approximately 730 L of oil has entered the system from one well during the past seven years. Although the volume of oil compared with the volume of water leaving the well is small (estimated at 1–2 μL/L), it could have a significant effect, particularly if it accumulated in sections of the distribution system.

Although all the oils tested were labeled as "food-grade" and approved for use in food-processing and water and wastewater plants, experience has shown that some oil-lubricated wells can experience high HPC bacteria and sporadic coliform counts. Oil 3, for example, had previously been used in the Paradise Valley Water Company wells (Table 1). Some manufacturers even advertise the biodegradability of their product as an advantage. Given that high HPC counts can lead to violations of the maximum contaminant level specified in the Total Coliform Rule, it is recommended that certain precautions be taken by systems served by oil-lubricated wells to limit the effect of the oil on distribution system water quality.

- Select a food-grade lubricating oil with minimal effect on AOC. If manufacturers cannot provide this information, the utility can perform the test outlined in the "Materials and methods" section.
- Monitor the oil consumption of each well. Inspect and service wells with unusually high consumption levels.
- When possible, operate oil-lubricated wells constantly to prevent high levels of AOC from entering the distribution system. It is thought that repeated startups may help mix the oil into the water column. Future research should evaluate the optimum operation to limit passage of oil into the distribution system.
- An aggressive and systematic flushing program should be scheduled to eliminate accumulated oil in the distribution system. Reservoirs and storage tanks should be inspected for oil films.
- Routine microbiological and chemical monitoring of each well can spot problem situations before contamination of the distribution system. Future research should evaluate the effect of oil droplets on disinfection efficiency.

In some situations it may be advisable to change from oil lubrication to water lubrication whenever a pump needs to be replaced. This may not be applicable in all situations, however. Use of a water-lubricated system for deep thermal wells, for example, would shorten equipment life. Knowing that differences exist between oils allows the alternative solution of changing oil types to minimize the effect on water quality. Most important is the awareness that substances used in day-to-day operations can affect water quality.

Acknowledgment

The authors acknowledge the support of Andrew A. Krueger, manager of California–American Water Company, as well as assistance from California–American's production department personnel. The authors thank James McVeigh, water quality director, American Water Works Service Co. Inc. This study was funded by the California–American Water Company.

References

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2. van der Kooij, D. & Hijnen, W.A.M. Measuring the Concentration of Easily Assimilable Organic Carbon in Water Treatment as a Tool for Limiting Regrowth of Bacteria in Distribution Systems. Proc. 1985 WQTC, Houston, Texas.
3. LeChevallier, M.W.; Schultz, W.; & Lee, R.G. Bacterial Nutrients in Drinking Water. *Appl. & Environ. Microbiol.*, 57:3:857 (1991).
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CH 16952 1 (Phase III)

Sum of amount	year			
vendor_information	2010	2011	2012	2013
ARCADIS U.S. INC			$ 5,601.40	
MCQUEEN ENVIRONMENTAL CONSULTING		$ 3,971.63		
NOBEL SYSTEMS, INC.		$ 339.30		
NORTHERN CALIFORNIA FENCE				$ 10,840.00
PACIFIC GAS & ELECTRIC CO.		$ 2,000.00	$ 18,798.07	
TESCO CONTROLS, INC.			$ 53,500.00	
WEST VALLEY CONSTRUCTION CO., INC.		$ 259,654.90	$ 40,943.89	$ 23,950.78
(blank)	$ 108.38	$ 113,833.80	$ 202,303.43	$ 17,605.91
Grand Total	**$ 108.38**	**$ 379,799.63**	**$ 321,146.79**	**$ 52,396.69**

CH 16952 1 (Phase III)

Grand Total
$ 5,601.40
$ 3,971.63
$ 339.30
$ 10,840.00
$ 20,798.07
$ 53,500.00
$ 324,549.57
$ 333,851.52
$ 753,451.49

CH 16952 2 (Phase III)

