Pacific Gas and Electric Company

Curt Russell
Topock Onsite Project Manager
Environmental Affairs

Topock Compressor Station
145453 National Trails Hwy
Needles, CA 92363

Mailing Address
P.O. Box 337
Needles, CA 92363

760.326.5582
Fax: 760.326.5542
Email: gcr4@pge.com

April 14, 2006

Mr. Norman Shopay
Project Manager
California Department of Toxic Substances Control
Geology and Corrective Action Branch
700 Heinz Avenue
Berkeley, CA 94710

Subject: *Interim Measures No. 3 Treatment and Extraction System Operation and Maintenance Plan, Revision 01, April 2006,* Pacific Gas and Electric Company, Topock Project

Dear Mr. Shopay:

This letter transmits the *Interim Measures No. 3 Treatment and Extraction System Operation and Maintenance (O&M) Plan, Revision 1,* for the Pacific Gas and Electric Company (PG&E) Topock site. The O&M Plan was originally submitted to the California Department of Toxic Substances Control (DTSC) on April 11, 2005.

This revision of the O&M Plan was prepared in compliance with Condition 6 in the January 26, 2006 DTSC letter providing conditional approval to commence start-up of extraction well PE-1. The revisions to O&M Plan reflect current operating conditions as well as the addition of extraction wells PE-1 and TW-3D.

If you have any questions, please do not hesitate to contact me. I can be reached at 760-326-5582.

Sincerely,

Matt Johns for Curt Russell

Curt Russell
Topock Onsite Project Manager

cc: Ning-Wu Chang/DTSC
Yvonne Meeks/PG&E

Interim Measures No. 3 Treatment and Extraction System Operation and Maintenance Plan

Rev. 1

Topock Compressor Station Needles, California

Prepared for

Department of Toxic Substances Control

On behalf of

Pacific Gas and Electric Company

April 2006

CH2MHILL

155 Grand Avenue, Suite 1000
Oakland, CA 94612

Interim Measures No. 3 Treatment and Extraction System Operation and Maintenance Plan

Rev. 1

Topock Compressor Station
Needles, California

April 2006

Prepared for

Department of Toxic Substances Control

On behalf of

Pacific Gas and Electric Company

Prepared by

CH2M HILL
155 Grand Avenue, Suite 1000
Oakland, California 94612

This document was prepared by CH2M HILL under the supervision of:

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS W. LANDFEAR
No. C 66545
EXP. 6/30/06
CIVIL
STATE OF CALIFORNIA

Douglas Landfear, P.E.
California Registered Civil Engineer
License No. C 66545

Contents

Tables

Figures

Appendices

Acronyms and Abbreviations

CCR	California Code of Regulations
Cr(VI)	hexavalent chromium
Cr(III)	trivalent chromium
CUPA	Certified Unified Program Agency
CWG	Consultative Workgroup
DTSC	Department of Toxic Substances Control
F.D.	forced draft
Fe(II)	ferrous iron
Fe(III)	ferric iron
gpm	gallons per minute
HDPE	high-density polyethylene
HMI	Human Machine Interface
IM	Interim measures
µg/L	micrograms per liter
mg/L	milligrams per liter
MCC	Motor Control Center
NTU	nephelometric turbidity units
O&M	operations and maintenance
PG&E	Pacific Gas and Electric Company
PLC	programmable logic controller
PTO	Permit to Operate
SOP	Standard Operating Procedure
TDS	total dissolved solids
TSS	total suspended solids
Water Board	Regional Water Quality Control Board, Colorado River Basin Region
WDR	Waste Discharge Requirements

1.0 Introduction

1.1 Purpose of Plan

This document presents the Treatment and Extraction System Operation and Maintenance Plan (O&M Plan) for the Interim Measure (IM) No. 3 groundwater extraction and treatment system located at the Pacific Gas and Electric Company (PG&E) Topock Compressor Station near Needles, California. The O&M plan presents the strategy and procedures for performing operations, conducting maintenance, and monitoring the plant. The plant shall be operated in accordance with this O&M plan and other related documents.

The O&M Plan is one of several documents that describe the overall operation of IM No. 3. Closely-related documents are included as appendices to this document and include:

Appendix A	Waste Discharge Requirements (WDRs).
Appendix B	Mass Balance.
Appendix C	Process and Instrumentation Diagrams.
Appendix D	Control System Operations Manual.
Appendix E	Standard Operating Procedures.
Appendix F	List of Equipment O&M Manuals.
Appendix G	Alarms and Troubleshooting Summary.
Appendix H	Daily Monitoring Checklists.
Appendix I	Phone List.
Appendix J	Treatment System Contingency Plan.

Other documents that form the overall Operations Plan are stand-alone documents and are referenced in this document:

- *Biological Resources Investigations for IM No. 3: Topock Compressor Station Expanded Groundwater Extraction and Treatment System, San Bernardino County, California* (CH2M HILL 2004).
- *Cultural Resources Management Plan* (Applied Earthworks 2004)
- *Waste Management Plan, Topock Compressor Station, Needles, California.* (CH2M HILL 2005a).
- *Interim Measures No. 3 Treatment and Extraction System Initial Startup Plan* (CH2M HILL 2005b).
- *Interim Measures Injection Well Operation and Maintenance Plan* (CH2M HILL 2005c).
- *Groundwater Compliance Monitoring Plan for Interim Measures No. 3 Injection Area* (CH2M HILL 2005d).
- *Hazardous Materials Business Plan (HMBP), Topock Groundwater Extraction Site, February 1, 2006 – March 1, 2007* (PG&E 2006).
- *Interim Measures Extraction System Operation and Maintenance Plan* (CH2M HILL 2006).

1.2 Interim Measures Objective

The objective of the overall Interim Measures is to provide hydraulic control of the plume boundaries near the Colorado River floodplain to maintain a net landward groundwater gradient.

Hydraulic control will be maintained by pumping groundwater from extraction wells located near the eastern edge of the plume. Treatment of the groundwater has been designed to meet the WDRs issued by the Colorado River Basin Regional Water Quality Control Board (Water Board) and employs the best-available treatment technologies.

Groundwater extraction, treatment, and discharge will be performed in compliance with applicable permits and requirements.

The completion criteria of the Interim Measures are as follows:

> *The IM No. 3 groundwater extraction and treatment system will be operated consistent with permits and authorizations until an alternative or permanent measure is implemented and stoppage of the extraction and treatment is authorized by the DTSC.*

1.3 Project Background

PG&E is addressing hexavalent chromium [Cr(VI)] in groundwater at the Topock Compressor Station under the oversight of the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC). The Topock Compressor Station is located in San Bernardino County, approximately 15 miles southeast of Needles, California (Figure 1-1).

Beginning in August 2003, DTSC and PG&E began working in a collaborative process with affected and interested agencies through the Topock Consultative Work Group (CWG), constituted under California's site designation process. CWG members include:

- DTSC.
- Water Board.
- United States Fish and Wildlife Service.
- United States Bureau of Land Management.
- United States Bureau of Reclamation.
- Representatives from local Native American Tribes.
- Arizona Department of Environmental Quality.
- Metropolitan Water District of Southern California.
- United States Geological Survey.

In compliance with the DTSC directive of February 9, 2004 (to implement actions termed IM No. 2), PG&E commenced pumping, transport, and disposal of groundwater from the MW-20 bench location in March 2004. Due to the influence of the Colorado River stage on groundwater levels, extracting groundwater at higher rates is necessary to maintain the stated goal of hydraulic control. Space and treatment capacity limitations at the MW-20 bench made the installation of additional facilities to extract, treat, and manage the higher groundwater flows necessary.

In a letter dated June 30, 2004, DTSC directed PG&E to expand existing groundwater extraction and management facilities to maintain hydraulic control of the chromium plume at the Topock site. This activity has been designated IM No. 3. The IM No. 3 project requires that PG&E design and install a groundwater extraction, conveyance, and treatment system, and piping and facilities for management of treated water. Figure 1-2 presents the location of the IM No. 3 groundwater extraction and treatment system.

The treatment system began treating groundwater in July 2005.

1.4 Treatment System Permits

This section presents a summary of the permits under which the treatment system is operated. Other requirements applying to the treatment system, including protection of environmental resources and preservation of historic resources, are described in separate documents.

1.4.1 Waste Discharge Requirements

The Water Board issued permits for three treated water management alternatives, which include:

- Discharge of treated water to subsurface injection wells.
- Discharge/reuse of treated water to the PG&E Topock Compressor Station.
- Discharge to the Colorado River.

Discharge of treated groundwater to subsurface injection wells is PG&E’s preferred alternative (and the only alternative being used) and is the basis for this O&M Plan. This Plan will be reviewed and updated in the event that another treated groundwater management alternative is implemented in the future.

The Water Board permit R7-2004-103, titled “Waste Discharge Requirements,” is presented in Appendix A, along with the related Monitoring and Reporting Program. Key operating requirements include:

- Complying with treated effluent discharge limitations.
- Submitting monthly and quarterly compliance monitoring reports and semiannual O&M reports.
- Obtaining approval by the Executive Officer of the Water Board before changing or adding treatment system chemicals.
- Maintaining a copy of the WDR on site.
- Training operators regarding the WDR requirements.
- Maintaining documentation of regular system inspections and maintenance.
- Performing non-compliance notifications and reporting.
- Preventing stormwater contamination.

1.4.2 Conditional Authorization Permit

PG&E obtained a grant of Conditional Authorization for treatment of Cr(VI) in groundwater under Section 25200.3 of the California Heath and Safety Code. The San Bernardino County Fire Department, the Certified Unified Program Agency (CUPA) with jurisdiction over the Topock site, is responsible for administering and enforcing the requirements of the grant of Conditional Authorization.

PG&E complies with the operating requirements under the Conditional Authorization permit including:

- Hazardous waste is managed in compliance with *hazardous waste generator standards* of Title 22 of the California Code of Regulations (CCR), Division 4.5, Chapter 12.
- *Operators are trained* per 22 CCR 66265.16 and be provided with annual review training.
- The *facility contingency plan* addresses the preparedness and prevention requirements of 22 CCR Division 4.5, Chapter 15, Article 3 and the contingency plan and emergency preparedness requirements of 22 CCR Division 4.5, Chapter 15, Article 4.
- Management of containers and *tanks containing hazardous waste* will be in accordance with 22 CCR, Division 4.5, Chapter 15, Articles 9 and 10. Tanks require documented daily inspections per 22 CCR 66265.195.

1.4.3 Hazardous Materials Business Plan

A Hazardous Materials Business Plan has been submitted to the CUPA. The key elements of the plan are a hazardous materials/waste inventory and accompanying location map and a response/contingency plan. The inventory is updated annually.

1.4.4 Mojave Desert Air Quality Management District Permit

A rented generator is used at the site and is permitted as California portable equipment through the Mojave Desert Air Quality Management District.

1.5 Treatment Objectives

Table 1-1 lists numerical wastewater discharge limitations set forth in the WDRs, Order R7-2004-0103 issued by the Water Board for discharge to injection wells (Appendix A). In addition to the specific numeric limits in Table 1-1, the WDRs contain narrative requirements that prohibit bypassing, overflowing, discharging, or spilling untreated or partially-treated waste; discharging waste in excess of the system capacity; and causing degradation of any water supply.

TABLE 1-1
Order R7-2004-0103, Waste Discharge Requirements - Subsurface Injection Numerical Effluent Limitations
Interim Measures No. 3 Treatment and Extraction System Operation and Maintenance Plan

Effluent Characteristic	Average Monthly Limit	Maximum Daily Limit
Flow (gpm)	*	*
pH (standard pH units)	Not Applicable	6.5 to 8.5

TABLE 1-1
Order R7-2004-0103, Waste Discharge Requirements - Subsurface Injection Numerical Effluent Limitations
Interim Measures No. 3 Treatment and Extraction System Operation and Maintenance Plan

Effluent Characteristic	Average Monthly Limit	Maximum Daily Limit
Chromium (VI) (µg/L)	8	16
Chromium (Total) (µg/L)	25	50

* The WDR does not contain a limit on flow; however, PG&E's WDR application described an average flow of 80 gpm and maximum of 200 gpm.
gpm = gallons per minute.
µg/L = micrograms per liter.

Monitoring of the groundwater in the vicinity of the injection wells is addressed in the *Groundwater Compliance Monitoring Plan for Interim Measures No. 3 Injection Area* (CH2M HILL 2005d). This document includes the methodology and criteria for confirming that subsurface injection of treated groundwater is not degrading groundwater quality.

Although PG&E has obtained permits for two other treated groundwater management alternatives—discharge to the Colorado River and industrial reuse at the Topock Compressor Station—subsurface injection is PG&E's preferred method for managing treated groundwater. Therefore, these treated groundwater management alternatives are not addressed in this O&M Plan.

1.6 IM No. 3 Groundwater Treatment System Overview

The IM No. 3 project consists of:

- Groundwater extraction system.
- Conveyance system.
- Treatment system.
- Treated water injection system.

Figure 1-2 shows the location of extraction, conveyance, treatment, and disposal/reuse facilities. Figure 1-3 is a process flow diagram for IM No. 3. Figure 1-4 presents the treatment pad layout. The groundwater treatment and subsurface injection facilities are located on Parcel 650-151-06, which PG&E purchased from the Metropolitan Water District in 2004. Each of the project components is described below.

1.6.1 Groundwater Extraction System

The extraction system is located along the eastern portion of the plume area (Figure 1-2). Multiple groundwater extraction wells have been installed to meet the objectives of the interim measure. Existing extraction wells include TW-2S, TW-2D, and TW-3D (located on the MW-20 bench) and PE-1 (located in the floodplain). TW-2S is a shallow groundwater extraction well; the other wells are screened in the Lower Zone of the Alluvial Aquifer. PE-1 was installed to target extraction from the distal end of the groundwater plume. The wells are capable of producing extraction rates up to the design capacity of the groundwater treatment plant.

The installation and use of additional extraction wells has been discussed during CWG technical committee meetings. Two possible additional extraction well locations are shown on Figure 1-2 and include:

- PE-2, located south of TW-2D.
- PE-3, located north of TW-2D.

The new wells would be installed in a manner similar to that used for existing wells and would be screened in appropriate sections of the aquifer at the direction of DTSC.

Electric submersible pumps are installed in each extraction well. Well head construction includes subsurface concrete vaults equipped with instrumentation, valves, and other pipe appurtenances. Underground piping and electrical conduits are connected to the well heads to convey water and provide power and control for the pump and instrumentation. Piping from the extraction wells to the treatment system is contained secondarily to comply with hazardous waste regulations.

1.6.2 Conveyance System

The water conveyance system delivers untreated water from the extraction wells to the treatment facilities, as well as treated water from the treatment facility back to the MW-20 bench or to the injection wells, and reverse osmosis concentrate back to the MW-20 bench.

Pipelines conveying untreated groundwater are constructed of double-contained high-density polyethylene (HDPE) pipe; treated effluent lines and reverse osmosis concentrate lines are constructed of single-contained HDPE pipe for underground lines and epoxy-lined carbon steel pipe for aboveground lines. Piping and appurtenances have been sized to accommodate the anticipated system flow rates. A combination of subsurface and aboveground alignments has been constructed to minimize and avoid impacts to cultural resources. Electrical utility access vaults are placed at selected points along the pipelines.

1.6.3 Treatment System

Extracted groundwater is conveyed to the treatment system. The system is a continuous treatment process that involves:

- Reducing the Cr(VI) to the less-soluble trivalent chromium [Cr(III)] form by reaction with ferrous chloride.
- Precipitating iron and Cr(III) by the addition of sodium hydroxide and air.
- Removing the majority of precipitated solids by gravity separation in a clarifier.
- Passing the clarified water through a microfilter to provide additional solids removal.
- Lowering the naturally-occurring total dissolved solids (TDS) of the groundwater using reverse osmosis. Reverse osmosis produces two streams: the reverse osmosis permeate (low TDS stream) and the reverse osmosis concentrate stream (high TDS stream). The permeate stream is blended with treated water from the microfilter through a reverse osmosis bypass loop. The purpose of this blending is to maintain the salinity of the treated water at a level comparable to the injection aquifer prior to re-injection. The concentrate stream is pumped to storage tanks at the MW-20 bench for disposal.

- Dewatering settled solids for transport and disposal.

Treatment facilities include process equipment such as storage tanks (influent, effluent, and chemical), pumps, piping, reactors, and instrumentation installed on a concrete slab foundation. Other features will include electrical power supply, security fencing, operator facilities, and equipment storage.

1.6.4 Treated Water Management

The preferred management approach for treated groundwater is subsurface injection in compliance with the WDR R7-2004-0103. A separate O&M manual has been prepared for the subsurface groundwater injection system (CH2M HILL 2005c). Therefore, subsurface injection is not addressed in this O&M Plan.

1.7 Residuals Management

The two main residual streams from the groundwater treatment system are treatment system waste solids and reverse osmosis concentrate (also commonly called “brine”). Waste solids are a hazardous waste and are removed and transported to a permitted hazardous waste disposal facility. Reverse osmosis concentrate is a non-hazardous waste. The concentrate is transported offsite.

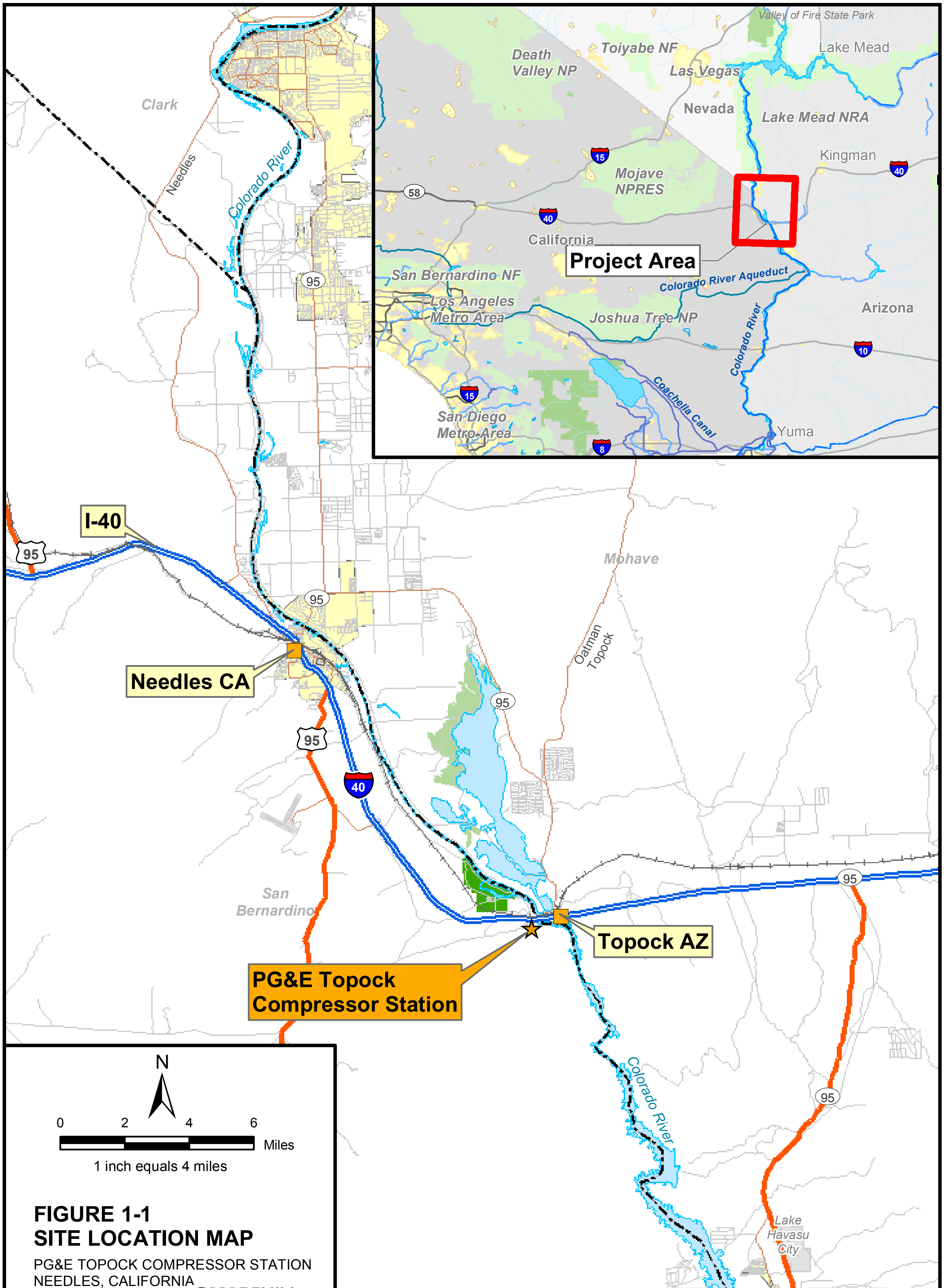


FIGURE 1-1
SITE LOCATION MAP

PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

BAO \\ZINFANDEL\PROJ\PACIFICGASELECTRICCO\TOPOCKPROGRAM\GIS\MXD\2005\LOCATION_MAP_PORTRAIT.MXD LOCATION_MAP 3/13/2006 16:16:09