		Assume - 5%
CAPINT: Capitalized Interest	$ 43,608.19	$2,180.41
CONSTOH: Construction Overhead	$ 110,350.57	$5,517.53
CONTRACT: Contractor Costs	$ 419,599.97	
LABOR: Labor Cost	$ 83,195.85	$4,159.79
OTHER: Other Cost	$ 6,849.35	$342.47
PAYTAX: Payroll Taxes and Insurance	$ 89,847.56	$4,492.38
		$16,692.58

CH 16041 3 (Phase I)

PERMITTING	Qty	2007 Estimate	
CEQA Compliance		$20,000.00	
Building Permit			
Conditional Use Permit			
Air Permit			
			$20,000.00
CONSULTANT			
Environmental	1	$22,010.00	
Structural	1	$6,000.00	
Electrical	1	$7,000.00	
			$35,010.00
LABOR			
Project Design - Eng	200	$13,792.00	
Drafting	200	$10,874.00	
WQ-Env Mgr/Supv	100	$6,896.00	
Field Labor	100	$4,320.00	
Field Mgr/Supv	82	$4,922.46	
			$40,804.46
OTHER			
5% Price Escalation	1	$4,790.00	
Contingency	1	$9,580.73	
Construction Overhead	1	$8,814.82	
			$23,185.55
	TOTAL	**$119,000.01**	**$119,000.01**

CH 16041 3 (Phase I)

	4/12/2013	
	ACTUAL	
PERMITTING		
PAUL, HASTINGS, JANOFSKY & WALKER LLP	$ 5,896.28	
Surveying - NORTH STAR ENGINEERING	$ 40,887.25	
		$46,783.53
LABOR: Labor Cost	$ 17,742.97	
		$17,742.97
OTHER: Other Cost	$ 1,300.29	
NELSON LUI	$ 130.61	
REKHA IPPAGUNTA	$ 68.20	
WEST VALLEY CONSTRUCTION CO. INC	$ 1,856.75	
		$ 3,355.85
CAPINT: Capitalized Interest	$ 14,726.48	
CONSTOH: Construction Overhead	$ 11,822.78	
PAYTAX: Payroll Taxes and Insurance	$ 16,706.48	
		$43,255.74
	$111,138.09	**$111,138.09**

CH 16860 4 (Phase II)

	Qty	2008 Estimate	
PERMITTING			
CEQA Compliance			
Building Permit			
Conditional Use Permit			
Air Permit			
			$0.00
CONSULTANT			
Environmental		$35,000.00	
Structural			
Electrical			
			$35,000.00
CONTRACTOR/VENDOR			
LABOR			
Project Design - Eng	150	$10,344.00	
Drafting			
Env Mgr/Supv	40	$2,401.20	
WQ Mgr/Supv	80	$4,802.40	
Field Labor			
Field Mgr/Supv	80	$4,802.40	
			$22,350.00
OTHER			
CWS 8 Well Head Construction	1	$110,000.00	
Carbon Absorbers	1	65000	
Traffic Controls	1	$20,000.00	
Control Panels	3	$18,000.00	
			$213,000.00
10% Price Escalation		$27,000.00	
10% Contingency		$27,001.85	
Construction Overhead		$25,948.15	
			$79,950.00
	TOTAL	**$350,300.00**	**$350,300.00**

CH 16860 4 (Phase II)

	4/12/2013	
	ACTUAL	
PERMITTING		
WEST VALLEY CONSTRUCTION CO. INC	$20,814.74	
		$20,814.74
LABOR: Labor Cost	$1,458.95	
		$1,458.95
CAPINT: Capitalized Interest	$3,473.08	
CONSTOH: Construction Overhead	$3,918.47	
PAYTAX: Payroll Taxes and Insurance	$1,474.63	
		$8,866.18
	$31,139.87	**$31,139.87**

CH 16952 5 (Phase III)

PERMITTING	Qty	2010 Estimate	
CONSULTANT			
CONTRACTOR/VENDOR			
2 in conveyance pipe	500	$30,000.00	
4 in conveyance pipe	3650	$292,000.00	
6 in conveyance pipe	2300	$287,500.00	
			$609,500.00
LABOR			
Project Design - Eng	35	$2,413.60	
Drafting			
Env Mgr/Supv			
WQ Mgr/Supv			
Field Labor			
Field Mgr/Supv			
			$2,413.60
OTHER			
Construction Management	1	$56,300.00	
			$56,300.00
10% Price Escalation	1	$54,008.62	
10% Contingency			
Construction Overhead	1	$72,222.22	
			$126,230.84
	TOTAL	**$794,444.44**	**$794,444.44**

CH 16952 5 (Phase III)

		4/12/2013	
		ACTUAL	
PERMITTING			
ARCADIS U.S. INC	$	5,601.40	
MCQUEEN ENVIRONMENTAL CONSULTING	$	3,971.63	
NOBEL SYSTEMS, INC.	$	339.30	
			$9,912.33
WEST VALLEY CONSTRUCTION CO., INC.	$	324,549.57	
NORTHERN CALIFORNIA FENCE	$	10,840.00	
			$335,389.57
LABOR: Labor Cost	$	83,195.85	
			$83,195.85
PACIFIC GAS & ELECTRIC CO.	$	20,798.07	
TESCO CONTROLS, INC.	$	53,500.00	
OTHER: Other Cost	$	6,849.35	
			$81,147.42
CONSTOH: Construction Overhead	$	110,350.57	
PAYTAX: Payroll Taxes and Insurance	$	89,847.56	
CAPINT: Capitalized Interest	$	43,608.19	
			$243,806.32
		$753,451.49	**$753,451.49**

CH 16936 1

	Acct	Description	ESTIMATED
PERMITTING	Acct	Description	
COUNTY OF BUTTE	3420	Building Permit	$3,000.00
CITY OF CHICO	3420	Building Permit	$3,000.00
	3420	Ceqa Compliance	$10,000.00
CONSULTANTS	3420	Ceqa Compliance	$10,000.00
NORTH STAR ENGINEERING	3420	Conditional Use Permit	$5,000.00
LIFESCAPES	3420	Conditional Use Permit	$5,000.00
SIERRA LANDSCAPE	3420	Consultant	$56,000.00
BROWN & MILLS, INC.	3420	Consultant	$56,000.00
GALLAWAY CONSULTING	3420	Geotech Inspection	$3,000.00
PACIFIC ENGINEERING GROUP	3420	Geotech Inspection	$3,000.00
	3420	Geotechnical Investigation	$7,500.00
	3420	Geotechnical Investigation	$7,500.00
	3420	Special Inspection	$3,000.00
	3420	Special Inspection	$3,000.00
	3240	Air Permit	$5,000.00
		PERMITTING	
	3420	Drafting	$6,524.40
	3420	Drafting	$7,360.80
	3420	Project Design - Eng	$19,308.80
CHAMBERS GROUP INC	3420	Project Design - Eng	$22,313.20
ARCADIS U.S. INC	3420	Env Mgr/Supv	$7,203.60
STEVEN ENGINEERING INC.	3420	Field Mgr/Supv	$7,203.60
	3420	Field Mgr/Supv	$7,863.60
VENDOR	3420	Field Mgr/Supv	$7,863.60
APPLIED TECHNOLOGY GROUP, INC.	3420	Field Labor	$5,184.00
	3420	Field Labor	$5,862.00
	3240	Drafting	$4,077.75
	3240	Project Design - Eng	$10,344.00
	3240	Project Design - Eng	$13,792.00
	3240	Field Mgr/Supv	$655.30
	3240	Field Mgr/Supv	$4,502.25
	3240	Field Labor	$1,728.00
	3240	Field Labor	$3,240.00
		DESIGN & LABOR	
CROSNO CONSTRUCTION INC.	3420	1.5 Mg Welded Steel Tank	$825,904.89
CLA-VAL, CO.	3420	1.5 Mg Welded Stell Tank	$825,904.89
CONTROL MICROSYSTEMS, INC.		**STORAGE TANK**	
	3420	18" Ebaa Iron	$11,000.00
ELECTRICAL DISTRIBUTORS CO	3420	18" Ebaa Iron	$11,000.00
CONSOLIDATED PARTS, INC.	3420	Install 18" Discharge Piping	$55,000.00
CONTROLCO	3420	Install 18" Discharge Piping	$55,000.00
MAPLE SYSTEMS, INC.	3420	Surge Tank - 10,000 Gal	$50,000.00
	3420	Misc. Materials	$14.82
EBAA IRON SALES, INC.	3420	Misc. Materials	$84.73
EMI OIL FILTRATION SYSTEMS, INC.	3240	Install Booster Pump	$169,958.36
INDUSTRIAL ELECTRIC MFG	3240	Booster Shelter	$30,800.00
MODERN CUSTOM FABRICATION, INC.	3240	Mag Meter	$7,000.00
COMMERCIAL PUMP AND MECHANICAL, INC.	3240	Misc. Materials	$56.33
POWERMETRICS INC	3240	Misc. Materials	$62.18
RPS INDUSTRIES		**PIPING**	