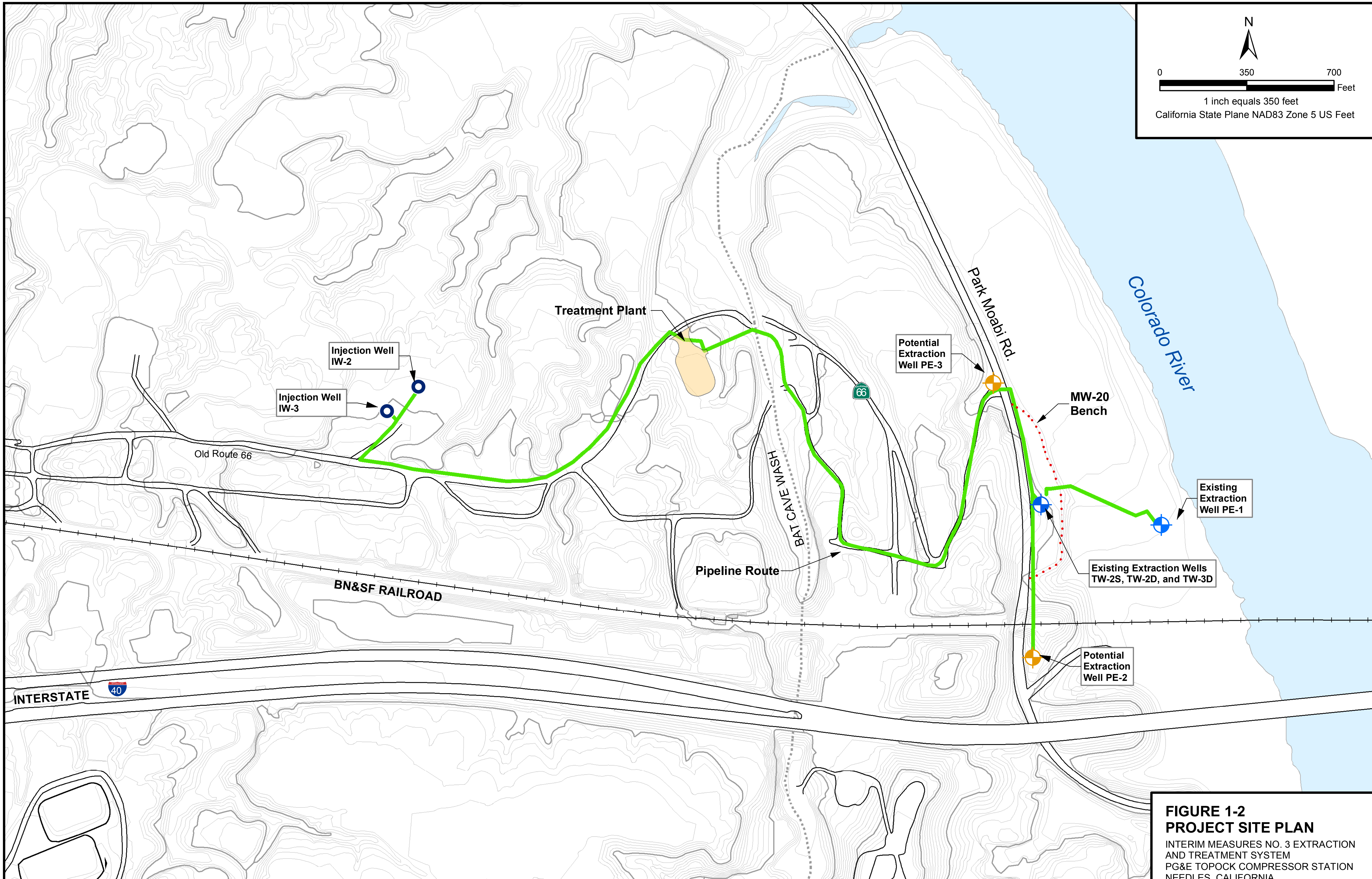
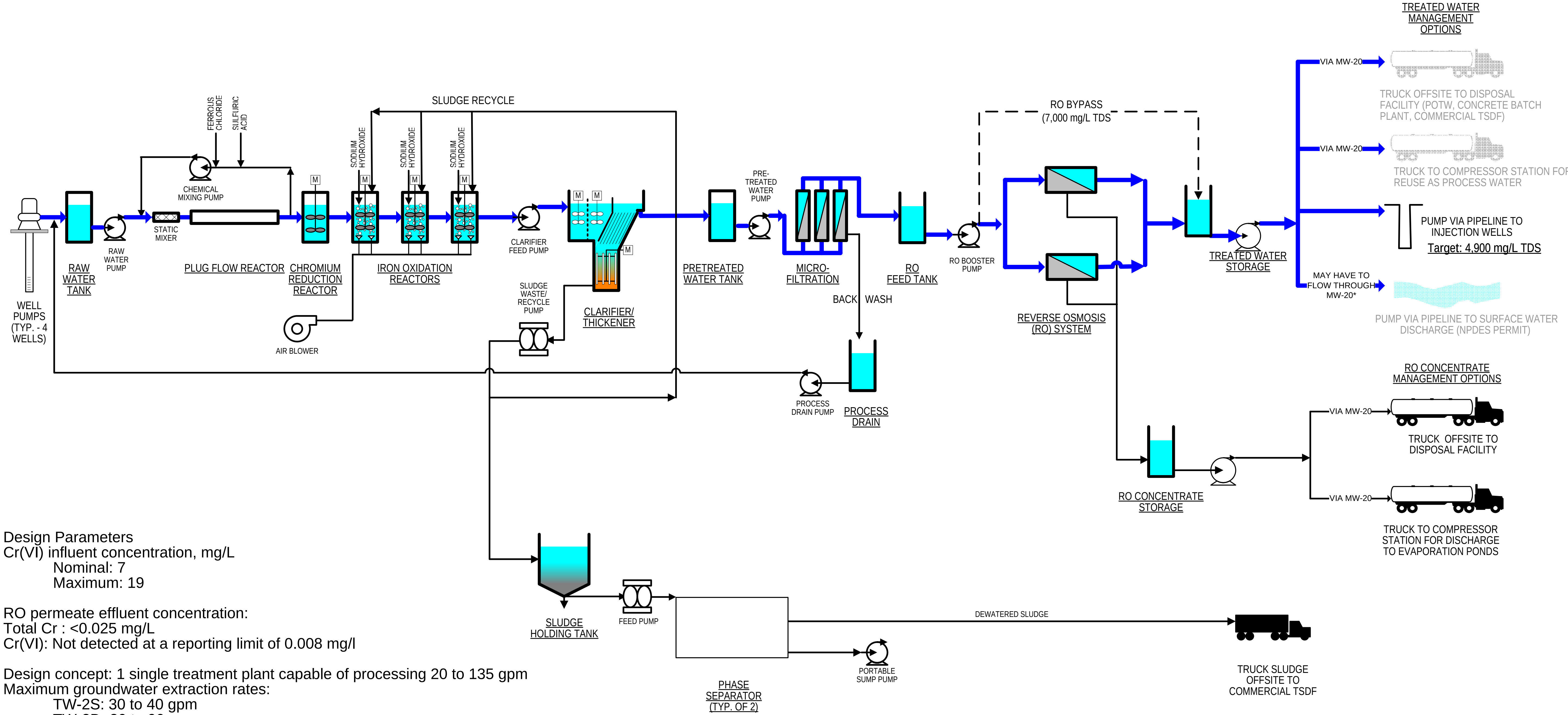


FIGURE 1-2
PROJECT SITE PLAN
INTERIM MEASURES NO. 3 EXTRACTION AND TREATMENT SYSTEM
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA
CH2MHILL



Design Parameters
Cr(VI) influent concentration, mg/L
Nominal: 7
Maximum: 19

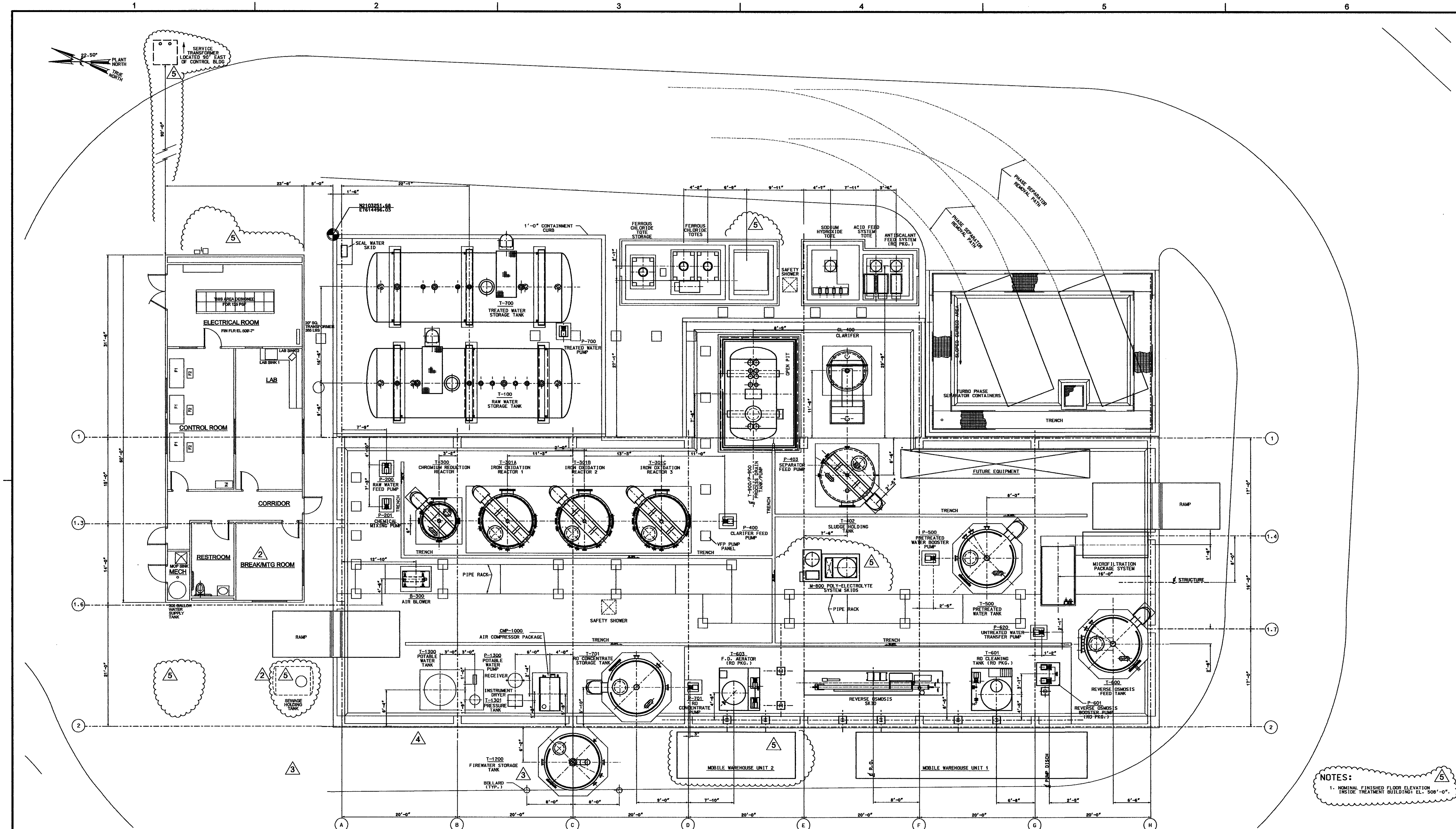
RO permeate effluent concentration:
Total Cr : <0.025 mg/L
Cr(VI): Not detected at a reporting limit of 0.008 mg/l

Design concept: 1 single treatment plant capable of processing 20 to 135 gpm
Maximum groundwater extraction rates:
TW-2S: 30 to 40 gpm
TW-2D: 80 to 90 gpm
PE-1: 30 to 40 gpm
Potential PE-2: 30 to 40 gpm
Potential PE-3: 20 to 40 gpm

Notes:
Cr - chromium
Cr(VI) - hexavalent chromium
gpm - gallons per minute
mg/L - milligrams per liter
NPDES - National Pollutant Discharge Elimination System
POTW - Publicly-owned treatment works
RO - Reverse osmosis
TSDF - treatment storage or disposal facility

CH2MHILL

FIGURE 1-3
EXPANDED GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
PROCESS FLOW DIAGRAM
INTERIM MEASURES NUMBER 3
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA



REUSE OF DOCUMENTS: THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF CH2M HILL AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CH2M HILL. ©CH2M HILL

REGISTERED PROFESSIONAL ENGINEER STEVEN DOUGLAS HOYER No. 31888 Exp. 12/31/05 MECHANICAL STATE OF CALIFORNIA

10/12/05

RESPONSIBLE ENGINEER: STEVEN D. HOYER PE# CA M31888

NO.	DATE	REVISION	BY	CHK
0	09/07/04	APPROVED FOR CONSTRUCTION	RKP	SDH
1	10/06/04	PLANT MOVED 5'-0" WEST, MISC. CHANGES	WHD	
2	12/01/04	ADDED FIREWATER STORAGE TANK AND DOUBLE WIDE TRAILER	WHD	RKP
3	01/31/05	REVISED FIREWATER STORAGE TANK, ADDED BOLLARDS	WHD	RKP
4	03/18/05	ADDED SPARE TANK AND POTABLE EQUIPMENT	WHD	RKP
5	10/07/05	FINAL RECORD ISSUE	EFC	RKP
	/ /			
	/ /			

REVISION APPROVAL — REV 5 DATE 10/10/05

DISCIPLINE	REVIEWED	DISCIPLINE	REVIEWED
CIVIL	mns	ELECTRICAL	
STRUCTURAL	mns	INST & CONTROL	
MECHANICAL		ARCHITECTURAL	—
PROCESS		ENVIRONMENTAL	
PIPING	SDH	GEN. ARRANG.	

PRINT DISTRIBUTION
DATE
STATUS
REV.
CLIENT
FIELD
INTRA CO.

STATUS

ISSUED	REV	DATE	SDE	PEM
PRELIMINARY		/ /		
FOR REVIEW AND APPROVAL	C	08/05/04		
APPROVED FOR CONSTRUCTION	0	09/07/04	SDH	TP
REVISED & APPROVED FOR CONSTRUCTION	5	10/12/05	SDH	SDH for KGS

SCALE 1/8"=1'-0"

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURE 3
EXPANDED GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

PROJ NO. 315994

CH2MHILL

FIGURE 1-4
TREATMENT SYSTEM LAYOUT

DWG. NO. TP-GA-10-01-03 REV. 5

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

FILENAME: tpga100103.dlv PLOT DATE: 10-OCT-2005 PLOT TIME:

2.0 Project Management

Key organizational contacts for the IM No. 3 groundwater extraction and treatment system are presented in Table 2-1.

TABLE 2-1
IM No. 3 Groundwater Extraction and Treatment System Key Organizational Contacts
Interim Measures No. 3 Treatment and Extraction System Operation and Maintenance Plan

Role	Name	Organization	Phone
Geotechnical Project Manager	Yvonne Meeks	PG&E	805/546-5243
Onsite Project Manager	Curt Russell	PG&E	760/326-5582
Onsite Inspector	Chris Smith	PG&E	928/764-3370
Hydrogeology	Martin Barackman	CH2M HILL	530/243-5886 x3401
Technical Support	Dennis Fink John Porcella Shawn Duffy	CH2M HILL	510/251-2888 x7693 510/251-2888 x7622 530/243-5886 x3303
Emergency and Downtime Events Contact	Matt Johns	CH2M HILL	720/286-5406 720/289-4166
Facility Operations	Kevin Mullin	OMI	760/447-2029 (cell) 760/326-3328 (office) 760/326-3329 (fax)
Site Security	Various	OSS	760/819-5555

The project organization will change as the project evolves. The table of contacts will be updated periodically to reflect key project team members. Note that the hydrogeologic efforts, which are a critical component of the IM No. 3 remediation project, are addressed in other documents. as described Section 1.0.

3.0 System Description

This section describes the groundwater extraction and treatment process. The basic physical/chemical processes are described first, followed by a description of each system component. The treatment system mass balance is presented in Appendix B. Process and Instrumentation Diagrams are presented in Appendix C.

3.1 Physical and Chemical Process Summary

3.1.1 Chromium Reduction and Precipitation Chemistry

Cr(VI) can be chemically reduced to Cr(III), which can be readily precipitated from solution under alkaline conditions. The ferrous form of iron [Fe(II)] is one of several chemical species that will reduce Cr(VI) to Cr(III). The reaction between Cr(VI) and Fe(II) is:

$$\underset{(Cr(VI))}{NaHCrO_4} + \underset{(Fe(II))}{3FeCl_2} + 8H_2O \rightarrow NaCl + \underset{(Cr(III))}{Cr(OH)_3} + \underset{(Fe(III))}{3Fe(OH)_3} + 5HCl \qquad (1)$$

The Cr(VI) and Fe(II) chemical forms are very soluble in water, while the Cr(III) and ferric iron [Fe(III)] forms are very insoluble in water.

The reaction proceeds quickly, and the reaction kinetics or rate of reaction comes from the following relationship (*Environmental Science and Technology.*, Volume 30, No. 5, 1996, pp. 1614 – 1617):

$$\frac{d[Cr(VI)_t]}{dt} = -k_{Cr}[Fe(II)]^{0.6}[Cr(VI)_i]^{1.0} \qquad (2)$$

where:

k_{Cr} = 56.3, millimole$^{-0.6}$ minute^{-1} L$^{0.6}$.

[Cr(VI)] = hexavalent chromium, millimole/L.

[Fe(II)] = initial Fe(II), millimole/L.

i and t = subscripts indicating **i**nitial and elapsed reaction **t**ime, respectively.

In the IM No. 3 system, the pipe reactor and chromium reduction reactor were designed based on these kinetics to provide complete chemical reduction of Cr(VI) in the extracted groundwater.

After Cr(VI) is converted to Cr(III) in the pipe reactor and chromium reduction reactor, the remaining Fe(II) (soluble) is oxidized to Fe(III) (insoluble) by bubbling oxygen (air) into three aeration tanks. Fe(II) readily oxidizes to Fe(III) upon contact with oxygen provided that the pH is in the neutral or alkaline range. Sodium hydroxide is added to the iron oxidation reactor tanks to raise the pH to the required range, and to accomplish the precipitation of Cr(III) and Fe(III). The precipitated solids are removed in a clarifier, which is located upstream of the microfilter.

The reaction rate between ferrous iron and dissolved oxygen in a mixed tank reactor is given by the following equation (*Environ. Sci. & Technol.*, Volume 14, Number 5, May 1980, pp. 561-568.):

$$\frac{d^2[Fe^{2+}]}{dt^2} = -k[Fe^{2+}][OH^-]^2 pO_2 \qquad (3)$$

where:

k = ~1.348×10^{13} L^2/(atm-min-mole) for 3,800 milligrams per liter (mg/L) TDS groundwater.

k = ~1.445×10^{12} L^2/(atm-min-mole) for 44,125 mg/L TDS groundwater.

$[Fe^{2+}]$ = ferrous iron concentration, mole/L.

$[OH^-] = [10^{(pH-14)}]$ mole/L.

pO_2 = effective oxygen partial pressure 0.15 to 0.18 atm (adjusted for temperature and salinity).

The effluent ferrous iron concentration from the aeration tanks can be predicted using a mass balance equation for mixed reactor vessels:

$$C_1 = C_0/(1 + k_1 V/Q) \qquad (4)$$

where:

C_1 = concentration of Fe^{2+} in mixed reactor effluent.

C_0 = concentration of Fe^{2+} in mixed reactor influent.

$k_1 = k[OH^-]^2 pO_2$.

V = reactor volume, gallons.

Q = flow rate through the reactor, gallons/minute.

The iron oxidation reactors were designed based on these relationships. Both the Cr(VI) reduction kinetics and the reaction between Fe(II) and dissolved oxygen formed the basis for determining the ferrous chloride feed rate.

3.1.2 Solids Removal

Fe(II) is converted to Fe(III) through reaction with Cr(VI) in the pipe reactor and chromium reduction reactor and through reaction with dissolved oxygen in the iron oxidation reactors. Ferric iron, in the form of ferric hydroxide, is very insoluble and precipitates readily. Chromium hydroxide co-precipitates with ferric hydroxide, and the combined solid (ferric hydroxide and chromium hydroxide) settles out in the clarifier. Clarification removes most of the solids formed in the treatment process. The small amount of solids passing through the clarifier are removed in the microfilter.

A portion of the settled solids in the clarifier are recycled to the iron oxidation tanks. Sludge recycle improves sludge settleability, promotes metal co-precipitation, and reduces fouling of instrument, pipe, and tank surfaces.

A polyelectrolyte may be added to the clarifier inlet to enhance sludge settleability in the clarifier. Polyelectrolytes are long-chain acrylate-based polymers with specialized functional groups. The purpose of the functional group is to bind to the solid particles based on the electrical surface charge on precipitated solids or chemical affinity, forming bridges between particles to increase their size. The efficacy of a given polymer depends on the nature of the solids to be coagulated, on the polymer dosage rate, and may depend on other properties of the wastewater such as pH. Jar tests were performed during treatment plant startup to select the appropriate polymer and dosage rate. The polymer dose rate is proportional to the influent groundwater flow rate. The quality of the floc formed in the clarifier is evaluated several times per day to ensure that the polymer dose rate is appropriate since polymer demand may vary with changes in influent water chemistry.

A small amount of suspended solids is discharged with the clarifier effluent stream. Final particulate removal is accomplished by microfiltration. The microfilter system consists of hollow-fiber membranes through which clarifier effluent is pumped under pressure. The membranes reject particles with an effective diameter of 0.1 microns or greater. The system uses pre-programmed backwash cycles that are initiated at regular intervals (approximately hourly) or at a pre-set transmembrane pressure. A clean-in-place operation is also conducted periodically (approximately monthly) to restore the flux rate of the microfilter membranes.

3.1.3 Dissolved Solids Removal

Chromium removal goals are achieved through the microfiltration process. However, a reverse osmosis system is used to remove dissolved solids from a portion of the microfilter permeate prior to subsurface injection of the treated water.

Reverse osmosis removes dissolved solids by applying a pressure greater than the solution osmotic pressure, thereby forcing water, but not salts, across a semi-permeable membrane. The reverse osmosis system generates a low-TDS product stream called the reverse osmosis permeate and a high-TDS waste stream called the reverse osmosis concentrate. The reverse osmosis permeate TDS is lower than treatment limits require. Therefore, a portion of the microfilter effluent is blended with the reverse osmosis permeate to achieve the target effluent TDS concentration specified in the *Interim Measures Injection Well Operation and Maintenance Plan* (CH2M HILL 2005c). Reverse osmosis concentrate is pumped to the MW-20 bench for transfer to an offsite disposal facility.

Antiscalant chemicals are added to the reverse osmosis system feed to prevent deposition of precipitates (scale) on the membrane surfaces. However, the reverse osmosis membranes must be cleaned periodically with chemicals to restore the membrane flux rate.

3.2 Instrumentation and Controls

The treatment system is controlled by several programmable logic controllers (PLCs). System operation is monitored through two WonderWare® Human Machine Interface (HMI) operator consoles running on personal computers. The software displays graphic representations of the treatment process. Plant operators are able to click on process equipment symbols to obtain information about the status of that equipment. Most rotating process equipment has local or remote hand switches either at the equipment or at the motor control center. When these switches are set to remote, the equipment may be controlled by the operator from the control console. Operators may also review trends in instrument readings and system warnings and alarms. The control system is described in more detail in Appendix D.

3.3 Influent Pumping

3.3.1 Purpose

The purpose of the influent pumping system is to extract groundwater at the wells and convey it to the treatment system. Because the extracted groundwater contains Cr(VI), the pumping and conveyance system has been designed and is operated to prevent releases of extracted groundwater to the environment.

3.3.2 System Components

The groundwater extraction and conveyance system currently consists of:

- Extraction wells TW-2S, TW-2D, TW-3D, and PE-1.
- Submersible extraction pumps P-100, P-101, P-102, and P-103.
- Double-containment piping with low-point leak detection sensors.

3.3.3 Process Description

Groundwater is extracted from the extraction wells and is conveyed to the water treatment plant by electrical submersible pumps. The target groundwater extraction rate is determined by DTSC and changes periodically. Power and instrumentation are provided to each of the extraction well pumps through underground conduits from the treatment system. Currently, TW-3D supplies most of the required extraction volume, with supplemental volume supplied by PE-1. Wells TW-2S and TW-2D are maintained as supplemental wells. Additional details of the groundwater pumping strategy are presented in the *Interim Measures Extraction System Operation and Maintenance Plan* (CH2M HILL 2006).

Because of the uncertainties involved in characterizing subsurface hydrology and groundwater chemistry, modifications to the extraction rate or installation of new wells may in the future be required to maintain optimal hydraulic control of groundwater. Periodic modification of the groundwater extraction system may be necessary, which could affect operation of the groundwater treatment system and management of treated groundwater.

3.3.4 Control System

Each well pump has a local hand switch that can be set to local or remote operation. Normal operation is in the remote mode. Local instrumentation includes a pump discharge pressure indicator and flow indicator. In remote operation, the pumps are controlled at the treatment system panel. The treatment system panel includes readouts for well level, flow rate, well pump discharge pressure, and presence of water in the well vault. Warning signals are provided at the control panel for high and low flow rates, well vault water level, well pump discharge pressures, and high and low well levels.

The pump discharge flow rate is controlled by manually setting a control valve in the pump vault. The pumps start and stop to maintain the level in Tank T-100 between level set points. If groundwater level falls below the pump suction, the system generates a warning at the control panel.

The extracted groundwater is conveyed from the well vault to the treatment plant by double-contained piping with low-point leak detection. Leak detection sensors are located at piping low points and approximately every 500 feet along the pipeline. Leak detection sensors provide warning signals at the leak detection control panel.

3.4 Raw Water Storage Tank

3.4.1 Purpose

The raw water storage tank (T-100):

- Provides hydraulic separation between the groundwater extraction pumps and the treatment system. The raw water storage tank has capacity for 27,000 gallons of extracted groundwater. When the raw water storage tank is full, the treatment system can be operated for up to 3 hours at the peak treatment flow rate of 135 gallons per minute (gpm) while the well pumps are shut down for maintenance or repairs. Similarly, the tank may be used to store groundwater from the extraction wells while the treatment system is temporarily shut down for maintenance.
- Provides positive suction head for the raw water feed pump.
- Provides storage for off-specification process streams for re-treatment.

3.4.2 System Components

- Raw water storage tank (T-100)
- Raw water feed pump (P-200)
- Control valve (FCV-200)

3.4.3 Process Description

The process objective is to maintain the water level in the raw water storage tank so that there is storage capacity to receive off-specification water, yet also enough water in the tank to operate the treatment system for a short time if the extraction wells shut down.

The process streams piped to the raw water storage tank include:

- Extraction wells (TW-2S, TW-2D, TW-3D, and PE-1).
- Process drain tank (T-900).

Piping and valves have been provided to route flow from the following process tanks back to the raw water storage tank if required:

- Pretreated water tank (T-500 and P-500)
- Reverse osmosis feed tank (T-600 and P-620)
- Reverse osmosis-treated water (P-605A and P-605B)

The extraction wells provide the primary flow into the raw water storage tank. The extraction well flow rate can be monitored from the control panel. The raw water storage tank discharges via the raw water feed pump, which has a discharge recycle loop back to the tank to maintain minimum pump flow. To maintain continuous, steady-state flow through the plant, the raw water feed pump discharge flow rate is typically set slightly higher than the extraction well flow rate to account for discharge from the process drain tank (T-900) into the raw water storage tank.

The 5,000-gallon process drain tank (T-900) discharges to the raw water storage tank via process drain pump (P-900), which is controlled by the level in the process drain tank. The process drain tank empties to the raw water storage tank approximately every 6-8 hours, depending on the influent flow rate to the treatment plant. The raw water storage tank level (T-100) is interlocked to the process drain pump (P-900) so that a high level in T-100 will shut down P-900.

Other flow inputs into the raw water tank are controlled manually by operators. Operators will assess water storage requirements and the available raw water tank capacity before performing manual transfers.

3.4.4 Control System

The raw water storage tank system has the following instrumentation and controls:

- A raw water influent line solenoid valve controlled from the control panel so that inflow to the tank can be immediately stopped. The valve can be actuated at the control panel or locally.
- A hand switch in the motor control center (MCC) allows for local or remote operation of the raw water feed pump. The pump has a local discharge pressure indicator.
- Level instrumentation provides level readout locally and at the control panel. High- and low-level set points turn the extraction pumps on and off. High- and low-level warnings at the control panel signal an imbalance of inflow and outflow at the raw water storage tank requiring operator attention. The low-low level alarm shuts down the treated water transfer pump (P-200). The high-high level alarm shuts down the extraction pumps and P-900.
- The flow rate from the raw water feed pump is displayed locally and at the control panel. The operator selects the target flow rate and flow control valve FCV-200 position modulates to achieve the target flow rate.

3.5 Plug-flow Cr(VI) Reduction (Pipe) Reactor and Ferrous Chloride and Sulfuric Acid Feed Systems

3.5.1 Purpose

The plug-flow Cr(VI) reduction reactor and associated chemical feeds convert Cr(VI) to Cr(III).

3.5.2 System Components

Components of the plug-flow Cr(VI) reduction reactor are:

- Serpentine pipe reactor.
- Chemical mixing pump (P-201).
- Sulfuric acid feed pump (P-801A).
- Ferrous chloride feed pump (P-800).

3.5.3 Process Description

Untreated groundwater discharged from the raw water pump (P-200) combines with a recycle stream into which ferrous chloride has been injected. The combined flow passes though a serpentine plug flow pipe reactor. The pipe reactor residence time is 2 minutes at the peak treatment flow rate. The reactor operates at ambient temperature. A portion of the pipe reactor effluent is discharged to the chromium reduction reactor (T-300). The remaining volume of pipe reactor effluent enters the recycle line to the chemical mixing pump (P-201). Ferrous chloride and sulfuric acid (if necessary) are added upstream of the chemical mixing pump. The ferrous iron component of the ferrous chloride reacts with Cr(VI), as described in Section 3.1.

The treatment chemicals, ferrous chloride (12- to 14-percent as iron) and sulfuric acid (35-percent solution), are stored in totes in the chemical storage area.

The ferrous chloride feed rate is set to be proportional to the groundwater flow rate indicated by the raw water feed flow meter. The design dosage was based on 200 percent of the stoichiometric requirement for Cr(VI) reduction (3:1 stoichiometric mole ratio), plus the Fe(II) demand imposed by dissolved oxygen in the feed. Periodically, the ferrous chloride concentration in pipe reactor effluent is checked by plant operators using a field test method, and the feed rate is adjusted as necessary. The setpoint is selected to maintain a Fe(II) excess of approximately 7 to 10 mg/L. Excess ferrous chloride ensures all the Cr(VI) is reacted, although it also increases the amount of sludge produced.

The sulfuric acid feed rate is controlled based on the pH measured in the recycle loop. Sulfuric acid is not required if the groundwater pH is sufficiently lowered by addition of ferrous chloride (to date, no sulfuric acid has been required). The target pH of the solution is approximately pH 6.0 to prevent Fe(II) from reacting with dissolved oxygen in the water.

3.5.4 Control System

The control system includes:

- Manual solenoid valve on the system inlet that allows the operator to stop flow to the treatment system from the control panel.
- AE/AIT 201: inline pH and temperature monitor on the discharge line from the raw water pump prior to introduction of the recycle stream from the chemical mixing pump. Values of pH and temperature are displayed both locally and at the control panel.
- AE/AIT 202-1 and AE/AIT 202-2: Two pH and temperature analyzers are located in the recycle loop on the suction side of the chemical mixing pump. Values of pH and

temperature are displayed both locally and at the control panel. The control system provides warnings if the pH analyzer values deviate by more than 0.5 units. The control system will alarm at high pH and shut down the raw water feed pump at high-high pH.

- The pH values are indicated locally and at the control panel.
- The ferrous chloride feed pump stroke length is set at the pump and the setting is verified at the HMI. The pump speed is automatically determined by the PLC using an algorithm based on the groundwater influent flow rate adjusted for the influent Cr(VI) concentration, the dissolved oxygen concentration, the ferrous chloride chemical concentration, and the pump stroke setting. The chemical feed rate can be fine-tuned using an operator adjustment factor. In general, all of the variables will remain fixed with the exception of the adjustment factor, which the operator will be able to adjust based on observed ferrous iron residual levels in the chromium reduction reactor tank (T-300). The actual feed rate is verified once per shift with the volumetric flow tube on the feed pump suction.
- If required, the sulfuric acid solution feed pump (P-801) motor speed will be automatically adjusted based on the average measured pH value from the two pH probes in the recycle loop.
- A flow switch downstream of the chemical mixing pump provides a signal to the control panel in the event of a low-flow condition, which could lead to inadequate chemical mixing. The low-flow signal will provide an operator alarm and will shut down the raw water feed pump.
- The chemical feed pumps can be operated locally or at the control panel.

3.6 Chromium Reduction Reactor (T-300)

3.6.1 Purpose

The chromium reduction reactor (T-300) provides additional residence time of 10 minutes at maximum design flow for Fe(II) and Cr(VI) to react.

3.6.2 System Components

Components of the chromium reduction reactor are:

- Chromium reduction reactor tank (T-300).
- Chromium reduction tank mixer (M-300).

3.6.3 Process Description

Effluent from the pipe reactor flows into the mechanically-agitated chromium reduction reactor (T-300) to provide an additional 10 minutes of residence time at maximum design flow for Cr(VI) reduction to meet the final effluent quality objective. The tank has a floating roof to reduce contact of groundwater with oxygen in the air.

3.6.4 Control System

Components of the control system are discussed below:

- A high-level switch that is set to shut down the raw water feed pump to prevent tank overflow.
- A hand switch in the MCC that allows for local or remote operation of the mixer.
- Temperature and pH probes inserted through the tank wall. The probes have local indicators and transmit data to the control system for display at the control panel.

3.7 Iron Oxidation Reactors (T-301A, T-301B, T-301C)

3.7.1 Purpose

Air is bubbled through the iron oxidation reactors (three tanks installed in series configuration) to oxidize soluble Fe(II) to insoluble Fe(III). If the Fe(II) is not oxidized, it may foul the microfilter and reverse osmosis membranes and could plug the injection wells.

3.7.2 System Components

Components of the iron oxidation reactors are:

- Iron oxidation reactor tanks (T-301A, T-301B, T-301C).
- Iron oxidation tank mixers (M-301A, M-301B, M-301C).
- Air blower (B-300).
- Sodium hydroxide feed pumps (P-802A, P-802B, P-802C).
- Iron oxidation tank demisters (one per tank).
- Clarifier feed pump (P-400).

3.7.3 Process Description

Effluent from the chromium reduction reactor (T-300) enters the bottom of the first iron oxidation reactor tank (T-301A). Water exits T-301A via an overflow pipe and flows to the second iron oxidation tank (T-301B) and then the third iron oxidation tank (T-301C). Treated groundwater flows between the tanks by gravity. The air blower (B-300) pushes air into the bottom of the tanks through perforated pipe.

The reactors were sized and process conditions were selected to reduce dissolved iron from a maximum residual iron (Fe^{2+}) concentration of 44 mg/L (at an influent Cr(VI) concentration of 19 mg/L) to less than 0.05 mg/L when high-TDS water (up to 44,000 mg/L of TDS) is being processed. Each reactor provides 40 minutes residence time at full flow. Bypass lines have been installed to allow a tank to be bypassed if operating conditions permit, or to be taken out of service for cleaning or maintenance during lower-flow periods.

The iron oxidation rate is pH-dependent and is faster at higher pH conditions. The pH of water in each iron oxidation reactor is raised with sodium hydroxide solution to a point at which Fe(II) will oxidize with atmospheric oxygen in air that is sparged into the reactors. The TDS concentration of the water affects the iron oxidation reaction. Therefore, the target pH level depends on the TDS concentrations, as shown below:

- TDS <5,000 mg/L pH ≥7.5
- TDS ~25,000 mg/L pH ~8.0

Precipitated solids can be recycled to any one of the three iron oxidation reactors from the bottom of the clarifier by the sludge recycle pump (P-404), although typically sludge is only recycled to T-301A. Manual diaphragm valves are installed on the sludge recycle lines at each iron oxidation reactor to allow shutoff or throttling of the recycled sludge flow. The sludge recycle rate is set to achieve a total suspended solids (TSS) concentration in the iron oxidation reactor tanks of approximately 2,000 to 4,000 mg/L. This level of TSS increases the reaction rate and reduces the rate of fouling of process equipment, including pH probes.

The demisters minimize drift loss of treated groundwater from the iron oxidation reactors by venting the sparged air through wire mesh packing. Water droplets in the air vented from the iron oxidation reactors impinge on the surface of the packing material. Periodic injection of reverse osmosis permeate from the forced draft aerator into the demisters washes the process water back into the iron oxidation tanks.

3.7.4 Control System

Components of the control system are discussed below:

- Addition of sodium hydroxide to raise the solution pH in the first and second iron oxidation reactors is either a proportional dosage based on the raw water feed flow rate to the treatment plant or feed-forward dosage based on the pH of the target Iron Oxidation Tank. Whether the dosage is based on flow or pH is selectable by the operator. The default is a flow-based proportional dosage.
- Adjustment of pH in the third iron oxidation reactor is based on the pH signal in the tank.
- Each iron oxidation reactor has dual pH probes. The average of both probes provides the main pH signal. When the pH probe signals differ by more than ~0.5 unit, a warning is indicated at the control panel and the operator cleans and calibrates both probes.
- Each tank has a high-level switch that will shut down the raw water feed pump (P-200) if the liquid level exceeds the set point.
- Demister wash water is controlled by a timer and solenoid valve (SV-302). There is a local hand switch to select local manual or automatic timer control of the demister water solenoid valve.
- Mixers can be operated locally or from the control panel by selecting the operating mode with hand switches located in the MCC.
- The iron oxidation tank (T-301C) ultrasonic level element provides a local level indicator and transmits the level signal back to the control panel. The level signal is used to control the variable frequency drive of the clarifier feed pump to maintain a constant level in Tank T-301C.

3.8 Clarifier

3.8.1 Purpose

The chromium reduction and iron oxidation processes feeding the clarifier generate solid precipitates that are removed before final discharge of treated groundwater. The major component of the precipitates is ferric hydroxide. The other significant component is chromium hydroxide, which co-precipitates with the ferric hydroxide.

3.8.2 System Components

Components of the clarifier system are:

- Clarifier (CL-400).
- Mixers (M-400A, M-400B, M-400C).
- Sludge recycle pump (P-404).
- Sludge withdrawal pump (P-401).

3.8.3 Process Description

An inclined-plate clarifier (CL-400) is provided to remove the majority of the chromium hydroxide and iron hydroxide precipitates formed in the upstream reaction. Bench-scale testing of groundwater may be performed periodically at the site to determine the appropriate polymer type and dosage rate to obtain a settleable floc. Polymer is added in a small rapid mix tank, and floc formation occurs in a small flocculation tank, both of which are integral to the clarifier unit. The polymer dose is minimized to avoid fouling the downstream microfilter system.

Settled solids are thickened in a compartment below the clarifier plates. A slow-moving thickening mechanism (M-400C) increases the solids content of the sludge and conveys the sludge to the underflow sludge extraction nozzle.

Sludge is removed from the clarifier thickening section by the sludge recirculation pump (P-404) and the sludge withdrawal pump (P-401). Both pumps are pneumatic diaphragm pumps. The sludge recirculation pump discharges sludge back to the iron oxidation reactors. The sludge withdrawal pump conveys sludge to the sludge holding tank (T-400). The target effluent quality from the clarifier overflow is a turbidity concentration less than 20 nephelometric turbidity units (NTU).

Control of the level of sludge in the clarifier thickening section is important for balancing sludge thickness for recycle against TSS in the clarifier overflow stream. The sludge level in the thickening section of the clarifier is determined by opening the individual valves spaced along the side of the thickening section and visually observing the appearance of the withdrawn liquid. Operators can control the sludge level by adjusting the discharge rate of the sludge withdrawal pump (P-401). The sludge recirculation pump flow rate is set to achieve a target TSS concentration in the iron oxidation tanks. The sludge discharge pump flow rate is set to maintain a constant sludge blanket level in the clarifier thickener section. See SOP-009 *Clarifier Solids Balancing and Wasting* for additional information.

3.8.4 Controls System

Components of the control system are discussed below:

- A torque indicator will automatically shut down the thickening mechanism and provide a warning at the control panel in the event the mechanism detects high sludge viscosity (high-torque condition).
- Hand switches in the MCC allow for local or remote operation of the rapid mix compartment mixer (M-400A), flocculation compartment mixer (M-400B), and clarifier thickening mechanism (M-400C).
- Polymer addition from the polyelectrolyte makedown system is controlled from the control panel by a variable frequency drive on the polymer feed pump.
- Solenoid valves on the sludge discharge lines to the sludge withdrawal pump and the sludge recycle pump open when the pumps are on and close when the pumps are off. These valves prevent sludge from draining through the pumps by gravity. The valves can be locally or remotely operated.
- Local hand switches are provided for the solenoid valves controlling air supply to the sludge withdrawal pump and sludge recycle pump so that the pumps can be operated locally or from the control panel. For each pump, the operator sets one timer for the desired time duration that the pump runs and a second timer for the desired time interval between the pump operating cycles.

3.9 Sludge Holding Tank and Phase Separators

3.9.1 Purpose

The sludge holding tank is used to accumulate sludge prior to dewatering. The phase separators are used to dewater sludge. Dewatered sludge is transported offsite in the phase separators.

3.9.2 System Components

System components include:

- Sludge holding tank (T-402).
- Separator feed pump (P-403).
- Phase separators (PS-405).
- Phase separator sump pump (P-405).

3.9.3 Process Description

The sludge holding tank (T-402) is an agitated, cone-bottom tank used to accumulate sludge prior to dewatering. The mixer is used if plugging of the discharge nozzle occurs; otherwise, the tank can be left unmixed and the operator will have the option to decant clear water from above the settled sludge level through a series of decant nozzles on the tank. Decanted water drains to the process drain tank (T-900).

The separator feed pump (P-403) is used to transfer sludge from the sludge holding tank to the phase separators. The phase separators are rolloff bins with steel mesh baskets which hold disposable sludge filters. Two phase separators are installed at the site. The sludge transfer process is a manual operation initiated by the operators.

The filtrate from the phase separators is discharged to a sump with a submersible sump pump (P-405), which transfers the filtrate to the process drain tank (T-900).

3.9.4 Control System

Components of the control system are discussed below:

- The sludge holding tank has a level element, level transmitter, and local readout. The sludge holding tank level can be monitored at the control panel. A high-level setting activates an alarm at the control panel and shuts down the sludge withdrawal pump (P-401). A low-level setting activates a warning at the control panel.
- The sludge holding tank mixer has a selector switch that allows for control locally or from the control panel.
- The separator feed pump (air-operated) has a solenoid valve on the air line. Timers for the run and off intervals can be set at the control panel. There is a hand switch that allows for control locally or from the control panel. There is a local pressure indicator on the pump discharge.
- Each phase separator has a high level switch that alarms at the control panel and shuts down the separator feed pump.

3.10 Pretreated Water Tank (T-500)

3.10.1 Purpose

The pretreated water tank provides hydraulic separation between the chromium reduction process and the microfilter, allowing the chromium reduction process to continue to run while the microfilter is temporarily shut down, and the microfilter to run when the chromium reduction process is temporarily shut down.

3.10.2 System Components

System components include:

- Pretreated water tank (T-500).
- Pretreated water transfer pump (P-500).

3.10.3 Process Description

The pretreated water tank receives the overflow effluent from the clarifier (CL-400) at a flow rate set by the clarifier feed pump (P-400). The pretreated water tank level is controlled by modulating a level control valve on the microfilter skid to control the discharge flow from the pretreated water transfer pump (P-500) that feeds the microfilter. High- and low-level set points start and stop the pretreated water transfer pump to prevent the tank from overflowing or the pump from running dry.

Off-specification water in the pretreated water tank can be returned to the raw water storage tank (T-100) for reprocessing by manually shutting off the diversion valve to the microfilter system and opening the manual valve to the raw water tank. Downstream systems will continue to operate unless the systems are otherwise shut down or the supply of pretreated water falls too low to sustain operations.

3.10.4 Control System

Components of the control system are discussed below:

- The ultrasonic level element in tank T-500 provides a local level readout and displays the level at the control panel. The level signal is used by the control system to modulate a control valve on the discharge line from the pretreated water transfer pump to maintain tank level within set points.
- High-high level in T-500 alarms at the control panel and shuts down the raw water feed pump (P-200).
- A hand switch in the MCC allows for local or remote operation of the pretreated water transfer pump.

3.11 Microfilter System

3.11.1 Purpose

The microfilter system removes solids in the clarifier effluent over a nominal cut-off diameter of 0.1 micron.

3.11.2 System Components

The microfilter system is a packaged, skid-mounted system that includes:

- Feed tank (T-501).
- Recirculation pump (P-501).
- Microfiltration modules.
- Reverse filtration tank (T-502).
- Reverse filtration pump (P-502).
- Control system.

3.11.3 Process Description

The microfilter system feed tank (T-501) receives flow from the pretreated water transfer pump. The microfilter system is sized to accommodate flow from this pump. There is a local level indicator at the tank that transmits the level signal back to the microfilter control panel. The speed of recirculation pump (P-501) is varied to increase flow through the microfilter to maintain the tank level. The microfilter feed tank has an overflow that drains to the process drain tank. There is a strainer after the recirculation pump to prevent large particles that inadvertently enter the system from fouling the microfilter membrane elements.

The microfilter system has two parallel banks of filter membranes, with 10 membranes each. One bank of membranes is in service at any given time. The recirculation pump transfers treated groundwater from the feed tank through the active membrane elements and back to the feed tank. A restricting orifice in the return line to the tank pressurizes the recirculation loop, which forces water to pass through the membranes as particulate-free microfilter permeate. The microfilter permeate is discharged to the reverse osmosis feed tank (T-600) and is also used to fill the reverse filtration tank (T-502).

As filtered water (permeate) exits the microfilter system and concentrated solids are returned to the feed tank (T-501), the turbidity, which is continuously monitored, gradually increases. The accumulated solids are blown down to the process drain tank periodically to avoid plugging the microfilter membrane elements. Backwash is performed automatically by the microfilter system and can be configured to initiate based either on a turbidity set point or on operating time.

When the backwash cycle initiates, the reverse filtration pump (P-502) pumps filtered water back through the membrane elements. Compressed air cleaning of the membranes is also part of the backwash sequence. System valves are automatically configured so that the contents of the system and the backwash water are routed to the process drain tank. Note that the microfilter system is temporarily offline during the backwash cycle (approximately 2 minutes out of every 40 minutes). The pretreated water tank, pretreated water pump, and microfilter system are all sized to accommodate this offline time.

The microfilter membrane elements require an additional cleaning when transmembrane pressure increases cause the flux rate to decline. At this point the active bank of filter membranes is taken out of service for cleaning and the spare bank is put into service. Microfilter system controls include a cleaning sequence consisting of sequential backflushing of the membrane elements with a chemical solution. Periodic cleaning is described further in the microfilter system O&M manual and SOP-019.

3.11.4 Control System

Components of the control system are discussed below:

- The microfilter system is controlled by the microfilter local PLC that is supplied with the unit. The microfilter PLC transmits signals to the main plant control panel, and operating data for the microfilter unit are displayed in the plant control room.
- The microfilter feed tank has a level element with a local indicator. The level signal controls the recirculation pump variable frequency drive. The local control panel has warnings for low- and high-tank liquid level that are passed to the control panel.
- The microfilter recirculation loop has pressure elements before and after the strainer, with pressure displayed locally and at the control panel.
- There is a local flow indicator in the recirculation loop after the microfiltration modules.
- There is a flow meter on the microfilter effluent line that displays the flow locally and at the control panel.

- There are turbidity meters on two slip streams, one off the recirculation loop after the strainer and the other on the microfilter permeate line. Both turbidity values are displayed on the control panel. The turbidity meter slipstreams drain to the process drain tank.

3.12 Reverse Osmosis Feed Tank

3.12.1 Purpose

The reverse osmosis feed tank stores microfilter effluent for further processing by the reverse osmosis unit or for blending with the reverse osmosis permeate to obtain a targeted effluent TDS concentration.

3.12.2 System Components

System components include:

- Reverse osmosis feed tank (T-600).
- Filtered water transfer pump (P-620).
- Reverse osmosis booster pumps (P-601A and P-601B).
- Reverse osmosis system sulfuric acid metering pump.
- Antiscalant feed system.

3.12.3 Process Description

The reverse osmosis feed tank (T-600) receives treated, filtered water from the microfilter system and recycled reverse osmosis permeate and concentrate. The reverse osmosis feed tank liquid level is maintained by controlling the amount of reverse osmosis permeate and concentrate recycled back to the tank. The reverse osmosis recycle stream compensates for the imbalance between the microfilter effluent flow rate (established by the groundwater extraction rate) and the reverse osmosis feed tank discharge (established by the small range of reverse osmosis feed flows that can be treated). The conductivity of the reverse osmosis recycle stream is matched to that of the microfilter effluent by modulating the proportion of reverse osmosis permeate and concentrate in the reverse osmosis recycle flow.