TESSCO, INC.
ROSEMOUNT, INC

CONTRACTOR
WEST VALLEY CONST

PG&E SERVICE

PACIFIC GAS & ELECTRIC CO.

CWS LABOR
ENGINEERING - CIVIL
ENGINEERING - ELECTRICAL
ENGINEERING DRAFTING
FIELD MGR/SUPV.
FIELD LABOR/EMT

CWS OVERHEAD
3% INFLATION
3% CAPITALIZED INTEREST
10% CONTINGENCY
CONSTRUCTION
EXPENSE
OTHER COSTS
PAYROLL TAX & INSURANCE
TAX & INSURANCE

3420	Electrical Conduit Connection	$10,000.00
3240	Conduit Trenching	$75,000.00
3240	Genset	$53,000.00
3240	Panel Board	$60,000.00
3240	Scada	$30,000.00
3240	Pg&E Service	$7,500.00
	ELECTRICAL	
3420	Site Concrete/Landcaping	$30,000.00
3420	Site Concrete/Landscaping	$20,000.00
3420	Fencing	$15,000.00
	SITE/LANDSCAPING	
3420	12% Price Escalation	$130,171.58
3420	Contingency @ 10%	$114,392.44
3420	Contingency @ 10%	$108,476.32
3420	Construction Escalation @ 6%	$68,635.46
3420		$260,227.27
3240	Contingency @ 10%	$23,283.47
3240	Contingency @ 10%	$25,430.51
3240	Construction Escalation @ 9%	$20,955.12
3240	Construction Escalation @ 9%	$22,887.46
3240		$56,927.27
	OVERHEAD	
		$3,488,700.00

CH 16936 1

			ACTUAL	
	PERMITTING			
	COUNTY OF BUTTE		$2,094.00	
	CITY OF CHICO		$7,923.00	
	PACIFIC GAS & ELECTRIC CO.		$21,692.31	
		TOTAL		**$31,709.31**
	STORAGE TANK & PIPING			
	NORTH STAR ENGINEERING		$11,412.50	
	LIFESCAPES		$4,864.00	
	SIERRA LANDSCAPE		$3,000.00	
	BROWN & MILLS, INC.		$6,869.45	
	GALLAWAY CONSULTING		$940.00	
	PACIFIC ENGINEERING GROUP		$1,000.00	
	CHAMBERS GROUP INC		$11,050.00	
	ARCADIS U.S. INC		$1,012.00	
	STEVEN ENGINEERING INC.		$837.44	
$180,000.00	CROSNO CONSTRUCTION INC.		$871,235.72	
	EBAA IRON SALES, INC.		$8,200.00	
	WEST VALLEY CONST		$718,687.77	
	CLA-VAL, CO.		$27,024.37	
	MODERN CUSTOM FABRICATION, INC.		$33,466.30	
	CWS LABOR		$63,501.89	
	CWS OVERHEAD		393187.98	
		TOTAL		**$2,156,289.42**
		REMAINING COST TO FINISH		$10,000.00
				$25,000.00
				$5,000.00
				$15,000.00
	PUMP EQUIPMENT & ELECTRICAL			
	COMMERCIAL PUMP AND MECHANICAL, INC.		$72,568.80	
	RPS INDUSTRIES		$23,821.30	
	APPLIED TECHNOLOGY GROUP, INC.		$1,194.22	
	CONTROL MICROSYSTEMS, INC.		$2,100.13	
	ELECTRICAL DISTRIBUTORS CO		$2,247.46	
	CONSOLIDATED PARTS, INC.		$1,086.36	
$135,026.90	CONTROLCO		$4,946.91	
	MAPLE SYSTEMS, INC.		$400.93	
	EMI OIL FILTRATION SYSTEMS, INC.		$12,136.18	
	INDUSTRIAL ELECTRIC MFG		$45,821.49	
$1,651,809.78	POWERMETRICS INC		$895.61	
	TESSCO, INC.		$371.40	
	ROSEMOUNT, INC		$7,982.86	
	CWS LABOR		$63,501.89	
	CWS OVERHEAD		252387.35	
	Others		$148.59	
		TOTAL		**$491,611.48**
		REMAINING COST TO FINISH		$30,000.00
				$15,000.00
				$5,000.00
				$15,000.00
				$20,000.00
$389,976.42			$2,679,610.21	$2,819,610.21