The filtered water transfer pump (P-620) is used to bypass the reverse osmosis unit and achieve a specified conductivity level at the treated water storage tank (T-700). The discharge piping of the filtered water transfer pump (P-620) and the reverse osmosis permeate pumps (P-605A and P-605B) combine upstream of the treated water storage tank (T-700). A static mixer is used to blend the flows. Conductivity control is achieved by modulating a flow control valve on the filtered water transfer pump (P-620) discharge based on a signal from a conductivity sensor located in the combined discharge pipe.

Operators can also configure the filtered water transfer pump (P-620) controls and discharge valves to recycle off-specification microfilter permeate to the raw water storage tank.

The reverse osmosis booster pumps (P-601A and P-601B) convey reverse osmosis feed water through cartridge filters and into the suction side of the reverse osmosis feed pump (P-602) at a pressure sufficient to meet suction head requirements of the reverse osmosis feed pump.

A commercial antiscalant is injected into the transfer line upstream of the cartridge filters. An injection line for sulfuric acid has also been installed upstream of the cartridge filters, although sulfuric acid is not currently required for reverse osmosis system operation.

The cartridge filters remove small particles that may have passed through the microfilter and also promote efficient mixing of the antiscalant in the reverse osmosis feed stream. Cartridge filters are changed when the difference in readings between the upstream and downstream pressure gauges exceeds the recommended value specified in the reverse osmosis system O&M manual.

3.12.4 Control System

Components of the control system are discussed below:

- The reverse osmosis feed tank (T-600) level is controlled by modulating a level control valve (LCV-603) on the reverse osmosis permeate recycle line to achieve the tank level set point.
- The reverse osmosis feed tank (T-600) has a level sensor with displays locally and at the control panel. Low tank level shuts down the reverse osmosis booster pump (P-601A and P-601B) and generates an alarm at the control panel. High tank level shuts down the pretreated water transfer pump (P-500) and generates an alarm at the control panel. A falling or low-level signal re-enables operation of the pretreated water transfer pump.
- Conductivity meters are located on the microfilter effluent stream to the reverse osmosis feed tank (microfilter permeate), on the reverse osmosis recycle stream (combined permeate and concentrate flows) to the reverse osmosis feed tank, and on the reverse osmosis booster pumps (P-601A and P-601B) discharge line. The control system modulates the reverse osmosis concentrate recycle stream flow control valve (FCV-602) to match the conductivity of the reverse osmosis recycle flow to that of the microfilter effluent. A warning is generated if the post-booster pump conductivity is 10 percent or more higher than the microfilter effluent conductivity. Such a warning condition would indicate that there is a problem with the reverse osmosis recycle stream controls.
- A flow control valve (FCV-615) installed downstream of the filtered water transfer pump (P-620) modulates the reverse osmosis bypass flow rate based on the conductivity sensor (AIT-702). The sensor is installed downstream of the point at which the discharge from the filtered water transfer pump (P-620) combines with the discharge from the reverse osmosis permeate pumps (P-605A and P-605B).
- Sulfuric acid, when used, is fed into the discharge piping of the reverse osmosis booster pumps at a rate determined by the pH set point of the reverse osmosis feed pH controller. The sulfuric acid reduces the pH to ~6.7, a pH sufficiently low that calcium carbonate will not deposit on the membranes during reverse osmosis operation. A pH feedback control loop is used to maintain the proper pH.
- Antiscalant is fed at a fixed rate in proportion to the reverse osmosis reject stream flow rate.
- A hand switch in the MCC allows for local or remote operation of the filtered water transfer pump (P-620).

- A hand switch at the local control panel allows for operation of the reverse osmosis booster pumps.
- The signal from the inline pH probe between the cartridge filters and the reverse osmosis feed pump controls the reverse osmosis system sulfuric acid feed pump through a feedback loop; however, sulfuric acid is not currently dosed into the reverse osmosis system.

3.13 Reverse Osmosis Unit

3.13.1 Purpose

The purpose of the reverse osmosis system is to reduce the TDS of the treated groundwater prior to subsurface injection. The TDS is reduced to a level that approximately matches the TDS of the formation into which the treated groundwater is injected. Because the reverse osmosis permeate has a much lower TDS than the naturally-occurring groundwater at the site, a portion of the permeate is blended with water that is bypassed around the reverse osmosis unit to achieve the desired TDS level.

3.13.2 System Components

The reverse osmosis system components include:

- Reverse osmosis feed pump (P-602).
- Reverse osmosis membrane skid.
- Reverse osmosis cleaning tank (T-601).
- Reverse osmosis cleaning pump.
- Sulfuric acid feed pump 2 (P-801B) (this pump is not currently used).
- Forced draft (F.D.) aerator (T-603).
- Blower (B-600).
- Post-treated reverse osmosis permeate pumps (P-605A and P-605B).
- Local control panel.

3.13.3 Process Description

The reverse osmosis feed pump (P-602) boosts the flow from the reverse osmosis booster pumps (P-601A and P-601B) up to the operating pressure of the reverse osmosis membranes. The flow through the reverse osmosis membrane modules is controlled by manual operation of a ball valve located downstream of P-602. Minimum flow is set by an orifice installed parallel to the needle valve.

A portion of the reverse osmosis concentrate is blended with a portion of the reverse osmosis permeate and recycled back to the reverse osmosis feed tank (T-600). The remainder of the concentrate flow is discharged into the reverse osmosis concentrate storage tank (T-701).

The reverse osmosis permeate flows to the Forced draft (F.D.) aerator (T-603). The purpose of the F.D. aerator is to strip carbon dioxide from the treated water through aeration, thereby increasing the pH of the permeate above pH 6.5. The F.D. aerator is only used if the conditions require it. The post-treated reverse osmosis permeate pumps (P-605A and P-605B) discharge the pH-adjusted permeate from the F.D. aerator sump to the reverse osmosis feed tank (T-600) and the treated water storage tank (T-700). The pumps cycle on and off based on the liquid level in the aerator sump.

The reverse osmosis cleaning tank (T-601) is used for periodic reverse osmosis system cleaning. Chemicals are added to the tank manually using a portable transfer pump. Makeup water is supplied from the treated water storage tank (T-700) via the treated water transfer pump (P-700). The cleaning solution is circulated through the reverse osmosis modules and both the concentrated and permeate are diverted back to the reverse osmosis cleaning tank. Further description of the reverse osmosis cleaning procedure is presented in SOP-018.

The reverse osmosis unit is a temporary system and, as such, the materials of construction may not be compatible with long-term use at the site. The unit should be inspected periodically for corrosion.

If the reverse osmosis system is shut down for more than a few days, the reverse osmosis membranes should be laid up per manufacturer's recommendations.

3.13.4 Control System

Components of the control system are discussed below:

- The reverse osmosis recovery (permeate flow rate as a percentage of feed flow rate) is manually adjusted via the needle valve on the reverse osmosis concentrate discharge.
- The reverse osmosis feed tank (T-600) level is controlled by modulating a valve on the reverse osmosis permeate recycle line to the reverse osmosis feed tank. Low level in the reverse osmosis feed tank shuts down the reverse osmosis feed pump (P-602). The recycle loop allows the reverse osmosis feed to remain within a tight range.
- The system alarms if the pressure in the permeate line exceeds a preset value, indicating a break in the membrane, and shuts down the reverse osmosis system.
- The level in the F.D. aerator tank (T-603) is displayed at the control panel. There are low-low and high-high level alarms at the panel. The level signal is used to control the flow control valve on the pump discharge to maintain the level within the desired set points. Low tank level causes the post-treated permeate pumps (P-605A and P-605B) to shut down.
- Permeate conductivity is monitored both upstream and downstream of the F.D. aerator. Signals for pH and temperature are also monitored downstream of the F.D. aerator. The conductivity, pH, and temperature values downstream of the F.D. aerator are displayed at the control panel. The control panel indicates warnings on high conductivity and low and high pH.
- Reverse osmosis permeate is mixed with water bypassed around the reverse osmosis unit (i.e., pumped directly from the reverse osmosis feed tank by P-620) and discharged to the treated water storage tank (T-700). A static mixer is used to blend the two water streams. A conductivity meter is installed near the inlet to the treated water storage tank and transmits a signal to the plant control panel. Based on a target conductivity set

point, the plant control panel adjusts a flow-control valve (FCV-615) downstream of P-620 to control the proportion of reverse osmosis bypass water discharge to T-700.

3.14 Reverse Osmosis Concentrate Storage Tank

3.14.1 Purpose

The reverse osmosis concentrate tank receives reverse osmosis concentrate from the reverse osmosis system and stores it prior to pumping it to tanks at the MW-20 bench.

3.14.2 System Components

System components include:

- Reverse osmosis concentrate storage tank (T-701).
- Reverse osmosis concentrate transfer pump (P-701).

3.14.3 Process Description

When the liquid level in the reverse osmosis concentrate tank reaches the high level set point, the reverse osmosis concentrate transfer pump is turned on. The pump discharges reverse osmosis concentrate via an underground pipeline to the MW-20 bench until the liquid low level set point is reached, at which point the pump is cycled off. The liquid level set points can be changed by the operator to provide more storage capacity in the event that discharge to the MW-20 bench must be temporarily stopped.

3.14.4 Control System

Component of the control system are discussed below:

- Ultrasonic level element with local and control panel level indicators. The pump starts at the low-level set point and turns off at the high-level set point. The high-high alarm shuts down the reverse osmosis system.
- A hand switch in the MCC allows for local or remote operation of the reverse osmosis concentrate transfer pump (P-701).

3.15 Treated Water Storage Tank

3.15.1 Purpose

The treated water storage tank supplies treated groundwater to the seal water system for use within the treatment plant (seal water, chemical makeup water, demister wash, etc.) and provides hydraulic separation between the treatment system and the treated water management system (injection wells).

3.15.2 System Components

System components include:

- Treated water storage tank (T-700).

- Treated water transfer pump (P-700).

3.15.3 Process Description

Reverse osmosis permeate is pumped to the treated water storage tank from the F.D. aerator tank (T-603) and the reverse osmosis feed tank (T-600). The treated water transfer pump discharges treated water to the injection wells. If necessary, treated water can also be pumped to the MW-20 bench Baker tanks by changing the configuration of manual valves. The pump cycles on and off to maintain the water level in the tank between operator-selected set points.

3.15.4 Control System

Components of the control system are discussed below:

- The level element in the treated water storage tank provides level indication locally and at the control panel. The level element signal controls the treated water transfer pump by cycling it on and off between the high and low set points. The tank low-low level alarm shuts down the treated water transfer pump. The tank high-high level alarm shuts down the reverse osmosis permeate pumps (P-605A and P-605B).
- A hand switch in the MCC allows for local or remote operation of the treated water transfer pump (P-700).
- The treated water transfer pump has a local pressure indicator.

3.16 Seal Water System

3.16.1 Purpose

The treated water storage tank supplies treated groundwater to the seal water system, which provides seal water to the process pumps.

3.16.2 System Components

System components include:

- Seal water tank (T-1100).
- Seal water pump (P-1100).

3.16.3 Process Description

The seal water pump uses treated effluent from the treated water storage tank (T-700) to pressurize the seal water tank, which is a small pressurized (bladder) tank. The seal water tank pressurizes the supply piping for the seal water system.

3.16.4 Control System

Components of the control system of this vendor-supplied package are discussed below:

- A pressure transmitter is installed downstream of the seal water pump to control the seal water pump speed through a variable frequency drive. Control of the pump speed maintains the pressure in the seal water tank within the set point limits.
- A low-pressure switch is installed in the seal water distribution header that provides a warning at the control panel.

3.17 Process Drain Tank (T-900)

3.17.1 Purpose

The process drain tank receives small incidental flows from various process equipment so it can be returned to the raw water storage tank for reprocessing.

3.17.2 Process Components

Process components include:

- Process drain tank (T-900).
- Process drain pump (P-900).

3.17.3 Process Description

The process drain tank receives wastewater from:

- Containment areas (accumulated rain water or spills).
- Phase separator pumpout vault.
- Clarifier and sludge holding tank decant.
- Microfilter backwash.
- Microfilter system turbidity meters.
- Tank and system drains and overflows.
- Strainer drains.

The tank is located in a sump so that wastewater can drain to the tank under gravity. A portable sump pump can be used to discharge accumulated water from the sump if required.

When the liquid level in the process drain tank reaches the high level set point, the process drain pump is turned on. The pump discharges wastewater to the raw water storage tank (T-100) until the liquid low-level set point is reached, at which point the pump is cycled off. The liquid level set points in T-900 can be changed by the operator to provide additional storage capacity, if required. Piping is also provided to pump the tank contents through a fill port into a tanker truck for offsite disposal.

3.17.4 Control System

Components of the control system are discussed below:

- The process drain tank (T-900) has a level element that indicates locally and at the control panel. The level element controls the process drain pump as the tank cycles between high- and low-level set points. There are high- and low-level warnings at the control panel.
- A hand switch in the MCC allows for local or remote operation of the process drain pump (P-900).
- A high-level switch will be used to detect water between the tank wall and the sump wall.

3.18 Chemical Feed Systems

3.18.1 Purpose

The chemical feed systems deliver chemicals to the treatment processes at the appropriate dosage rates.

3.18.2 System Components

System components include:

- Ferrous chloride feed pump (P-800).
- Sulfuric acid feed pump 1 (P-801A).
- Sulfuric acid feed pump 2 (P-801B).
- Sulfuric acid feed pump 3 (P-801C).
- Sodium hydroxide feed pump 1 (P-802A).
- Sodium hydroxide feed pump 2 (P-802B).
- Sodium hydroxide feed pump 3 (P-802C).
- Polyelectrolyte feed pump to clarifier (P-804).
- Polyelectrolyte feed pump to dewatering (P-805).

Note that other chemical feed pumps are used as part of the microfilter system and reverse osmosis system cleaning procedures and are described in the corresponding sections.

3.18.3 Process Description

Chemical totes and drums are stored in areas with secondary containment. Incompatible materials are segregated. Chemical feed pumps operate automatically in response to system instrumentation values, as described previously.

3.18.4 Control System

Additional information related to chemical feed system control is provided in the sections corresponding to the systems into which the chemicals are dosed. An indication of whether or not a chemical feed pump has power from the MCC will be displayed on the HMI. However, the HMI does not provide an indication of whether or not the pumps are actually on or off. Visual observation of each feed pump is required to confirm operation. The chemical feed pumps will normally operate in the automatic mode.

3.18.4.1 Ferrous Chloride Feed Pump

Components of the control system are discussed below:

- Local indication of chemical pump discharge pressure.
- Warning of pump low-flow condition.
- The operator will be able to regulate the rate of the ferrous chloride pump, P-800, from the HMI screen. The chemical feed rate is proportional to the groundwater influent flow rate adjusted for the influent Cr(VI) concentration, the dissolved oxygen concentration, the ferrous chloride chemical concentration, and the pump stroke setting. The chemical feed rate can be fine-tuned using an operator adjustment factor. In general, all of the variables will remain fixed, with the exception of the adjustment factor, which the operator will be able to adjust based on observed ferrous iron residual levels in the chromium reduction reactor tank (T-300). The PLC will then determine the correct pulse rate to operate the metering pump. Should the operator select to operate the pump in manual mode, via the HMI, the pulse rate sent to the metering pump will be solely determined by the operator. Manual mode is designed to be used only in abnormal plant operational scenarios.

3.18.4.2 Sulfuric Acid Feed Pump 1 (to Plug Flow Cr(VI) Reduction Reactor)

Components of the control system are discussed below:

- Local indication of chemical pump discharge pressure.
- Warning of pump low-flow condition.
- The operator will be able to regulate the rate of the sulfuric acid pump (P-801A) from the HMI screen. The chemical feed rate is controlled through a dynamic feedback control loop, which moderates the feed rate based on the differential between an operator-selected pH level set point and the measured pH level in the chemical mixing pump (P-201) suction line, as determined by the AE-202 pH sensor. If the measured pH level is higher than the set point, the feed rate is increased. If the measured pH level is lower than the set point, the feed rate is decreased. The PLC will determine the correct pulse rate to operate the metering pump. To date, it has not been necessary to operate this pump to control pH in the plug flow reactor.

3.18.4.3 Sulfuric Acid Feed Pump 2 (to Treated Water Line)

This pump is provided to lower effluent pH, if found to be necessary to prevent precipitation in the effluent pipeline.

Components of the control system are discussed below:

- Local indication of chemical pump discharge pressure.
- Warning of pump low-flow condition.
- The operator will be able to regulate the rate of the sulfuric acid pump (P-801B) from the HMI screen. The chemical feed rate is controlled through a dynamic feedback control loop, which moderates the feed rate based on the differential between an operator-

selected pH level set point and the measured pH level in the pipe upstream of the treated water storage tank (T-700), as determined by the AE-606 pH sensor. If the measured pH level is higher than the set point, the feed rate is increased. If the measured pH level is lower than the set point, the feed rate is decreased. The PLC will determine the correct pulse rate to operate the metering pump. To date, it has not been necessary to operate this pump to control the pH of the treated water.

3.18.4.4 Sulfuric Acid Feed Pump 3 (to Reverse Osmosis Feed Line)

Components of the control system are discussed below:

- Local indication of chemical pump discharge pressure.
- Warning of pump low-flow condition.
- The operator will be able to regulate the rate of the sulfuric acid pump (P-801C) from the HMI screen. The chemical feed rate is controlled through a dynamic feedback control loop, which moderates the feed rate based on the differential between an operator-selected pH level set point and the measured pH level in the reverse osmosis feed pump (P-602) suction line, as determined by the AE-604 pH sensor. If the measured pH level is higher than the set point, the feed rate is increased. If the measured pH level is lower than the set point, the feed rate is decreased. The PLC will determine the correct pulse rate to operate the metering pump. To date, it has not been necessary to operate this pump to control pH in the reverse osmosis unit.

3.18.4.5 Sodium Hydroxide Feed Pump 1 (Feed to Iron Oxidation Reactor 1)

Components of the control system are discussed below:

- Local indication of chemical pump discharge pressure.
- Warning of pump low-flow condition.
- The operator will be able to regulate the rate of the sodium hydroxide pump (P-802A) from the HMI screen. The pump flow is proportional to the groundwater influent flow rate as determined by the PLC.

3.18.4.6 Sodium Hydroxide Feed Pump 2 (Feed to Iron Oxidation Reactor 2)

Components of the control system are discussed below:

- Local indication of chemical pump discharge pressure.
- Warning of pump low-flow condition.
- The operator will be able to regulate the rate of the sodium hydroxide pump (P-802B) from the HMI screen. The pump flow is proportional to the groundwater influent flow rate as determined by the PLC.

3.18.4.7 Sodium Hydroxide Feed Pump 3 (Feed to Iron Oxidation Reactor 3)

Components of the control system are discussed below:

- Local indication of chemical pump discharge pressure.

- Warning of pump low-flow condition.
- Operator will be able to regulate the rate of the sodium hydroxide pump (P-802C) from the HMI screen. The chemical feed rate is controlled through a pH feedback control loop at an operator-selected set point based on the tank T-301C pH sensor. The PLC will determine the correct pulse rate to operate the metering pump.

3.18.4.8 Polyelectrolyte Feed Pump to Clarifier (P-804)

Components of the control system are discussed below:

- Warning of low polyelectrolyte level.
- Local indication of pump discharge pressure.
- The operator will be able to start and stop the polyelectrolyte feed pump to the clarifier (P-804) locally. The pump discharge rate can be adjusted remotely at the HMI by adjusting the variable frequency drive for the pump. The discharge rate can be verified by performing a drawdown test using the calibration column next to the pump. The dose rate of polyelectrolyte is set to create floc of the proper size and separation in the clarifier.
- There are no automatic flow-pacing connections to the plant process control system.

3.18.4.9 Polyelectrolyte Feed Pump to Dewatering System (P-805)

Components of the control system are discussed below:

- Warning of low polyelectrolyte level.
- Local indication of pump discharge pressure.
- The operator will be able to start and stop the polyelectrolyte feed pump to the dewatering system (P-805) locally. The pump discharge rate can be adjusted remotely at the HMI by adjusting the variable frequency drive for the pump. The discharge rate can be verified by performing a drawdown test using the calibration column next to the pump.
- There are no automatic flow-pacing connections to the plant process control system.

3.19 Injection Wells

3.19.1 Purpose

The injection wells are used to return treated water to the aquifer.

3.19.2 System Components

System components include:

- Injection wells (IW-2 and IW-3).
- Flow meters (FE-1202 and FE-1203).
- Pressure gauges (PIT-1202 and PIT-1203).

- Flow control valves (FV-1202 and FV-1203).
- Well water level sensors (LE-1202 and LE-1203).

3.19.3 Process Description

Two injection wells (IW-2 and IW-3) are currently installed at the site. Additional wells may be installed in the future if required. The treated water transfer pump (P-700) discharges treated effluent into a header that distributes flow to the injection wells. The injection flow rate and pressure are displayed locally and transmitted to the plant control panel for display on the HMI. The operator can control the discharge flow rate to each well from the HMI by setting the flow control valves to the desired flow rate. The flow control valves include solenoid shutoffs which remain open when P-700 is operating and fail closed when P-700 turns off. This feature is designed to hold water in the pipeline when the transfer pump is not operating, to minimize air entrainment in the line.

The injection wells are sealed at the surface with a flange. Injection pipe penetrates through each flange into the wells. Air/vacuum release valves are provided at each injection well head to regulate pressure in the well. Air injection pipe and water effluent pipe are installed to facilitate periodic backflushing of the injection wells.

3.19.4 Control System

The control system includes:

- Flow meters (FIT-1202 and FIT-1203) that indicate locally and at the control panel.
- Pressure gauges (PIT-1202 and PIT-1203) that indicate locally and at the control panel.
- Flow control valves with solenoid shutoffs (FV-1202 and FV-1203) that allow for remote control of the injection flow rate and hold the injection line open or close based on the operation of the treated water transfer pump (P-700).
- Level elements in the wells that indicate locally and at the control panel.

Additional information on the control and monitoring of the injection wells is included in the *Interim Measures Injection Well Operation and Maintenance Plan* (CH2M HILL 2005c).

3.20 MW-20 Bench Tanks

3.20.1 Purpose

The MW-20 bench tanks store reverse osmosis concentrate or off-specification treated water for offsite disposal.

3.20.2 System Components

System components include:

- Three 19,000-gallon tanks (T-702, T-703, T-704).

3.20.3 Process Description

Reverse osmosis concentrate is pumped by the reverse osmosis concentrate transfer pump (P-701) to the MW-20 bench tanks. Off-specification treated water can also be pumped to these tanks using the treated water transfer pump (P-700). The tank levels are monitored once per shift and inlet valves are configured manually to regulate flow into the tanks. The wastewater in the tanks is pumped into trucks for offsite disposal.

3.20.4 Control System

The control system includes:

- Reverse osmosis concentrate flow meter (FIT-701) that indicates locally and at the control panel.
- High-level switches that provide warnings at the control panel.
- High-high level switches that shut down the reverse osmosis concentrate pump (P-701).

3.21 Other Systems

Additional systems at the plant include:

- Instrument air.
- Laboratory facilities.
- Fire suppression.
- Safety showers.
- Intercom.
- Fire alarms.
- Toilets.
- Potable water supply.
- Emergency generator.

These systems will be monitored and maintained by the operations staff.

4.0 Initial Startup Procedures

Initial startup of the system was completed in 2005. If the plant is to be shut down for an extended time period, the startup procedures as outlined in the *Interim Measures No. 3 Treatment and Extraction System Initial Startup Plan* (CH2M HILL 2005b) may be used to re-start the plant. Such a startup would likely take 1 to 3 weeks, depending on the extent of lay-up of the plant.

Operating procedures, including startup and shutdown procedures after initial startup, are presented in Section 5.0 and Appendix E.

5.0 Operating Procedures

Specific information presented in this section includes:

- Control system description and operation.
- Field instrumentation.
- Listing of periodic operations.
- Troubleshooting.
- Process upset conditions.

5.1 Control System Description

See Appendix D for the control systems operations manual. Initial set points are summarized in Table 5-1. These set points may be periodically adjusted by the operations manager based on plant operating experience.

5.2 Field Instrumentation

Field instruments are listed in design documents.

5.3 Standard Operating Procedures

Appendix E presents SOPs for periodic operations, including (among others):

- System "hot" and "cold" startup.
- Generator startup and shutdown.
- Calculation of ferrous dosage.
- Polymer make-up.
- Solids Wasting.
- Cleaning and maintenance of instrumentation and control equipment.
- Offsite trucking of wastewater.
- Reverse osmosis unit clean-in-place procedure.
- Laboratory analysis of hexavalent chromium, ferrous iron, percent solids, and other parameters.

Appendix F lists equipment O&M manuals, which provide descriptions of installation, operation, and maintenance procedures, as well as drawings and materials data, for the major equipment used at the site, including (among others):

- Reverse osmosis system.
- Microfilter system.
- Centrifugal pumps, extraction well pumps, chemical metering pumps, and air-operated pumps.
- Mixers.
- Air compressor and air blower.

- Clarifier
- Polymer feed system
- Instrumentation and controls

The equipment O&M manuals are bound separately.

5.4 Process Upset Prevention, Detection, and Recovery

The treatment plant has been designed with the capability for recycling and retreating system effluent, if necessary, due to an upset or unanticipated condition. A detailed analysis of possible failure modes is presented in Appendix G. Upset conditions linked to compliance with effluent limitations include:

- Elevated hexavalent or total chromium concentration in the treated water effluent, per WDR R7-2004-0103.
- pH values outside of limitation range in the treated water effluent, per WDR R7-2004-0103.
- TDS concentrations in the treated water effluent above a level which has been determined in consultation with the Regional Water Quality Control Board above the acceptable target set in *Groundwater and Hydrogeologic Investigation Report for Interim Measures No. 3 Injection Area* (CH2M HILL 2005e).

In general, recovery from most alarm conditions is achieved by simply restarting the system. In some cases, samples from specific treatment tanks may need to be tested and the system placed in recirculation mode before normal operation can be resumed.

5.4.1 Hexavalent Chromium Upset Condition

5.4.1.1 Prevention of Upset Condition

Critical systems in the reduction of Cr(VI) to Cr(III) are:

- Addition of the proper amount of ferrous chloride.
- pH control of ferrous chloride/groundwater mixture in the proper range.
- Adequate mixing and contact time of ferrous chloride solution and groundwater.

Treatment system design assures adequate mixing and contact time of ferrous chloride with groundwater. The pipe reactor and recycle loop are sized to achieve the target Cr(VI) reduction. Were the chemical mixing pump to cease operation, the control system is configured to shut the entire treatment system down. There is additional mixing and retention time in the chemical reduction reactor (T-300).

If ferrous chloride is not getting to the pipe reactor recycle loop injection location, as indicated by the low flow switch and the flowmeter in the ferrous chloride feed line, the control system is configured to shut the system down.

There are dual pH probes in the pipe reactor loop and in the chemical reduction reactor tank. The control system will alarm at the control panel and shut down the treatment system if the pH is outside of its target range. Warnings appear at the control panel if the dual pH probe readings differ by more than a specified amount.

Finally, the reverse osmosis system, although not intended for the removal of Cr(VI), would remove approximately 90 percent of the hexavalent chromium in the reverse osmosis feed water.

5.4.1.2 Detection of Upset Condition

The control panel will provide warnings and alarms to the operators in the event of out-of-specification pH and ferrous chloride flow conditions. Periodic sampling for Cr(VI) will also be done at points throughout the system, as described in Appendix H.

5.4.2 Trivalent Chromium Upset Condition

5.4.2.1 Prevention of Upset Condition

Critical systems in the removal of Cr(III) are:

- pH control in the iron oxidation reactors to promote co-precipitation of chromium hydroxide with ferric hydroxide.
- Integrity of the microfilter membranes, which provide a barrier to precipitated chromium hydroxide particles.

There are dual pH probes in the iron oxidation reactors. The control system will alarm at the control panel and shut down the treatment system if the pH is outside of its target range. Warnings appear at the control panel if the dual pH probe readings differ by more than a specified amount.

Turbidity meters are installed in the microfilter effluent discharge line to confirm that the microfilter membranes are operating correctly. The control system will alarm at the control panel and shut down the treatment system if the turbidity exceeds its normal value by more than a predetermined amount.

5.4.2.2 Detection of Upset Condition

The control panel will provide warnings and alarms to the operators in the event of out-of-specification pH and turbidity values. Periodic sampling for total chromium will also be done at points throughout the system, as described in Appendix H.

5.4.3 High or Low pH Upset Condition

5.4.3.1 Prevention of Upset Condition

In the treatment process, the initial pH is adjusted by addition of acid and caustic to optimize treatment chemistry. The final pH is measured prior to discharge into the treated water storage tank. The control system is configured to provide warnings at the control panel in the event that any of the pH probes register an out-of-specification value.

5.4.3.2 Detection of Upset Condition

The treatment system has continuous-reading pH probes at various process locations that will provide warnings at the control panel in the event that measured values are not within specified ranges.

5.4.4 High TDS Upset Condition

5.4.4.1 Prevention of Upset Condition

TDS is removed from the groundwater by the reverse osmosis process. TDS is monitored in the treatment system through the surrogate parameter of conductivity. The conductivity of the reverse osmosis permeate from the reverse osmosis process and that of the blended (microfilter permeate and reverse osmosis permeate) final effluent is continuously monitored. The system will be shut down if the reverse osmosis permeate or blended final effluent conductivity exceeds a specified maximum value.

5.4.4.2 Detection of Upset Condition

Conductivity is measured: (1) at the influent to the reverse osmosis feed tank (T-600), (2) at the influent to the reverse osmosis system, (3) in the reverse osmosis permeate line upstream and downstream of the F.D. aerator, (4) in the recycle stream to the reverse osmosis feed tank, (5) at the inlet to the reverse osmosis concentrate storage tank, and (6) at the inlet to the treated water storage tank. The control system warns the operators in the event that conductivity values are outside of acceptable ranges.

5.4.5 Recovery from an Upset Condition

In the event of an upset condition, the treatment system will be shut down. Operators need to identify and document the upset condition, correct the upset condition, manage any out-of-specification groundwater in the system, and restart the system.

5.4.5.1 Identify the Upset Condition

The first step in recovering from an upset condition is to identify and document the nature and cause in the daily operations log. At a minimum, actions that should be taken to identify the nature of the upset condition include:

1. If the shut down was not operator-initiated, review the warning and alarm log to identify the event(s) triggering the shutdown.
2. Analyze samples from the reverse osmosis feed tank and treated water storage tank to assess whether the Cr(VI) concentration is above the monthly average permit limit of 8 parts per billion (micrograms/liter or μg/L) and/or the maximum daily limit of 16 μg/L, using onsite laboratory procedures.
3. Review the conductivity data for AIT-702 to confirm that the treated groundwater entering the treated water storage tank is consistent with the value required for subsurface injection (approximately 4,200 mg/L).
4. Review pH data from AIT-606 to confirm that the pH values are within the acceptable discharge range.

5.4.5.2 Correct the Upset Condition

Once the cause of the upset condition is identified, it should be corrected, and the correction should be documented in the daily log.

5.4.5.3 Manage Out-of-Specification Groundwater

Out-of-specification groundwater in process units up to and including the reverse osmosis feed tank can be re-circulated using the filtered water transfer pump (P-620) back to the raw water storage tank. Out-of-specification groundwater in the reverse osmosis system can be recirculated to the raw water storage tank by opening valve V-TW-114-02 and closing valve V-TW-105-02.

There may be conditions, such as an overdose of polymer, that require draining selected process units to the off-specification water tank. Equipment drains have been provided with drain-hose fittings for this purpose.

In the event that the water in the treated water storage tank does not meet discharge requirements for subsurface injection and it cannot be re-treated, it can be pumped to tanks at the MW-20 bench for offsite disposal. However, the discharge lines from the treated water storage tank and the reverse osmosis concentrate storage tank are not designed to handle wastewater that is a hazardous waste. In the event of an upset condition that results in either of these tanks containing hazardous wastewater (pH less than 2.0 or greater than 12.5 or total chromium concentration greater than 5 parts per million), the water in the tank will either be re-treated onsite or loaded into trucks for transportation to a permitted offsite disposal facility.

5.4.5.4 Restart the Treatment System

The treatment system should be restarted using the startup SOPs in Appendix E.

TABLE 5-1
Treatment Plant Control Set Point List – April 2006
Interim Measures No. 3 Treatment and Extraction System Operation and Maintenance Plan

Parameter	Set Point	Control Approach
Raw Water Storage Tank T-100 Level	High tank level at 10.5 feet, low tank level at 2.0 feet	On-Off Control of extraction well pumps.
Treatment Plant Flow Rate at FIC-200	Flow rate selected by operator in the range 20 to 135 gpm	Modulation of Flow Control Valve FCV-200
FeCl Pump P-800 Feed Rate	Dose (mL/gpm) proportional to influent groundwater flow rate	PLC adjusts pump pulse rate based on groundwater flow rate and operator-specified parameters.
NaOH Pump P-802A Feed Rate	Dose (ml/gpm) set by operator along with influent flow rate	Adjusts pump speed based on dose set point and influent flow rate
NaOH Pump P-802B Feed Rate	Dose (ml/gpm) set by operator along with influent flow rate	Adjusts pump speed adjusted based on dose set point and influent flow rate
NaOH Pump P-802C Feed Rate	pH of 8.0 standard units	Adjusts pump speed based on signal from AIT-301C
Polymer System P-804 and P-805 Feed Rates	Feed rates set by operator at HMI by adjusting pump VFDs	Observation of floc in clarifier and periodic jar tests by plant operator
Iron Oxidation Tank C T-301C Level	Tank level at 12 ft	Adjusts VFD on Clarifier Feed Pump P-400
Demister Water Wash Solenoid Valve SV-302	On every 3 hours On for 30 seconds	Timer Control
Sludge Recycle Flow Rate	Continuous operation	Operator sets P-404 timer based on observation of clarifier floc and sludge
Clarifier Sludge Transfer to Sludge Holding Tank	On every 60 minutes On for 3 minutes	Operator sets P-401 timer based on observation of clarifier sludge level.
Sludge Storage Tank Level	High tank level at 11 ft Low tank level at 3 ft	Manual control of Phase Separator Feed Pump (P-403)
Process Drain Tank T-900 Level	High tank level at 6.5 ft Low tank level at 2.5 ft	On/off control of Process Drain Pump (P-900)
Reverse Osmosis Feed Tank T-600 Level	High tank level at 14 ft Low tank level at 3 ft Target level between 8-10 feet	Adjusts LCV-603 on Reverse Osmosis Permeate Recycle line
Reverse Osmosis Feed Tank Conductivity	AIT-604 to match AIT-600 within ±5 %	Adjusts FCV-602 on Reverse Osmosis Conc. Recycle line based on AIT-600 signal
F.D. Aerator Tank T-603 Level	High tank level at 10 inches Low tank level at 1.1 inches Target level at 7 inches	Adjusts Level Control Valve LCV-604
Treated Water Storage Tank T-700 Level	High level at 7 ft Low level at 3 ft	On/off control of Treated Water Transfer Pump (P-700)
Reverse Osmosis Concentrate Storage Tank Level Control T-701	High tank level at 12 ft Low tank level at 2 ft	On/off control of Reverse Osmosis Conc. Transfer Pump (P-701)

Note: These set points may be periodically adjusted by the plant operations manager based on plant operating experience.

6.0 Description of Maintenance

It is the responsibility of the plant operators to incorporate regular preventive maintenance into the routine work schedule based on the guidelines presented in this plan and the maintenance requirements provided in the manufacturer's manual for each piece of equipment in the plant. A computerized maintenance management program ("MP2") has been implemented at the facility to keep track of maintenance requirements. Operators access the program daily to determine required maintenance tasks. Operators keep maintenance records documenting completion of preventative maintenance tasks.

7.0 Replacement Schedule for Equipment and Installed Components

Equipment and installed components will be inspected and maintained as described in Section 6.0. Equipment will be replaced as-needed, based on the results of the inspections and preventative maintenance.

Proposed system downtimes for preventative maintenance include:

- Twice a year: 1-week downtime each.
- Twice a year: 4-day downtime each.
- Monthly (in other 8 months): 2-day downtime each.

Maintenance will include activities such as pump lubrication, cleaning the reverse osmosis and microfilter membranes, and other activities described in Section 6.0. These activities are required to keep the plant running and to reduce the chance of unexpected mechanical failures. Downtimes will be scheduled to occur at low-flow seasons as much as possible.

8.0 Waste Management Plan

Waste streams resulting from operation of the groundwater extraction and treatment system include residual solids, reverse osmosis concentrate, empty containers of treatment chemicals, waste lubricating oil, and off-specification treated groundwater. Management of these wastes is addressed in the Waste Management Plan, which has been prepared as a separate document.

9.0 Sampling and Monitoring

9.1 Process Monitoring

Process monitoring includes:

- Logging alarms and documenting operator interventions.
- Confirming key process set points.
- Recording key local process instrument readings (level, flow, pH, turbidity, pressure, etc.).
- Determining sludge levels in the clarifier, sludge storage tank, and phase separators.
- Assessing treatment chemical volumes.
- Confirming chemical feed rates.
- Monitoring groundwater at various treatment system locations for Fe(II), Cr(VI), total chromium, conductivity, and total suspended solids.
- Documenting general plant conditions.

Process monitoring and laboratory analytical checklists are included in Appendix H. Routine laboratory analyses are conducted onsite using standard laboratory equipment.

The chemistry of the treatment process is monitored using a Hach DR 4000V Spectrophotometer. The Hach DR 4000V is used to routinely analyze water for Fe(II), Cr(VI), and total chromium. The Hach analyses are used to monitor and analyze the chromium reduction, iron oxidation, clarification, and microfiltration processes.

9.2 Compliance Sampling

Compliance monitoring activities are required under the WDR for Underground Injection of Treated Groundwater issued by the Water Board. The WDR is presented in Appendix A. Compliance monitoring guidance is provided in the *Groundwater Compliance Monitoring Plan for Interim Measures No. 3 Injection Area* (CH2M HILL 2005d).

9.3 Hazardous Waste Inspections

The following hazardous waste inspections will be performed:

- Container storage areas will be inspected at least weekly for leaking containers and for deterioration of the containment system caused by corrosion or other factors (22 CCR 66265.174).
- Hazardous waste tanks will be inspected daily for overfill/spill control equipment, corrosion or releases of waste and, for uncovered tanks, the level of waste in the tank (22 CCR 66265.195).

10.0 O&M Contingency Procedures

The Contingency Plan is included in Appendix J.

11.0 Data Management, Documentation, and Reporting Requirements

11.1 Records

Treatment plant records include:

- Data historian, which contains a log of all PLC inputs.
- Process monitoring records (see Appendix H).
- Maintenance/calibration records (see Section 6.0).
- Conditional Authorization inspection and monitoring records (see the California Health and Safety Code, Section 25200.3).
- Hazardous waste generator records (22 CCR, Section 66262.40).
- Monthly and Quarterly Self-monitoring Reports (see Appendix A, *Monitoring and Reporting Program No. R7-2004-0103,* Reporting Section).
- Semi-Annual Operation and Maintenance Reports (see Appendix A, *Monitoring and Reporting Program No. R7-2004-0103,* Operation and Maintenance Section).
- Reporting of non-compliance.

These records will be retained for a period of at least 5 years.

11.2 Monthly and Quarterly Monitoring Reports

Monthly and quarterly monitoring reports meeting the requirements of the WDRs, Monitoring and Reporting Program, will be prepared according to the WDR Reporting section and will be submitted to the Water Board by the dates specified in Item 9 of the WDR Reporting section. Each report will contain the following statement:

> "I declare under the penalty of law that I have personally examined and am familiar with the information submitted in this document, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of a fine and imprisonment for knowing violations."

This statement will be signed by a duly-authorized representative of PG&E.

11.3 Semiannual Operations and Maintenance Reports

Semiannual O&M reports meeting the requirements of the WDRs and the Monitoring and Reporting Program will be prepared according to the WDR Operations and Maintenance section and submitted to the Water Board twice each year (January 15, covering the period July 1 through December 31 and July 15, covering the period January 1 through June 30). These reports will summarize:

- Monthly analytical results.
- Data regarding daily volumes of groundwater treated.
- Groundwater monitoring data.
- Residual solids generated and disposal facilities used.
- Reverse osmosis concentrate generated and disposal facilities used.
- Summary of WDR violations and corrective actions.
- Summary of operation or maintenance problems that required shutting down the treatment system and corrective actions.
- Summary of any treatment plant modifications that affect the capacity or performance of the extraction and treatment system.

Each report will contain the following statement:

> "I declare under the penalty of law that I have personally examined and am familiar with the information submitted in this document, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of a fine and imprisonment for knowing violations."

This statement will be signed by a duly-authorized representative of PG&E.

11.4 Reporting of Non-compliance

Non-compliance that might endanger human health or the environment will be reported orally to the Water Board and the Governor's Office of Emergency Services as soon as there is knowledge of the non-compliance, notification is possible, and notification can be performed without impeding cleanup or other emergency measures. A written report will be submitted to the Water Board within 5 days of the date that the occurrence of non-compliance is discovered. The report will contain a description of the non-compliance and its suspected cause, the period of non-compliance, the anticipated time to achieve full compliance, and the steps taken or planned to reduce, eliminate, and prevent recurrence of the non-compliance.

In the event that an immediate or potential threat to human health or the environment is identified, or new releases of hazardous waste or hazardous waste constituents are discovered, or new solid waste management units are discovered, PG&E will orally notify the DTSC coordinator within 48 hours of discovery and will notify the DTSC in writing within 10 days of findings, including the immediacy and magnitude of the potential threat to human health and/or the environment.

12.0 References

CH2M HILL. 2004. *Biological Resources Investigations for IM No. 3: Topock Compressor Station Expanded Groundwater Extraction and Treatment System, San Bernardino County, California.* December.

__________. 2005a. *Waste Management Plan, Topock Compressor Station, Needles, California*. March 24.

__________. 2005b. *Interim Measures No. 3 Treatment and Extraction System Initial Startup Plan, Topock Compressor Station, Needles, California*. April 6.

__________. 2005c. *Interim Measures Injection Well Operation and Maintenance Plan, Topock Compressor Station, Needles, California.* April 7.

__________. 2005d. *Groundwater Compliance Monitoring Plan for Interim Measures No. 3 Injection Area, Waste Discharge Requirements Order No. R7-2004-0103, PG&E Topock Compressor Station, Needles, California.* June 17.

__________. 2006. *Interim Measures Extraction System Operation and Maintenance Plan, PG&E Topock Compressor Station, Needles, California.* March 13.

Department of Toxic Substances Control (DTSC). 1996. *Corrective Action Consent Agreement (Revised). Pacific Gas and Electric Co.'s Topock Compressor Station, Needles, California EPA ID No. CAT080011729.* February 2.

Pacific Gas and Electric Company (PG&E). 2006. *Hazardous Materials Business Plan (HMBP), Topock Groundwater Extraction Site, February 1, 2006 – March 1, 2007.*

Appendix A
Waste Discharge Requirements

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
COLORADO RIVER BASIN REGION

ORDER NO. R7-2004-0103

WASTE DISCHARGE REQUIREMENTS
FOR
PACIFIC GAS AND ELECTRIC, OWNER/OPERATOR
GROUNDWATER REMEDIATION FACILITY

Southeast of Needles – San Bernardino County

The California Regional Water Quality Control Board, Colorado River Basin Region (Regional Board) finds that:

1. The Topock Compressor Station is a natural gas compressor station used for transmission of natural gas by pipeline. Pacific Gas and Electric Company (PG&E), 77 Beale Street, San Francisco, CA 94105, is the owner and operator of the Topock Compressor Station and proposed Groundwater Remediation Facility. The proposed location for the Groundwater Remediation Facility is San Bernardino County Assessor's parcel No. 650-151-06. PG&E is currently in the process of purchasing the land from the Metropolitan Water District. PG&E is hereafter referred to either as PG&E or the Discharger.

2. The Topock Compressor Station Class II surface impoundments, proposed groundwater extraction wells and proposed conveyance piping are located on land owned or managed by the U.S. Bureau of Land Management (BLM). BLM is the federal administering agency for the land.

3. From 1951 to 1964, PG&E discharged untreated wastewater containing hexavalent chromium from the compressor station cooling tower to percolation beds in Bat Cave Wash, an ephemeral stream bed draining into the Colorado River.

4. In 1964, PG&E began treatment of blow down water by reduction of hexavalent chromium to trivalent chromium (chrome III) prior to discharge to the percolation beds. On August 14, 1969, the Regional Board adopted Resolution No. 69-25 prohibiting PG&E from discharging wastewater containing hexavalent chromium. At approximately the same time, PG&E began disposing of the treated blow down water by subsurface injection at well PGE8.

5. On November 6, 1970, PG&E submitted a Report of Waste Discharge for disposal of 0.030 million gallons per day (mgd) of industrial wastewater from cooling tower operations into one on-site lined basin designed by a California registered civil engineer.

6. On December 10, 1970, the Regional Board adopted Resolution No. 70-72 to regulate the proposed discharge of cooling tower wastewater into the one on-site lined basin.

7. On September 11, 1975, the Regional Board rescinded Resolution No. 70-72 and adopted Board Order No. 75-52.

8. Board Order No. 75-52 permitted a maximum of 0.030 mgd of industrial wastewater containing chromate to be discharged to four lined evaporative basins. Also, the Board Order prohibited the discharge of wastewater to the Colorado River or to any channel draining to the Colorado River. In addition, the Board Order specified that chemical residues obtained by chemical flocculation or evaporation of process wastewater shall be discharged only at a solid waste disposal site approved to receive these wastes.

9. On October 2, 1985, the Regional Board rescinded Board Order No. 75-52 and adopted Board Order No. 85-99.

10. Board Order No. 85-99, allowed the discharger to replace the hazardous chromate-based cooling tower water treatment process with phosphate-based inhibitors. Phosphate-based inhibitors are in use today.

11. On January 27, 1988, the Regional Board rescinded Board Order No. 85-99 and adopted Board Order No. 88-30, which was revised on March 23, 1988.

12. Revised Board Order No. 88-30 allowed discharge to four new Class II surface impoundments. PG&E closed the four existing lined evaporative basins along with all hazardous waste facilities at the Topock Compressor Station. Closure was done in compliance with closure requirements of 40 CFR Part 265 and Subchapter 15, Chapter 3, Title 23 of the California Code of Regulations

13. On May 14, 1998, Board Order No. 88-30 was rescinded and Board Order No. 98-050 was adopted.

14. The ponds are currently regulated under Waste Discharge Requirements (WDRs) Order No. 98-050.

15. On May 10, 1995, PG&E notified the Regional Board Office that the results of analyses of groundwater samples collected from two abandoned production wells at Topock located approximately 2000 feet northeast of the former percolation ponds and 1700 feet southwest of the Colorado River, indicated concentrations of 2,300 parts per billion (ppb) and 2,850 ppb total chromium and concentrations of 1,480 ppb and 2,340 ppb hexavalent chromium for the two wells respectively. The samples were collected from a depth of approximately 120 feet below ground surface (bgs). The source of pollution is believed to be historical discharges to the Bat Cave Wash and is not associated with the current evaporation basins

16. The California Department of Health Services has set the Maximum Contaminant Level (MCL) for total chromium in drinking water at 50 ppb.