CH 16936 1

$235,500.00

$65,000.00

$831,386.90

$3,488,700.00

10/19/2012
REMARKS

Permitting	
Permitting	
New Service	
Cons - Surveyor	
Cons - Landscaping	
Cons - Landscaping	
Cons - Geotechnical	
Cons - Environmental	
Cons - Structural	
Cons - Environmental	
Cons - WQ Proj Management	
Cons - Environmental	
Storage Tank (PH I)	
Seismic	
Contractor (PH II)	
Control valve	
Pressure Tank	
Tank Disinfection & CWS Labor	
Landscaping	
CWS Labor	
CWS Overhead	$55,000.00
Booster Pumps	
Pump Shelter	
Electrical	
Electrical	
Electrical	
Electrical	
Electrical	
Electrical	
Electrical	
Electrical	
Electrical	
Electrical	
Electrical	
W/Valley	
PG&E Permit	
CWS Labor	
CWS Overhead	
Contingency	$85,000.00

CH 16936 1

$140,000.00	Difference

Reason for cost overrun

PID 16936
District: Chico
Preparer: Maurice S Francis
Original cost: $3,488,700
Estimated Projected cost: $2,819,461.62
Budget Year: 2009

Note: Explanation for first 1.5 MG storage tank completion. Plans to add the 2nd storage tank maybe deferred indefinitely due to current economy.

Description	Amount	Actual
Permitting	$ 180,000.00	$ 31,709.31
Design & Labor	$ 135,026.90	$ 259,123.98
Storage Tank	$1,651,809.78	$ 847,735.35
Piping	$ 389,976.42	$ 851,863.83
Electrical	$ 235,500.00	$ 175,573.65
Site & Landscaping	$ 65.000.00	$
Capitalized Interest	$	$ 99,335.64
Overhead	$ 831,386.90	$ 414,119.49
Others	$	$ 148.59
Remaining cost to finish		
Storage Tank		$ 55,000.00
Electrical		$ 85,000.00
Total	$3,488,700.00	$2,819,610.21

Although the initial budget was for two storage tanks, the charges incurred to-date is for the first one. The actual cost of the project was significantly more due to unforeseen site conditions that were not known at the time of the original estimate. Specifically, additional piping and depth were required to tie in the piping to the new station, and large amounts of earthwork were needed to remove the spoils from the first tank foundation. These changes led to much higher costs for labor, permitting compliance, design and project management. Additionally, the original estimate did not include capitalized interest which has a current charge of $99,335.64.

The additional cost for piping was $461,887.41. A longer and larger pipe diameter was installed to tie-in storage tank piping to existing pipelines on Silver Dollar Way and Dr. Martin Luther King Jr Parkway respectively. This was done to achieve better circulation to avoid stagnant water accumulation in the distribution pipeline serving the area. Additional depth was needed to install the longer pipeline.

The estimated remaining cost to complete the project is $140,000, bringing the final project cost to $2,819,610.21. This additional cost will be used for landscaping, and for completing the additional PG&E design/construction cost for the new service. Some site grading and tank disinfecting work, including laboratory cost for water sampling analysis is also anticipated prior to final project completion.

All other cost elements have been installed and the tank is expected to be in service by the end of 2012.