17. On February 26, 1996, the Department of Toxic Substances Control (DTSC) and PG&E entered into a Corrective Action Consent Agreement (CACA) at the Topock Gas Compressor Station due to hazardous levels of chromium found in the groundwater. DTSC is the lead agency in the Resource Conservation and Recovery Act (RCRA) investigation under the CACA.

18. Under the terms of the CACA, PG&E agreed to conduct a RCRA Facility Investigation (RFI), and to implement appropriate corrective action measures. The draft RFI was submitted in May, 2000.Results of the RFI indicated hexavalent chromium in a groundwater plume at concentrations of 13,000 ppb located 600 feet from the Colorado River at monitoring well cluster MW-20.

19. On June 30, 2004 DTSC directed PG&E to prepare and immediately implement Interim Measure No. 3 to expand existing groundwater extraction and management facilities to address hydraulic control of the chromium (VI) plume at the Topock site.

20. On June 30, 2004, DTSC issued a Notice of Exemption (NOE) for the proposed project summarized in Interim Measure No. 3. The NOE addresses the California Environmental Quality Act (CEQA) requirements for an Emergency Project, Title 14, Section 15269(c) providing for actions necessary to prevent an emergency.

21. On July 8, 2004 PG&E submitted Summary of Proposed Project for Interim Measures No.3 – Revision 1 that provided a general summary of the proposed project. The proposal describes the method of treatment to be used and means of disposal of treated water and waste products. They are as follows:

    a. Discharge to Land - Subsurface injection to one or more of three proposed injection well fields. Up to ten injection wells are proposed;

b. Discharge to Topock Compressor Station Class II surface impoundments - Reuse of treated groundwater in the Compressor Station cooling tower;

c. Discharge to Surface Water - Discharge of treated groundwater to the Colorado River under the National Pollutant Discharge Elimination System (NPDES).

22. On July 29, 2004 PG&E submitted an application and Report of Waste Discharge for a permit to discharge treated groundwater by three methods of disposal. A separate application was submitted for each method.

23. This Board Order only addresses discharge by subsurface injection Discharge to the Topock Compressor Station Class II surface impoundments and discharge to the Colorado River are addressed in separate Board Orders.

24. The discharger proposes operation of a treatment facility for implementation of Interim Measures No. 3 to address hydraulic control of the contaminated groundwater plume boundaries and prevent contaminated groundwater from entering the Colorado River. The design flow for the treatment facility is 135 gallons per minute (gpm), with a maximum capacity of 150 gpm of contaminated groundwater.

25. The discharger proposes to discharge a maximum of 135 gallons per minute (gpm) of treated groundwater into one or more of three proposed injection well fields located on San Bernardino County Assessor's parcel No. 650-151-06. PG&E is currently in the process of purchasing the land from the Metropolitan Water District. The final effluent will be composed of RO permeate that may be blended with RO concentrate or microfilter water from the treatment facility. It will be discharged to the groundwater on the west side of Parcel 650-151-06, as indicated on Attachment "A" incorporated herein and made a part of this Board Order.

26. The extracted groundwater will be treated with chemical reduction, precipitation, and solids removal by gravity or clarifier. Ferrous chloride will be used to reduce Cr (VI) to Cr (III). The precipitated solids containing Cr (III) and Fe (III) will be removed by gravity settling and microfiltration. Reverse Osmosis (RO) will be used as a polishing step for the treated water to reduce Total Dissolved Solids (TDS). Under this Order, RO concentrate and liquids may be discharged directly to the lined ponds owned an operated by PG&E at the Topock Compressor Station or to an appropriate disposal facility. Residual solids will be disposed according to federal and state regulations.

27. The discharger proposes to use the following chemicals for the treatment of extracted groundwater:

Name of Chemicals	Purpose
Ferrous Chloride	Chemical Reducing Reagent
Sodium Hydroxide	pH Control
Sulfuric Acid	pH Control
Antiscalant Formulation	Mineral Control
Anionic Polymer	Particle Setting and Solids Dewatering
Sodium Hypochlorite Solution	Microfilter Cleaning
Citric Acid Cleaner	Microfilter and RO Cleaning
Hydrochloric Acid Solution	Microfilter Cleaning

Nonionic Surfactant	Microfilter and RO Cleaning
Sodium Metabisulfite	RO Membrane Preservation
Sodium Bicarbonate	pH Control

28. The Report of Waste Discharge application described the proposed discharge (RO Permeate) as follows:

Parameter	Units	Average	Maximum
Aluminum	mg/L[1]	0.05	0.1
Ammonia (as N)	mg/L	1.5	3.0
Barium	mg/L	0.3	0.98
Boron	mg/L	1.9	3.6
Color	units	15	30
Copper	mg/L	0.02	0.04
Flow	gpm[2]	80	200
Fluoride	mg/L	0.3	0.6
Hexavalent Chromium	mg/L	0.008	0.016
Iron (total)	mg/L	0.3	0.6
Lead	mg/L	0.002	0.004
Manganese	mg/L	0.05	0.1
Molybdenum	mg/L	0.01	0.02
Nickel	mg/L	0.012	0.024
Nitrate/Nitrite as N	mg/L	10	20
pH	units	7.5	8.4
Sulfate	mg/L	250	500
Summer Temperature	° F	80	100
TDS	mg/L	500	1000
Total Chromium	mg/L	0.025	0.050
Turbidity	NTU	5	10
Winter Temperature	° F	80	85
Zinc	mg/L	0.08	0.10

29. The Water Quality Control Plan for the Colorado River Basin Region of California (Basin Plan) as amended to date designates the beneficial uses of ground and surface waters in the Region. The Basin Plan contains water quality objectives for the Colorado River and the Piute Hydrologic Unit.

30. The beneficial uses of the Colorado River are:

a. Municipal supply (MUN)
b. Agricultural supply (AGR)
c. Aquaculture (AQUA)
d. Industrial supply (IND)
e. Groundwater recharge (GWR)
f. Water contact recreation (REC I)
g. Non contact water recreation (REC II)
h. Warm freshwater habitat (WARM)
i. Cold freshwater habitat (COLD)
j. Wildlife habitat (WILD)
k. Hydropower generation (POW)
l. Preservation of rare and endangered species (RARE)

[1] Milligrams per Liter
[2] Gallons per Minute

31. The beneficial uses of ground waters in the Piute Hydrologic Unit are:

    a. Municipal supply (MUN)
    b. Industrial supply (IND)
    c. Agricultural supply (AGR)

32. Federal regulations for storm water discharges were promulgated by the United States Environmental Protection Agency (USEPA) (40 CFR Parts 122, 123, and 124). The regulations require specific categories of facilities which discharge storm water associated with industrial activity to obtain National Pollutant Discharge Elimination System (NPDES) permits and to implement Best Conventional Pollutant Technology (BCT) and Best Available Technology Economically Achievable (BAT) to reduce or eliminate industrial storm water pollution.

33. The State Water Resources Control Board (SWRCB) adopted Order No. 97-03-DWQ (General Permit No. CAS000001), specifying waste discharge requirements for discharges of storm water associated with industrial activities, excluding construction activities, and requiring submittal of a Notice of Intent by industries to be covered under the Permit.

34. The proposed discharge is consistent with the anti-degradation provisions of 40 CFR 131.12 and State Water Resources Control Board Resolution No. 68-16. If terms of the permit are met, the impact on water quality will be insignificant, including potential impacts on a municipal water source, which is the beneficial use most likely affected by the discharge.

35. In accordance with the California Environmental Quality Act (CEQA), DTSC, acting as the lead agency, has filed a Notice of Exemption for the Interim Measure 3 Emergency Groundwater Extraction and Management project at Pacific Gas and Electric Company, Topock Compressor Station. On July 1, 2004, the NOE (SCH#2004078010) was filed with the State Clearing House. The NOE states, in part: "In February 2004, [DTSC] directed [PG&E] to initiate immediate pumping, transport, and disposal of groundwater at the Topock site to ensure that groundwater containing chromium does not reach the Colorado River. Due to the influence of the Colorado River stage on groundwater levels . . . , extracting groundwater at higher rates will be necessary to maintain the stated goal of hydraulic control." The NOE further describes the project as follows: "The critical elements for this proposed project are the piping, conveyance of groundwater, construction of temporary treatment facilities, and development of a disposal method for the treated water.

36. DTSC concludes in the NOE that the project is statutorily exempt under Title 14 CCR Section 15269(c) (and Public Resources Code Section 21080(b)(4)) as an action to prevent or mitigate an emergency. The NOE states: "These project activities are necessary to prevent or mitigate an emergency situation wherein the waters of the Colorado River may be impacted with a hazardous constituent, chromium, which is in contaminated groundwater in close proximity to the river. Immediate action is necessary to contain and reverse the flow of groundwater away from the Colorado River. Commencement of the development of additional extraction, treatment, and treated water disposal capacity is urgent to assure that increased pumping rates will be available to respond to impending fluctuations of the Colorado River level.

37. The Regional Board has reviewed the NOE prepared by DTSC. The Regional Board concurs that an emergency condition exists because the flow of groundwater to the Colorado River has not yet been contained. It is necessary and desirable to have in place alternative disposal options to accommodate increased extraction and treatment rates (resulting in the need for increased disposal capacity) that may be required to contain the groundwater flow to the river. While the duration of the Interim Measures has not been determined, it is appropriate to limit the term of this Order as described in Provision No. 23, by which time it is reasonable to conclude that DTSC will have undertaken an environmental analysis of all disposal alternatives.

38. The Board has notified the discharger and all known interested agencies and persons of its intent to issue waste discharge requirements for this discharge and has provided them with an opportunity for a public meeting and an opportunity to submit comments.

39. The Board, in a public meeting, heard and considered all comments pertaining to this discharge.

IT IS HEREBY ORDERED, that in order to meet the provisions contained in Division 7 of the California Water Code and regulations adopted thereunder, the discharger shall comply with the following:

A. Effluent Limitations

1. Representative samples of wastewater discharged to from the treatment system shall not contain constituents in excess of the limits indicated below. The discharge to the groundwater shall be monitored at a location which is acceptable by the Regional Board's Executive Officer or his designee:

Constituent	Unit	Average Monthly Effluent Limit	Maximum Daily Effluent Limit
Chromium (VI)	µg/L[3]	8	16
Chromium (Total)	µg/L	25	50

2. The hydrogen ion (pH) of the effluent shall be maintained within the limits of 6.5 to 8.4.

3. The effluent shall not contain heavy metals, chemicals, pesticides or other constituents in concentrations toxic to a human health.

B. Prohibitions

1. Bypass, overflow, discharge or spill of untreated or partially treated waste is prohibited.

2. The discharge of waste to land not owned or controlled by the discharger is prohibited.

3. Discharge of treated wastewater at a location or in a manner different from that described in this Board Order is prohibited.

4. The discharger shall not discharge waste in excess of the design treatment capacity of the disposal system.

5. The discharge shall not cause degradation of any water supply.

6. The discharger shall not cause degradation of any water supply in compliance with State Board Resolution No. 68-16.

C. Specifications

1. The treatment or disposal of wastes from the facility shall not cause pollution or nuisance as defined in Section 13050(l) and 13050(m) of Division 7 of the California Water Code.

2. No changes in the type or amount of treatment chemicals added to the process water as described in this Board Order shall be made without the written approval of the Regional Board's Executive Officer.

[3] micrograms per Liter

3. The facility shall be protected from any washout or erosion of wastes or covering material, and from any inundation, which could occur as a result of floods, having a predicted frequency of once in 100 years. The facility includes extraction wells, treatment plant, conveyance system, injection wells, and monitoring wells.

D. Provisions

1. The discharger shall comply with all conditions of this Board Order. Noncompliance constitutes a violation of the Porter-Cologne Water Quality Control Act, and is grounds for enforcement action; for Order termination, revocation and re-issuance, or modification of waste discharge requirements; or denial of an Order renewal application.

2. The discharger shall comply with "Monitoring and Reporting Program No. R7-2004-0103, and future revisions thereto, as specified by the Regional Board's Executive Officer.

3. The discharger shall ensure that all site-operating personnel are familiar with the content of this Board Order, and shall maintain a copy of this Board Order at the site.

4. The discharger shall develop an operation and maintenance plan for the management of the subsurface injection wells and conveyance system and submit a copy of the plan to the Regional Board’s Executive Officer, or his designee, for review and approval at least 30 days prior to any discharge.

5. The discharger shall construct a representative groundwater monitoring system, acceptable to the Regional Board’s Executive Officer, in the vicinity of the subsurface injection wells, which shall enable groundwater samples to be collected and analyzed as specified in Monitoring and Reporting Program R7-2004-0103 and revisions thereto. The discharger shall begin construction within 60 days of approval of the design plans, barring any extenuating circumstances reported to the Regional Board’s Executive officer. The groundwater monitoring system shall include at a minimum one groundwater well up gradient and two groundwater wells down gradient of each injection well field.

6. The design plans for the groundwater monitoring system shall be submitted to the Regional Board’s Executive Officer for approval within 45 days of adoption of this Board Order. Either a Professional Engineer (PE), Registered Geologist (RG), Certified Engineering Geologist (CEG), or a Certified Hydro Geologist (CHG) must certify the design plans.

7. The discharger shall, at all times, properly operate and maintain all systems and components of collection, treatment and control which are installed or used by the discharger to achieve compliance with the conditions of this Board Order. Proper operation and maintenance includes effective performance, adequate process controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems when necessary to achieve compliance with the conditions of this Board Order. All systems both in service and reserved, shall be inspected and maintained on a regular basis. Records shall be kept of the inspection results and maintenance performed and made available to the Regional Board upon demand.

8. A contingency plan detailing mitigation measures in the event of a plant upset shall be submitted for approval by the Regional Board’s Executive Officer at least 30 days prior to any discharge. The plan shall provide an analysis of potential causes of system failure, the effect of failure, and the proposed course of corrective action.

9. Unless otherwise approved by the Regional Board's Executive Officer, all analyses shall be conducted at a laboratory certified for such analyses by the California State Department of Health Services. All analyses shall be conducted in accordance with the latest edition of "Guidelines Establishing Test Procedures for Analysis of Pollutants", promulgated by the United States Environmental Protection Agency.

10. The discharger shall report any noncompliance that may endanger human health or the environment. The discharger shall immediately report orally information of the noncompliance as soon as (1) the discharger has knowledge of the discharge, (2) notification is possible, and (3) notification can be provided without substantially impeding cleanup or other emergency measures, to the Regional Board office and the Office of Emergency Services. During non-business hours, the discharger shall leave a message on the Regional Board office voice recorder. A written report shall also be provided within five (5) business days of the time the discharger becomes aware of the incident. The written report shall contain a description of the noncompliance and its cause, the period of noncompliance, the anticipated time to achieve full compliance, and the steps taken or planned, to reduce, eliminate, and prevent recurrence of the noncompliance. The discharger shall report all intentional or unintentional significant spills that occur within the facility to the Regional Board office in accordance with the above time limits.

11. The discharger shall allow the Regional Board, or an authorized representative, upon presentation of credentials and other documents as may be required by law, to:

    a. Enter upon the premises regulated by this Board Order, or the place where records must be kept under the conditions of this Board Order;

    b. Have access to and copy, at reasonable times, any records that shall be kept under the conditions of this Board Order;

    c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Board Order; and

    d. Sample or monitor at reasonable times, for the purpose of assuring compliance with this Board Order or as otherwise authorized by the California Water Code, any substances or parameters at this location.

12. The discharger shall comply with the following:

    a. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

    b. The discharger shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this Board Order, and records of all data used to complete the application for this Board Order, for a period of at least 5 years from the date of the sample, measurement, report or application.

    c. Records of monitoring information shall include:

        1. The date, exact place, and time of sampling or measurements.
        2. The individual(s) who performed the sampling or measurements.
        3. The date(s) analyses were performed.
        4. The individual(s) who performed the analyses.
        5. The results of such analyses.

13. Prior to any change in ownership or management of this operation, the discharger shall transmit a copy of this Board Order to the succeeding owner/operator, and forward a copy of the transmittal letter to the Regional Board.

14. Prior to any modifications in this facility, which would result in material change in the quality or, quantity of wastewater treated or discharged, or any material change in the location of discharge, the discharger shall report all pertinent information in writing to the Regional Board and obtain revised requirements before any modifications are implemented.

15. Adequate measures shall be taken to assure that flood or surface drainage waters do not erode or otherwise render portions of the discharge facilities inoperable.

16. All storm water discharges from this facility must comply with the lawful requirements of municipalities, counties, drainage districts, and other local agencies, regarding discharges of storm water to storm water drain systems or other courses under their jurisdiction.

17. Storm water discharges from the facility shall not cause or threaten to cause pollution or contamination.

18. Storm water discharges from the facility shall not contain hazardous substances equal to or in excess of a reportable quantity listed in 40 CFR Part 117 and/or 40 CFR Part 302.

19. The discharger shall provide a plan as to the method, treatment, handling and disposal of solids waste that is consistent with all State and Federal laws and regulations, including any and all prior approvals required by the Bureau of Land Management, and obtain prior written approval from the Regional Board specifying location and method of disposal, before disposing of treated or untreated solid waste.

20. This Board Order does not authorize violation of any federal, state, or local laws or regulations

21. This Board Order does not convey any property rights of any sort or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state, or local laws or regulations.

22. The Regional Board directs the Executive Officer to forthwith prepare and file with the Office of Planning and Research, State Clearinghouse, a Notice of Exemption under Public Resources Code Section 21080(b)(4) and Title 14, California Code of Regulations, Section 15269(c).

23. This Board Order expires no later than two years from the date of first discharge, but in no event later than January 31, 2007, unless specifically authorized by a future order of the Regional Board. This Board Order may be modified, rescinded and reissued, for cause. The filing of a request by the discharger for a Board Order modification, rescission and re-issuance, or a notification of planned changes or anticipated noncompliance does not stay any Board Order condition. Causes for modification include the promulgation of new regulations, modification of land application plans, or modification in sludge use or disposal practices, or adoption of new regulations by the State Board or the Regional Board, including revisions to the Basin Plan.

I, Philip A. Gruenberg, Executive Officer, do hereby certify that the foregoing is a full, true and correct copy of an Order adopted by the Regional Water Quality Control Board, Colorado River Basin Region, on October 13, 2004.

____
Executive Officer

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
COLORADO RIVER BASIN REGION

MONITORING AND REPORTING PROGRAM NO. R7-2004-0103

FOR
PACIFIC GAS AND ELECTRIC COMPANY, OWNER/OPERATOR
GROUNDWATER REMEDIATION FACILITY

Southeast of Needles – San Bernardino County

MONITORING

1. The collection, preservation and holding times of all samples shall be in accordance with United States Environmental Protection Agency (USEPA) approved procedures. Unless otherwise approved by the Regional Board's Executive Officer, all analyses shall be conducted by a laboratory certified by the State Department of Health Services. All analyses shall be conducted in accordance with the latest edition of the "Guidelines Establishing Test Procedures for Analysis of Pollutants" (40 CFR Part 136), promulgated by the USEPA.

2. Pursuant to the California Water Code (CWC) Section 13267, samples taken for Total Chromium shall be analyzed with a method having a method detection limit (MDL) of 1.0 ppb and samples taken for Chromium VI shall be analyzed with a method having a MDL of 0.2 ppb. The analytical results shall be reported consistent with actual observations by a California certified laboratory, and shall be reported in terms of the practical quantitation limit (PQL), if the MDL cannot be achieved. These requirements are necessary to ensure compliance with the Waste Discharge Requirements set forth in Board Order R7-2004-0103, determine the impact on the receiving groundwater, and confirm that the discharge of treated ground water does not violate Waste Discharge Requirements. Ground water monitoring in the area proposed for extraction has shown that these constituents are present at very high levels and the discharge is a potential threat to ground water and to the Colorado River.

3. Samples shall be collected at the location approved by the Regional Board's Executive Officer. If no location is specified, sampling shall be conducted at the most representative sampling point available.

4. If the facility is not in operation, or there is no discharge under this Order during a required reporting period, the discharger shall forward a letter to the Regional Board indicating that there as been no activity during the required reporting period. No sampling or analysis is required during any reporting period if the facility is not operated during that period.

5. The discharger shall monitor the treatment facility influent, effluent, and receiving water in accordance with the following:

TREATMENT FACILITY START UP PHASE AND START UP REPORTING

1. The discharger shall inform the Regional Board in writing of the location of all sampling stations and the expected start up date at least 10 days prior to beginning operational start up.

2. During the start up phase of the ground water treatment facility, sampling of the system influent and effluent must be performed on the first (1^{st}) and third (3^{rd}) days of operation.

   a. On the 1^{st} day of operation, the system shall be allowed to run until at least three (3) extraction well volumes are removed and until three (3) consecutive readings taken at least one (1) hour apart for pH, specific conductivity, and temperature are within five (5) percent of each other. Discharge shall be conveyed to a holding tank or disposed at an offsite, permitted facility.

b. Once these criteria are met, the treatment system effluent shall be sampled and submitted for analysis. During this phase of the start up, all treatment system effluent shall be discharged to a holding tank, or disposed at an offsite, permitted facility until the results of the 1st day analysis show that the effluent is in compliance with the effluent limitations set forth in Board Order R7-2004-0103.

c. If the analyses of the treatment system effluent collected during the 1st day of operation indicate that the effluent is in compliance, the system shall be operated with the treatment system effluent being discharged to the injection wells provided the analyses are received within 48 hours of sampling. If the discharge is not in compliance with the effluent limitations, it shall be conveyed to a holding tank or disposed at an offsite, permitted facility.

d. A second series of samples shall be collected on the 3rd day. If the samples from the 3rd day are in compliance, effluent from the treatment system shall continue to be discharged to the injection wells. If the discharge is not in compliance with the effluent limitations, it shall be conveyed to a holding tank or disposed at an offsite, permitted facility.

3. If the treatment system is shut down for more than 96 hours during start up phase, the start up and sampling procedures must be repeated.

4. A report on the start up phase shall be submitted to the Regional Board no more than fifteen (15) calendar days after completion of the start up phase. The report should contain a summary of all monitoring results, copies of laboratory reports, Chain of custody forms, flow rates, and a description of any changes or modifications to the treatment system.

TREATMENT FACILITY REPORTING AFTER START UP PHASE

1. Upon completion of the start up phase, the discharger shall begin the normal monitoring and reporting for the daily operation and maintenance of the treatment system. The Treatment System Influent and effluent, sludge monitoring and operation and maintenance reporting shall be monitored as listed below in the following sections.

A. Groundwater Treatment System Influent

1. Extracted groundwater shall be analyzed for the following constituents immediately prior to treatment:

Constituents	Units	Type of Sample	Sampling Frequency	Reporting Frequency
Flow	gpm[1]	Metered	Continuous	Monthly
TDS	mg/L[2]	Grab	See Footnote[3]	Monthly
Turbidity	NTU[4]	Grab	See Footnote[3]	Monthly
Specific Conductance	µmhos/cm[5]	Grab	See Footnote[3]	Monthly
pH	pH units	Grab	See Footnote[3]	Monthly
Total Chromium	µg/L[6]	Grab	See Footnote[3]	Monthly
Chromium VI	µg/L	Grab	See Footnote[3]	Monthly
Aluminum	µg/L	Grab	Monthly	Monthly
Ammonia (as N)	mg/L	Grab	Monthly	Monthly
Antimony	µg/L	Grab	Monthly	Monthly

[1] gallons per minute reported as a monthly average
[2] mg/L = milligrams per Liter
[3] Samples shall be taken on the 1st and 3rd days during start up phase. Sampling will continue twice weekly for the first month, weekly for the following two months, and monthly thereafter.
[4] Nephelometric Turbidity Units
[5] micromhos per centimeter
[6] micrograms per Liter

Arsenic	µg/L	Grab	Monthly	Monthly
Barium	µg/L	Grab	Monthly	Monthly
Boron	mg/L	Grab	Monthly	Monthly
Copper	µg/L	Grab	Monthly	Monthly
Fluoride	mg/L	Grab	Monthly	Monthly
Lead	µg/L	Grab	Monthly	Monthly
Manganese	µg/L	Grab	Monthly	Monthly
Molybdenum	µg/L	Grab	Monthly	Monthly
Nickel	µg/L	Grab	Monthly	Monthly
Nitrate/Nitrite (as N)	mg/L	Grab	Monthly	Monthly
Sulfate	mg/L	Grab	Monthly	Monthly
Total Iron	µg/L	Grab	Monthly	Monthly
Zinc	µg/L	Grab	Monthly	Monthly

B. Groundwater Treatment System Effluent

1. Treated groundwater shall be analyzed for the following constituents immediately after treatment:

Constituents	Units	Type of Sample	Sampling Frequency	Reporting Frequency
Flow	gpm	Metered	Continuous	Monthly
TDS	mg/L	Grab	See Footnote[7]	Monthly
Turbidity	NTU	Grab	See Footnote[7]	Monthly
Specific Conductance	µmhos/cm	Grab	See Footnote[7]	Monthly
pH	pH units	Grab	See Footnote[7]	Monthly
Total Chromium	µg/L	Grab	See Footnote[7]	Monthly
Chromium VI	µg/L	Grab	See Footnote[7]	Monthly
Aluminum	µg/L	Grab	Monthly	Monthly
Ammonia (as N)	mg/L	Grab	Monthly	Monthly
Antimony	µg/L	Grab	Monthly	Monthly
Arsenic	µg/L	Grab	Monthly	Monthly
Barium	µg/L	Grab	Monthly	Monthly
Boron	mg/L	Grab	Monthly	Monthly
Copper	µg/L	Grab	Monthly	Monthly
Fluoride	mg/L	Grab	Monthly	Monthly
Lead	µg/L	Grab	Monthly	Monthly
Manganese	µg/L	Grab	Monthly	Monthly
Molybdenum	µg/L	Grab	Monthly	Monthly
Nickel	vg/L	Grab	Monthly	Monthly
Nitrate/Nitrite (as N)	mg/L	Grab	Monthly	Monthly
Sulfate	mg/L	Grab	Monthly	Monthly
Total Iron	µg/L	Grab	Monthly	Monthly
Zinc	µg/L	Grab	Monthly	Monthly

C. Groundwater Monitoring

1. The discharger shall submit an injection well field groundwater monitoring plan to the Regional Board's Executive Officer for approval at least 30 days prior to discharge. The monitoring plan shall include monitoring analytes and frequency.

[7] Samples shall be taken on the 1st and 3rd days during start up phase. Sampling will continue twice weekly for the first month, and weekly thereafter.

D. Groundwater Treatment System Reverse Osmosis Concentrate Monitoring

1. Reverse Osmosis Concentrate shall be analyzed for the following constituents:

Constituents	Units	Type of Sample	Sampling Frequency	Reporting Frequency
Flow	gpm	Metered	Continuous	Monthly
TDS	mg/L	Grab	See Footnote[3]	Monthly
Specific Conductance	µmhos/cm	Grab	See Footnote[3]	Monthly
pH	pH units	Grab	See Footnote[3]	Monthly
Total Chromium	mg/L	Grab	See Footnote[3]	Monthly
Chromium VI	mg/L	Grab	See Footnote[3]	Monthly
Antimony	mg/L	Grab	Monthly	Monthly
Arsenic	mg/L	Grab	Monthly	Monthly
Barium	mg/L	Grab	Monthly	Monthly
Beryllium	mg/L	Grab	Monthly	Monthly
Cadmium	mg/L	Grab	Monthly	Monthly
Cobalt	mg/L	Grab	Monthly	Monthly
Copper	mg/L	Grab	Monthly	Monthly
Fluoride	mg/L	Grab	Monthly	Monthly
Lead	mg/L	Grab	Monthly	Monthly
Molybdenum	mg/L	Grab	Monthly	Monthly
Mercury	mg/L	Grab	Monthly	Monthly
Nickel	mg/L	Grab	Monthly	Monthly
Selenium	mg/L	Grab	Monthly	Monthly
Silver	mg/L	Grab	Monthly	Monthly
Thallium	mg/L	Grab	Monthly	Monthly
Vanadium	mg/L	Grab	Monthly	Monthly
Zinc	mg/L	Grab	Monthly	Monthly

E. Groundwater Treatment System Sludge Monitoring

1. Representative composite sludge samples shall be taken from each treatment tank whose purpose is to accumulate sludge for disposal prior to transportation of the sludge offsite. If sludge is transported offsite more frequently than monthly, a representative sample shall be taken on a monthly or quarterly basis as specified below. Sludge samples shall be tested for the following constituents:

Constituents	Units	Type of Sample	Sampling Frequency	Reporting Frequency
Fluoride	mg/kg[8]	Composite	See Footnote[8a]	Monthly
Total Chromium	mg/kg	Composite	See Footnote[8a]	Monthly
Chromium VI	mg/kg	Composite	See Footnote[8a]	Monthly
Antimony	mg/kg	Composite	See Footnote[8a]	Monthly
Arsenic	mg/kg	Composite	See Footnote[8a]	Monthly
Barium	mg/kg	Composite	See Footnote[8a]	Monthly
Beryllium	mg/kg	Composite	See Footnote[8a]	Monthly
Cadmium	mg/kg	Composite	See Footnote[8a]	Monthly
Cobalt	mg/kg	Composite	See Footnote[8a]	Monthly
Copper	mg/kg	Composite	See Footnote[8a]	Monthly
Lead	mg/kg	Composite	See Footnote[8a]	Monthly

[8] milligrams per kilogram
[8a] Each time sludge is transported offsite, unless sludge is transported offsite more frequently than monthly, in which case the sampling frequency shall be monthly.

Mercury	mg/kg	Composite	See Footnote[8a]	Monthly
Molybdenum	mg/kg	Composite	See Footnote[8a]	Monthly
Nickel	mg/kg	Composite	See Footnote[8a]	Monthly
Selenium	mg/kg	Composite	See Footnote[8a]	Monthly
Silver	mg/kg	Composite	See Footnote[8a]	Monthly
Thallium	mg/kg	Composite	See Footnote[8a]	Monthly
Vanadium	mg/kg	Composite	See Footnote[8a]	Monthly
Zinc	mg/kg	Composite	See Footnote[8a]	Monthly
Bioassay			See Footnote[8b]	Quarterly

2. The discharger shall report quarterly on the quantity, location and method of disposal of all sludge and similar solid materials being produced at the wastewater treatment facility.

3. The discharger shall quarterly collect one representative composite sample of sludge for each treatment tank and have an aquatic bioassay test performed on the samples. Report and select a procedure from the Static Acute Bioassay Procedure for Hazardous Waste Sample by the California Department of Fish and Game, Water pollution Control Laboratory, revised November 1988 or by other test methods approved by the California Department of Fish and Game. The discharger shall provide a report supporting any deviation from a standard procedure and must be approved by the Regional Board's Executive Officer.

OPERATION AND MAINTENANCE

1. The discharger shall inspect and document any operation/maintenance problems by inspecting each unit process. In addition, calibration of flow meters and equipment shall be performed in a timely manner and documented. Operation and Maintenance reports shall be submitted to the Regional Board Office twice-annually.

REPORTING

1. The discharger shall arrange the data in tabular form so that the specified information is readily discernible. The data shall be summarized in such a manner as to clearly illustrate whether the facility is operating in compliance with waste discharge requirements.

2. Records of monitoring information shall include:

   a. The date, exact place, and time of sampling or measurement(s);
   b. The individual(s) who performed the sampling or measurement(s);
   c. The date(s) analyses were performed;
   d. The individual(s) who performed the analyses;
   e. The analytical techniques or method used; and
   f. The results of such analyses.

3. The results of any analysis taken more frequently than required at the locations specified in this Monitoring and Reporting Program shall be reported to the Regional Board.

4. Monitoring reports shall be certified under penalty of perjury to be true and correct, and shall contain the required information at the frequency designated in this monitoring report.

[8b] Each time sludge is transported offsite, unless sludge is transported offsite more frequently than quarterly, in which case the sampling frequency shall be quarterly.

5. Each report shall contain the following statement:

   "I declare under the penalty of law that I have personally examined and am familiar with the information submitted in this document, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of a fine and imprisonment for knowing violations".

6. A duly authorized representative of the discharger may sign the documents if:

   a. The authorization is made in writing by the person described above;

   b. The authorization specified an individual or person having responsibility for the overall operation of the regulated disposal system; and

   c. The written authorization is submitted to the Regional Board's Executive Officer.

7. Reporting of any failure in the facility shall be as described in Provision No. 9 of Board Order R7-2004-0103. Results of any analysis performed as a result of a failure of the facility shall be provided within fourteen (14) days after collection of the samples.

8. The discharger shall attach a cover letter to the Self Monitoring Report. The information contained in the cover letter shall clearly identify violations of the WDRs, discuss corrective actions taken or planned and the proposed time schedule of corrective actions. Identified violations should include a description of the requirement that was violated and a description of the violation.

9. Daily, twice-weekly, weekly, and monthly monitoring reports shall be submitted to the Regional Board by the 15th day of the following month. Quarterly monitoring reports shall be submitted to the Regional Board by January 15, April 15, July 15, and September 15 of each year. semi-annual reports shall be submitted to the Regional Board by January 15 and July 15 of each year.

10. Submit monitoring reports to:

    California Regional Water Quality Control Board
    Colorado River Basin Region
    73-720 Fred Waring, Suite 100
    Palm Desert, CA 92260

Ordered by: ______________________________
Executive Officer

____
Date

Appendix B
Mass Balance

IM No. 3
Treatment and Extraction System
Material Balance

Revision H (2/15/2005)

Input Variables

Nominal Influent Flow Rate	100	gpm
Maximum Influent Flow Rate	132	gpm
Nominal Influent Cr(VI) Concentration	7	mg/L
Maximum Influent Cr(VI) Concentration	19	mg/L
Nominal Influent TDS Concentration	5,890	mg/L
Maximum Influent TDS Concentration	7,610	mg/L
Influent TSS Concentration	4	mg/L
Influent Dissolved Oxygen Conc	8.3	mg/L
Influent Alkalinity	56	mg CaCO3/L
Iron-to-Chromium Dose Factor	6	mol/mol
Iron-to-Oxygen Dose Factor	2	mol/mol
$FeCl_2$ Solution, ≈ 32%	3.4	Molar
H_2SO_4 Solution, 35%	4.5	Molar
NaOH Solution, 25%	8.0	Molar
Percentage of NaOH to Oxidation Tank 1	80	%
Percentage of NaOH to Oxidation Tank 2	0	%
Percentage of NaOH to Oxidation Tank 3	20	%
Nominal Clarifier Sludge Removal Rate	99	%
Clarifier Sludge Concentration	3.0	%
Density of Clarifier Sludge	1.02	kg/L
Filter Cake Solids Concentration	15	%
Filter Cake Density	70	lb/ft3
Microfilter TSS Removal Rate	90	%
RO Permeate Recovery	75	%
RO Solids Removal Rate	95	%

Standard Conversions and Constants

Density of Water	1	g/ml
Density of Water	1000	kg/m3
Grams per kilogram	1000	g/kg
Milligrams per gram	1000	mg/g
Pounds per kilogram	2.2	lb/kg
Liters per gallon	3.785	L/gal
Liters per cubic meter	1000	L/m3
Milliliters per liter	1000	ml/L
Minutes per hour	60	min/hr
Hours per day	24	hr/day
Mol Wt of Chromium	51.996	g/mol
Mol Wt of Oxygen	32	g/mol
Mol Wt of Iron	55.84	g/mol
Mol Wt of Chlorine	35.45	g/mol

		Well Water Supply		Pipe Reactor Recycle		Ferrous Chloride		Sulfuric Acid		Chromium Backmix Reactor		Iron Reactor Feed	
		Stream	1	Stream	2	Stream	3	Stream	4	Stream	5	Stream	6
	Units	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min
Water Volumetric Flow Rate	gpm	100	132	100	132					100	132	100	132
Water Mass Flow Rate	lb/hr	49,962	65,950	49,962	65,950					49,962		49,962	
Cr(VI) Mass Flow Rate	lb/hr	0.350	1.253	0.350	1.253					0	0	0	0
Cr(T) Mass Flow Rate	lb/hr	0.350	1.253	0.350	1.253					0.350	1.253	0.350	1.253
Cr(T) Concentration (liquid stream)	mg/L	7	19	7	19					7	19	7	19
Cr(T) Concentration (sludge stream)	mg/kg												
$FeCl_2$ Solution, ≈ 32% Vol Flow Rate	gal/hour					2.3	6.3						
$FeCl_2$ Solution, ≈ 32% Mass Flow Rate	lb/hr					26.2	70.8						
Sodium Hydroxide, 25% solution	gal/hour												
Antiscalant at 50% dilution	gal/hour												
Sulfuric Acid, 35% solution	gal/hour							0.021	0.03				
TDS	mg/L	5,890	7,610										
TSS	mg/L												
Settled Solids Mass Flow Rate	lb/day												
Settled Solids Volumetric Flow Rate	gal/day												
Clarifier Sludge Mass Flow Rate	lb/day												
Clarifier Sludge Volumetric Flow Rate	gal/day												
Filter Cake Mass Generation Rate	lb/day												
Filter Cake Volumetric Generation Rate	ft3/day												
Air Flow	cfm@60°F												
pH	--	7.9		6.8	~4.5					6.8	6.65	>6.8	>6.65
Fe^{2+}	mg/L					190,334	190,334			74	151		
Temperature	°F	77	100										

		Sodium Hydroxide - 1st Oxidation Reactor		Sodium Hydroxide - 2nd Oxidation Reactor		Sodium Hydroxide - 3rd Oxidation Reactor		Air Flow - Chromium Backmix Reactor		Air Flow - 1st Iron Oxidation Reactor		Air Flow - 2nd Iron Oxidation Reactor		Air Flow - 3rd Iron Oxidation Reactor		Clarifier Liquid Feed Stream		Clarifier Bottom Solids Stream	
		Stream	7A	Stream	7B	Stream	7C	Stream	8	Stream	9A	Stream	9B	Stream	9C	Stream	10	Stream	12
	Units	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min
Water Volumetric Flow Rate	gpm															100	132	0.51	1.40
Water Mass Flow Rate	lb/hr															49,962	65,950		
Cr(VI) Mass Flow Rate	lb/hr															0.0	0.0		
Cr(T) Mass Flow Rate	lb/hr															0.350	1.253	0.346	1.241
Cr(T) Concentration (liquid stream)	mg/L															7	19		
Cr(T) Concentration (sludge stream)	mg/kg																	1,316	1,720
$FeCl_2$ Solution, ≈ 32% Vol Flow Rate	gal/hour																		
$FeCl_2$ Solution, ≈ 32% Mass Flow Rate	lb/hr																		
Sodium Hydroxide, 25% solution	gal/hour	0.689	3.047	0.000	0.000	0.172	0.762												
Antiscalant at 50% dilution	gal/hour																		
Sulfuric Acid, 35% solution	gal/hour																		
TDS	mg/L																		
TSS	mg/L															160	331	30,000	30,000
Settled Solids Mass Flow Rate	lb/day																	189	519
Settled Solids Volumetric Flow Rate	gal/day																	22	61
Clarifier Sludge Mass Flow Rate	lb/day																	6,315	17,305
Clarifier Sludge Volumetric Flow Rate	gal/day																	744	2037
Filter Cake Mass Generation Rate	lb/day																		
Filter Cake Volumetric Generation Rate	ft3/day																		
Air Flow	cfm@60°F							0	0	90	90	90	90	90	90				
pH	--	7.5	8.2			7.5	8.2									7.5	8.2	7.5	8.2
Fe^{2+}	mg/L																		
Temperature	°F									77	41.7/108.6	77	41.7/108.6	77	41.7/108.6	77	100		

IM No. 3
Treatment and Extraction System
Material Balance

Revision H (2/15/2005)

Input Variables

Nominal Influent Flow Rate	100
Maximum Influent Flow Rate	132
Nominal Influent Cr(VI) Concentration	7
Maximum Influent Cr(VI) Concentration	19
Nominal Influent TDS Concentration	5,890
Maximum Influent TDS Concentration	7,610
Influent TSS Concentration	4
Influent Dissolved Oxygen Conc	8.3
Influent Alkalinity	56
Iron-to-Chromium Dose Factor	6
Iron-to-Oxygen Dose Factor	2
$FeCl_2$ Solution, ≈ 32%	3.4
H_2SO_4 Solution, 35%	4.5
NaOH Solution, 25%	8.0
Percentage of NaOH to Oxidation Tank 1	80
Percentage of NaOH to Oxidation Tank 2	0
Percentage of NaOH to Oxidation Tank 3	20
Nominal Clarifier Sludge Removal Rate	99
Clarifier Sludge Concentration	3.0
Density of Clarifier Sludge	1.02
Filter Cake Solids Concentration	15
Filter Cake Density	70
Microfilter TSS Removal Rate	90
RO Permeate Recovery	75
RO Solids Removal Rate	95

Standard Conversions and Constants

Density of Water	1
Density of Water	1000
Grams per kilogram	1000
Milligrams per gram	1000
Pounds per kilogram	2.2
Liters per gallon	3.785
Liters per cubic meter	1000
Milliliters per liter	1000
Minutes per hour	60
Hours per day	24
Mol Wt of Chromium	51.996
Mol Wt of Oxygen	32
Mol Wt of Iron	55.84
Mol Wt of Chlorine	35.45

		Solids Phase Separator		Separator Filtrate Flow Rate		Microfilter Feed		Filtered Water		Raw RO Feed	
		Stream		Stream		Stream	11	Stream	13	Stream	14
	Units	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min
Water Volumetric Flow Rate	gpm	0.09	0.25	0.42	1.15	99	131	99	131	99	131
Water Mass Flow Rate	lb/hr										
Cr(VI) Mass Flow Rate	lb/hr										
Cr(T) Mass Flow Rate	lb/hr					0.003	0.013	0.0003	0.001	0.0003	0.001
Cr(T) Concentration (liquid stream)	mg/L					0.07	0.19	0.007	0.019	0.007	0.019
Cr(T) Concentration (sludge stream)	mg/kg	6,579	8,602								
$FeCl_2$ Solution, ≈ 32% Vol Flow Rate	gal/hour										
$FeCl_2$ Solution, ≈ 32% Mass Flow Rate	lb/hr										
Sodium Hydroxide, 25% solution	gal/hour										
Antiscalant at 50% dilution	gal/hour										
Sulfuric Acid, 35% solution	gal/hour										
TDS	mg/L									6,178	8,193
TSS	mg/L					1.6	3.3	0.16	0.33		
Settled Solids Mass Flow Rate	lb/day					0.08	0.22	0.01	0.02		
Settled Solids Volumetric Flow Rate	gal/day										
Clarifier Sludge Mass Flow Rate	lb/day										
Clarifier Sludge Volumetric Flow Rate	gal/day										
Filter Cake Mass Generation Rate	lb/day	1,263	3,461								
Filter Cake Volumetric Generation Rate	ft3/day	18.0	49								
Air Flow	cfm@60°F										
pH	--					7.5	8.2	7.5	8.2	7.5	8.2
Fe^{2+}	mg/L										
Temperature	°F									77	100

		Sulfuric Acid		Scale Inhibitor		RO Feed		RO Permeate		RO Concentrate		Sodium Hydroxide Dosing		Post-Treated RO Permeate	
		Stream	15	Stream	16	Stream	17	Stream	18	Stream	19	Stream	20	Stream	21
	Units	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min	Nominal	Max/Min
Water Volumetric Flow Rate	gpm					99	131	75	98	25	33			75	98
Water Mass Flow Rate	lb/hr					49,707	65,250	37,280	48,938	12,427	16,313			37,280	48,938
Cr(VI) Mass Flow Rate	lb/hr														
Cr(T) Mass Flow Rate	lb/hr					0.0003	0.0013								
Cr(T) Concentration (liquid stream)	mg/L					0.007	0.019								
Cr(T) Concentration (sludge stream)	mg/kg														
$FeCl_2$ Solution, ≈ 32% Vol Flow Rate	gal/hour														
$FeCl_2$ Solution, ≈ 32% Mass Flow Rate	lb/hr														
Sodium Hydroxide, 25% solution	gal/hour											0.028	0.09		
Antiscalant at 50% dilution	gal/hour			0.050	0.07										
Sulfuric Acid, 35% solution	gal/hour	0.022	0.089												
TDS	mg/L					6,178	8,193	309	410	23,478	31,134			309	410
TSS	mg/L														
Settled Solids Mass Flow Rate	lb/day														
Settled Solids Volumetric Flow Rate	gal/day														
Clarifier Sludge Mass Flow Rate	lb/day														
Clarifier Sludge Volumetric Flow Rate	gal/day														
Filter Cake Mass Generation Rate	lb/day														
Filter Cake Volumetric Generation Rate	ft3/day														
Air Flow	cfm@60°F														
pH	--					6.7	6.1	5.24	4.51	7.29	6.44			6.2	7.0
Fe^{2+}	mg/L														
Temperature	°F														

Appendix C
Process and Instrumentation Diagrams

INSTRUMENT IDENTIFICATION

EXAMPLE SYMBOLS

FIRST LETTER (S)
SUCCEEDING LETTERS
CLARIFYING ABBREVIATIONS

T RC BB
LLUUS

SET NUMBER (USED WHEN THERE ARE MULTIPLE DEVICES WITH THE SAME UNIT NUMBER)
UNIT NUMBER
LOOP NUMBER

INSTRUMENT IDENTIFICATION LETTERS TABLE

LETTER	FIRST-LETTER: PROCESS OR INITIATING VARIABLE	FIRST-LETTER: MODIFIER	SUCCEEDING-LETTERS: READOUT OR PASSIVE FUNCTION	SUCCEEDING-LETTERS: OUTPUT FUNCTION	SUCCEEDING-LETTERS: MODIFIER
A	ANALYSIS (+)		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE (*)	USER'S CHOICE (*)	USER'S CHOICE (*)
C	USER'S CHOICE (*)			CONTROL	
D	DENSITY (S.G)	DIFFERENTIAL			
E	VOLTAGE		PRIMARY ELEMENT, SENSOR		
F	FLOW RATE	RATIO (FRACTION)			
G	USER'S CHOICE (*)		GLASS, GAUGE VIEWING DEVICE	GATE	
H	HAND (MANUAL)				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOTION	MOMENTARY			MIDDLE, INTERMEDIATE
N	TORQUE		USER'S CHOICE (*)	USER'S CHOICE (*)	USER'S CHOICE (*)
O	USER'S CHOICE (*)		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD OR PRINT		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED (+)	X AXIS	UNCLASSIFIED (+)	UNCLASSIFIED (+)	UNCLASSIFIED (+)
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION	Z AXIS		DRIVE, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

TABLE BASED ON THE INSTRUMENTATION, SYSTEMS, AND AUTOMATION SOCIETY (ISA) STANDARD.
(+) WHEN USED, EXPLANATION IS SHOWN ADJACENT TO INSTRUMENT SYMBOL. SEE ABBREVIATIONS AND LETTER SYMBOLS.
(*) WHEN USED, DEFINE THE MEANING HERE FOR THE PROJECT

DIGITAL SYSTEM INTERFACES

▲ ANALOG INPUT
▼ ANALOG OUTPUT
△ DISCRETE INPUT
▽ DISCRETE OUTPUT

GENERAL INSTRUMENT OR FUNCTIONAL SYMBOLS

FIELD MOUNTED INSTRUMENT
REAR-OF-PANEL MOUNTED INSTRUMENT
PANEL MOUNTED INSTRUMENT
MOTOR CONTROL CENTER MOUNTED INSTRUMENT

SPECIAL CASES

QL OO — ON AND OFF EVENT LIGHTS
ZL OC — OPENED AND CLOSED POSITION LIGHTS
ZS OC — OPENED AND CLOSED POSITION SWITCHES
HS OO — ON-OFF HAND SWITCH. MAINTAINED CONTACT SWITCH (CONTROLLED DEVICE WILL RESTART ON RETURN OF POWER AFTER POWER FAILURE).
HS SS — STOP-START HAND SWITCH MOMENTARY CONTACT SWITCHES (CONTROLLED DEVICE WILL NOT RESTART ON RETURN OF POWER AFTER POWER FAILURE).
xIC — CONTROL OR DISPLAY FUNCTION VIA THE OPERATOR INTERFACE WITH THE DISTRIBUTED CONTROL SYSTEM (FUNCTION OPERATOR ACCESSIBLE) 2

TRANSDUCERS

A	ANALOG	I	CURRENT
D	DIGITAL	P	PNEUMATIC
E	VOLTAGE	PF	PULSE FREQUENCY
F	FREQUENCY	PD	PULSE DURATION
H	HYDRAULIC	R	RESISTANCE

EXAMPLE:

FY I/P — CURRENT TO PNEUMATIC TRANSDUCER (BACK OF PANEL, IN A FLOW LOOP)

4 NO CONSTRUCTION COMMENTS RECEIVED

LINE LEGEND

PROCESS (CLOSED CONDUIT, DASHED LINE INDICATES ALTERNATE FLOW STREAM)
PROCESS (OPEN CHANNEL)
---A--- ANALOG SIGNAL (4 TO 20 mAdc, ETC.)
DISCRETE SIGNAL (ON/OFF, ETC.)
--- PD --- PULSE DURATION SIGNAL
--- PF --- PULSE FREQUENCY SIGNAL
PNEUMATIC SIGNAL
-XXXXX- FILLED SYSTEM SIGNAL
-L-L-L- HYDRAULIC SYSTEM SIGNAL
BUILDING OR FACILITY BOUNDARY
(4) (8) (3) PARALLELING LINES (PARENTHETICAL NUMBER INDICATES THE NUMBER OF SIGNALS REPRESENTED)
CONNECTING LINES
NON-CONNECTING LINES

INTERFACE SYMBOLS

SHEET CONNECTOR FROM SOURCE OR TO DESTINATION DRAWING

PIPELINE NUMBER
TP-PR-10-10-SS [A1] 1
TO OR FROM DESCRIPTION LINE 1
TO OR FROM DESCRIPTION LINE 2

TP-PR-10-10- SS = DESTINATION OR SOURCE P&ID DRAWING AND SHEET NO.
[A1] = GRID LOCATION OF MATCHING SYMBOL ON CONNECTED SHEET

(N) PROCESS OR SIGNAL LINE CONTINUATION N=1,2,3,ETC
INTERFACE TO OR FROM PROCESS EXTERNAL TO PROJECT

PIPELINE NUMBERING

PIPELINE SIZE (INCHES)
SERVICE OR FLOW STREAM
PIPING LINE NUMBER
PIPE MATERIAL SPEC
ELECTRIC HEAT TRACING
-H = THERMAL INSULATION
-P = PERSONNEL PROTECTION

4"-RW-100-1KB 4"-RW-100-1HB-E 2

SPEC BREAK UG AG 1KB 1HB 1

VALVE & EQUIPMENT TAG NUMBERS

COMPONENT OR FITTING CODE
SERVICE OR FLOW STREAM
PIPING LINE NUMBER
SEQUENCE NUMBER

V-RW-100-01 PROCESS VALVES

D-W-X-Y
D = EQUIPMENT OR VALVE TYPE
W = UNIT PROCESS NUMBER
X = LOOP NUMBER
Y = UNIT NUMBER

V-NNNN NON-PROCESS VALVES
MATERIAL SPEC NUMBER
COMPONENT OR FITTING CODE
EJ = EXPANSION JOINT
FH = FLEXIBLE HOSE
1 PS = PERMANENT STRAINER
TS = TEMPORARY STRAINER

TYPE (D)
ARV AIR RELEASE VALVE
AVRV AIR AND VACUUM RELEASE VALVE
E EJECTOR
FCV FLOW CONTROL VALVE
G GATE
LCV LEVEL CONTROL VALVE
M MECHANICAL EQUIPMENT
P PUMP
PCV PRESSURE CONTROL VALVE
PSE RUPTURE DISK
PSV PRESSURE RELIEF VALVE
T TANK
TCV TEMPERATURE CONTROL VALVE
V VALVE

PIPELINE MATERIAL LIST

1CV = CARBON STEEL, WITH FLEXIBLE VICTAULIC FITTINGS
1HB = SCHEDULE 80 CPVC
1KA = SINGLE WALL HDPE, SDR 11
1KB = DOUBLE CONTAINMENT HDPE, SDR 11/ 7
3 1PV = FBE LINED CARBON STEEL, WITH FLEXIBLE VICTAULIC COUPLINGS
2CA CARBON STEEL, FIRE PROTECTION
3DV = 304L SS WITH VICTAULIC PRESS FIT COUPLINGS
8NA = 316 STAINLESS STEEL TUBING

ABBREVIATIONS & LETTER SYMBOLS

AC	ALTERNATING CURRENT
ALKY	ALKALINITY
AM	AUTO-MANUAL
CAM	COMPUTER-AUTO-MANUAL
CCS	CENTRAL CONTROL SYSTEM
CL_2 etc.	CHLORINE (TYPICAL: USE STANDARD CHEMICAL ELEMENT ABBREVIATION)
CM	COMPUTER-MANUAL
COD	CHEMICAL OXYGEN DEMAND
CP-X	CONTROL PANEL NO. X
DC	DIRECT CURRENT
DO	DISSOLVED OXYGEN
EJ	EXPANSION JOINT
FCL_2	FREE CHLORINE RESIDUAL
FH	FLEXIBLE HOSE
FOS	FAST-OFF-SLOW
FOSA	FAST-OFF-SLOW-AUTO
FOSR	FAST-OFF-SLOW-REMOTE
FP-W-X	FIELD PANEL NO. WX (W = UNIT PROCESS NUMBER X = PANEL NUMBER)
FR	FORWARD-REVERSE
HOA	HAND-OFF-AUTO
HOR	HAND-OFF-REMOTE
LOS	LOCKOUT STOP
LOR	LOCAL-OFF-REMOTE
LR	LOCAL-REMOTE
MA	MANUAL-AUTO
MC	MODULATE-CLOSE
MCC-X	MOTOR CONTROL CENTER NO. X
OC	OPEN-CLOSE (D)
OCR	OPEN-CLOSE-REMOTE
OCA	OPEN-CLOSE-AUTO
OO	ON-OFF
OOA	ON-OFF-AUTO
OOR	ON-OFF-REMOTE
ORP	OXIDATION REDUCTION POTENTIAL
OSC	OPEN-STOP-CLOSE
pH	HYDROGEN ION CONCENTRATION
PS	PERMANENT STRAINER
RM-X	REMOTE MULTIPLEXING MODULE NO. X
RTU-X	REMOTE TELEMETRY UNIT NO. X
SF	SLOWER-FASTER
SS	START-STOP
SSC	SUPERVISORY SET POINT CONTROL
TCL_2	TOTAL CHLORINE RESIDUAL
TOC	TOTAL ORGANIC CARBON
TOD	TOTAL OXYGEN DEMAND
TS	TEMPORARY STRAINER
TURB	TURBIDITY
VHC	VOLATILE HYDROCARBONS
VIB	VIBRATION
Δ	DIFFERENCE
Σ	SUM
X	MULTIPLY
÷	DIVIDE
f(x)	CHARACTERIZED
X^n	RAISE TO THE Nth POWER
√	SQUARE ROOT
AVG	AVERAGE
1:1	REPEAT OR BOOST
>	SELECT HIGHEST SIGNAL
<	SELECT LOWEST SIGNAL
±	BIAS
%	GAIN OR ATTENUATE

GENERAL NOTES

1. COMPONENTS AND PANELS SHOWN WITH A SINGLE ASTERISK (*) ARE TO BE PROVIDED AS PART OF A PACKAGE SYSTEM.
2. COMPONENTS AND PANELS SHOWN WITH A DOUBLE ASTERISK (**) ARE TO BE PROVIDED UNDER DIVISION 16, ELECTRICAL.
3. THIS IS A STANDARD LEGEND. THEREFORE, NOT ALL OF THIS INFORMATION MAY BE USED ON THIS PROJECT.

REGISTERED PROFESSIONAL ENGINEER KENNETH L. MARTINS No. C046876 Exp. 6/30/2007 CHEMICAL STATE OF CALIFORNIA

RESPONSIBLE ENGINEER: Kenneth L. Martins
PE # CH4876 Exp. 6-30-05

NO.	DATE	REVISION	BY	CHK
D	07/28/04	FOR INTERNAL REVIEW	EFC	AJ
0	09/03/04	APPROVED FOR CONSTRUCTION	EFC	AJ
1	10/13/04	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
2	01/23/05	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
3	02/14/05	REVISED PIPELINE MATERIAL LIST - APPROVED FOR CONSTRUCTION	EFC	AJ
4	09/27/05	FINAL RECORD ISSUE	EFC	AJ

REVISION APPROVAL — REV 4 — DATE 09/27/05

DISCIPLINE	REVIEWED	DISCIPLINE	REVIEWED
CIVIL	—	ELECTRICAL	KCM
STRUCTURAL	—	INST & CONTROL	KCM
MECHANICAL	AJ	ARCHITECTURAL	—
PROCESS	AJ for KLM	ENVIRONMENTAL	—
PIPING	SDH	GEN. ARRANG.	RP

PRINT DISTRIBUTION: DATE, STATUS, REV., CLIENT, FIELD, INTRA CO.

STATUS

ISSUED	REV	DATE	SDE	PEM
PRELIMINARY				
FOR REVIEW AND APPROVAL	D	07/28/04		
APPROVED FOR CONSTRUCTION	0	09/03/04	KLM	TP
REVISED & APPROVED FOR CONSTRUCTION	4	10/03/05	AJ for KLM	AJ

SCALE NONE

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURE 3
EXPANDED GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

PROJ NO. 315994

CH2MHILL

PROCESS AND INSTRUMENTATION DIAGRAM
SHEET 01
SYMBOLS AND NOMENCLATURE
LEGEND 1 OF 2

DWG. NO. TP-PR-10-10-01 REV. 4

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

FILENAME: tppr101001.dwg PLOT DATE: 27-SEP-2005 PLOT TIME:

VALVE SYMBOLS

- GATE
- KNIFE GATE
- BUTTERFLY
- GLOBE
- BALL
- VEE- BALL
- PLUG
- SEAT PORT ECCENTRIC PLUG
- DIAPHRAGM
- PINCH
- NEEDLE
- SWING CHECK
- BALL CHECK
- SAMPLE
- MUD
- PRESSURE RELIEF
- AIR AND / OR VACUUM RELEASE
- REGULATED SIDE PRESSURE CONTROL VALVE
- BPR BACK PRESSURE REGULATOR 2
- MULTI-PORT VALVES (BALL VALVE SHOWN. FOR OTHER VALVE TYPES, APPROPRIATE VALVE SYMBOL SHOWN.) ARROWS INDICATE FLOW PATTERN. SEAT PORTS ARE IMPLIED BY INDICATED FLOW PATTERN.
- FIRE HYDRANT

GATE SYMBOLS

- SLUICE
- BUTTERFLY
- FLAP
- FABRICATED SLIDE
- SHEAR

PRIMARY ELEMENT SYMBOLS

- PARSHALL FLUME
- WEIR
- OFFICE PLATE
- FLOW TUBE
- PITOT-STATIC
- VORTEX METER
- ROTAMETER
- ULTRASONIC FLOWMETER (INLINE)
- ELECTROMAGNETIC FLOWMETER
- PROPELLER OR TURBINE METER
- STATIC MIXER
- DENSITY METER (X: N = NUCLEAR, O = OPTICAL, U = ULTRASONIC)
- ULTRASONIC FLOWMETER (CLAMP-ON)
- LEVEL (ULTRASONIC)
- LEVEL (BUBBLER TUBE)
- LEVEL (FLOAT)

ACTUATOR SYMBOLS

- P Z XX — PNEUMATIC W/POSITIONER
- P S XX — PNEUMATIC W/SOLENOID
- E XX — ELECTRIC
- E Z XX — ELECTRIC W/POSITIONER
- EH XX — ELECTROHYDRAULIC
- H XX — HYDRAULIC
- P B XX — PNEUMATIC WITH VOLUME BOOSTER
- S — SOLENOID
- MANUAL

NOTE:
ON LOSS OF PRIMARY POWER (PNEUMATIC, ELECTRICAL OR HYDRAULIC)
XX: FO =FAIL OPEN
FC =FAIL CLOSED
FLP=FAIL TO LAST POSITION

4 NO CONSTRUCTION COMMENTS RECEIVED

MISCELLANEOUS SYMBOLS

- SIGHT GLASS
- DIAPHRAGM SEAL
- BLIND FLANGE
- AIR GAP
- V — VENT TO ATMOSPHERE
- AERATOR
- PLUG
- RECEPTACLE
- A — SELF CONTAINED AIR SUPPLY
- SD D — COMPOSITE SAMPLER (DIPPER TYPE)
- SS — COMPOSITE SAMPLER (SUCTION TYPE)
- TV — TV CAMERA
- RADIO ANTENNA
- A ON-TD X-SEC B — "ON" TIME DELAY B "ON" X-SEC. AFTER A "ON". INSTANT "OFF".
- OFF-TD X-SEC — "OFF TIME DELAY B "OFF" X-SEC. AFTER A "OFF" INSTANT "ON"
- I OR I — INTERLOCK. SEE CONTROL DIAGRAMS
- A S C B R — MEMORY ELEMENT S= SET , R= RESET
- XX AIR SET — AIR SET XX= SUPPLY PRESSURE IN PSIG.
- FILTER/ REGULATOR/ GAUGE SET
- BFP — BACK-FLOW PREVENTER
- PERMANENT STRAINER 1
- T — TEMPORARY STRAINER
- 120V — 120 VOLT, 60 HZ POWER
- 480V — 480 VOLT, 60 HZ POWER
- ANNULAR DIAPHRAGM SEAL
- RUPTURE DISK
- PIG INSERT POINT
- OR — PIG CATCH POINT
- OR M — MIXER
- M — ELECTRIC MOTOR
- PRESSURE GAUGE
- X — TONE TRANSMITTER NO. X
- X — TONE RECEIVER NO. X
- VOICE COMMUNICATION POINT
- TV — TV MONITOR
- A B AND C — LOGIC ELEMENT: IF A AND NOT B THEN C
- A B OR C — LOGIC ELEMENT: IF A OR B THEN C
- S R — ON/OFF RELAY. INPUT IS CONNECTED TO OUTPUT WHEN SWITCHING SIGNAL IS PRESENT.
- S R — SWITCHING SIGNAL SWITCHING RELAY. INPUT WITH DOT IS CONNECTED TO OUTPUT WHEM SWITCHING SIGNAL IS PRESENT OTHER INPUT IS CONNECTED TO OUTPUT WHEN SWITCHING SIGNAL IS NOT PRESENT.
- F — FLUSHING CONNECTION SIZES PER DWG. TP-PI-05-00-06 V-1690 V-1390 HOSE ADAPTOR 2
- S — SEAL WATER SET V-1390 1/2" x 3/8" 2
- FLEXIBLE CONNECTOR (HOSE)
- HOSE CONNECTION
- SSEW — SAFETY SHOWER AND EYE WASH STATION 3

PUMP AND COMPRESSOR SYMBOLS

NOTE: XX: AS = ADJUSTABLE SPEED
CS-1 = CONSTANT SPEED (SINGLE SPEED)
CS-2 = CONSTANT SPEED (TWO SPEED)

- CENTRIFUGAL PUMP (DRY PIT)
- CENTRIFUGAL WET PIT PUMP OR TURBINE PUMP
- CHEMICAL FEED PUMP
- DIAPHRAGM PUMP
- GEAR PUMP OR BLOWER (POSITIVE DISPLACEMENT)
- PISTON PUMP
- PROGRESSIVE CAVITY PUMP
- SUBMERSIBLE SUMP PUMP
- COMPRESSOR (CENTRIFUGAL)
- COMPRESSOR (PISTON)
- BLOWER OR FAN (CENTRIFUGAL)
- EJECTOR

SERVICE OR FLOW STREAM IDENTIFCATION

- AHP — AIR,HIGH PRESSURE PROCESS
- AI — AIR, INSTRUMENT
- AL — ALUM
- ALP — AIR, LOW PRESSURE PROCESS
- ASH — SODA ASH
- B — BRINE
- BA — BLOWING AIR
- BDS — BLENDED DIGESTED SLUDGE
- BFE — BIO-FILTER EFFLUENT
- BFI — BIO-FILTER INFLUENT
- BFR — BIO-FILTER RECYCLE
- BFW — BRINE FEEDWATER
- BS — BRINE SLUDGE
- BWS — BACKWASH SUPPLY
- BYP — BYPASS
- C — CARBON SLURRY
- CD — CARBON DIOXIDE GAS
- CG — CHLORINE GAS (PRESSURE)
- CGV — CHLORINE GAS (VACUUM)
- CHS — CHLORINE SLUDGE
- CL — CHLORINE LIQUID
- CNA — CELL CAUSTIC
- CO — CONDENSATE DRAIN
- CS — CHLORINE SOLUTION
- CWR — COOLING WATER RETURN
- CWS — COOLING WATER SUPPLY
- DR — DRAIN (SANITARY)
- DAS — DIGESTED ACTIVATED SLUDGE
- DG — DIGESTER GAS
- DIW — DEIONIZED WATER
- DS — DIGESTED SLUDGE
- DW — DISTILLED WATER
- F — FILTRATE
- FC — FERRIC CHLORINE
- FE — FILTER EFFLUENT
- FI — FILTER INFLUENT
- FOR — FUEL OIL RETURN
- FOS — FUEL OIL SUPPLY
- FTW — FILTER TO WASTE
- G — NATURAL GAS
- GAS — GASOLINE
- GOX — GASEOUS OXYGEN
- GOX 1 - GOX PRODUCT
- GOX 2 - GOX PRODUCT
- GOX 3 - GOX VENT
- GOX 4 - GOX PRESSURE BUILD
- GOX 5 - GOX ADDITION
- GR — GRIT SLURRY
- H — HYDROGEN GAS
- HPR — HIGH PRESSURE RETURN (CONDENSATE)
- HPS — HIGH PRESSURE STEAM
- HS — HEAVY SOLIDS
- HWR — HEATING WATER RETURN
- HWS — HEATING WATER SUPPLY
- IA — INSTRUMENT AIR
- LD — DRY LIME
- LOX — LIQUID OXYGEN
- LPO — LIQUID POLYMER
- LPR — LOW PRESSURE RETURN (CONDENSATE)
- LPS — LOW PRESSURE STEAM
- LS — LIME SLURRY
- LSD — LIME SLUDGE
- ML — MIXED LIQUOR
- MPR — MEDIUM PRESSURE RETURN (CONDENSATE)
- MPS — MEDUIM PRESSURE STEAM
- NA — SODIUM HYDROXIDE
- NT — NITROGEN TRICHLORIDE
- OF — OVERFLOW
- P — PROPANE GAS
- PDS — PRIMARY DIGESTED SLUDGE
- PE — PRIMARY EFFLUENT
- PI — PRIMARY INFLUENT
- PLE — PLANT EFFLUENT
- PO — POLYMER SOLUTION
- PS — PRESSURE SEWER
- PSD — PRIMARY SLUDGE
- PSM — PRIMARY SCUM 3
- PW — POTABLE WATER
- RAS — RETURN ACTIVATED SLUDGE
- RB — RAW BRINE
- RCS — RECARBONATION SLUDGE
- RCY — RECYCLE
- RHW — RECIRCULATED HOT WATER
- RS — RAW SEWAGE
- RSD — RECIRCULATED SLUDGE
- RW — RAW WATER
- S — SANITARY SEWER (GRAVITY)
- SA — SAMPLE
- SAS — SODA ASH SOLUTION
- SB — SPENT BRINE
- SC — COLD SLUDGE
- SDG — SULFUR DIOXIDE GAS
- SDL — SULFUR DIOXIDE LIQUID
- SDS — SULFUR DIOXIDE SOLUTION
- SDV — SULFUR DIOXIDE GAS (VACUUM)
- SE — SECONDARY EFFLUENT
- SH — HEATED SLUDGE
- SSD — SECONDARY DIGESTED SLUDGE
- SSM — SECONDARY SCUM
- SW — SURFACE WASH
- TAS — THICKENED ACTIVATED SLUDGE
- TB — TREATED BRINE
- TBS — THICKENER BOTTOM SLUDGE
- TDS — THICKENED DIGESTED SLUDGE
- TPS — THICKENED PRIMARY SLUDGE
- TUF — THICKENER UNDERFLOW
- TW — TREATED WATER
- UD — UNDERDRAIN
- VT — VENT
- VAC — VACUUM
- WAS — WASTE ACTIVATED SLUDGE
- WS — WASTE STREAM

REGISTERED PROFESSIONAL ENGINEER KENNETH L. MARTINS No. CH004876 Exp. 6/30/2007 CHEMICAL STATE OF CALIFORNIA

RESPONSIBLE ENGINEER: Kenneth L. Martins Exp. 6-30-05 PE # CH4876

NO.	DATE	REVISION	BY	CHK
D	07/28/04	FOR INTERNAL REVIEW	EFC	AJ
0	09/03/04	APPROVED FOR CONSTRUCTION	EFC	AJ
1	10/13/04	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
2	01/23/05	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
3	03/18/05	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
4	09/27/05	FINAL RECORD ISSUE	EFC	AJ

REVISION APPROVAL REV 4 DATE 09/27/05

DISCIPLINE	REVIEWED	DISCIPLINE	REVIEWED
CIVIL	—	ELECTRICAL	KCM
STRUCTURAL	—	INST & CONTROL	KCM
MECHANICAL	AJ	ARCHITECTURAL	—
PROCESS	AJ for ELM	ENVIRONMENTAL	—
PIPING	SDH	GEN. ARRANG.	[illegible]

PRINT DISTRIBUTION: DATE, STATUS, REV., CLIENT, FIELD, INTRA CO.

STATUS

ISSUED	REV	DATE	SDE	PEM
PRELIMINARY				
FOR REVIEW AND APPROVAL	D	07/28/04		
APPROVED FOR CONSTRUCTION	0	09/03/04	KLM	TP
REVISED & APPROVED FOR CONSTRUCTION	4	10/03/05	AJ for ELM	AJ

SCALE NONE

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURE 3
EXPANDED GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

PROJ NO. 315994

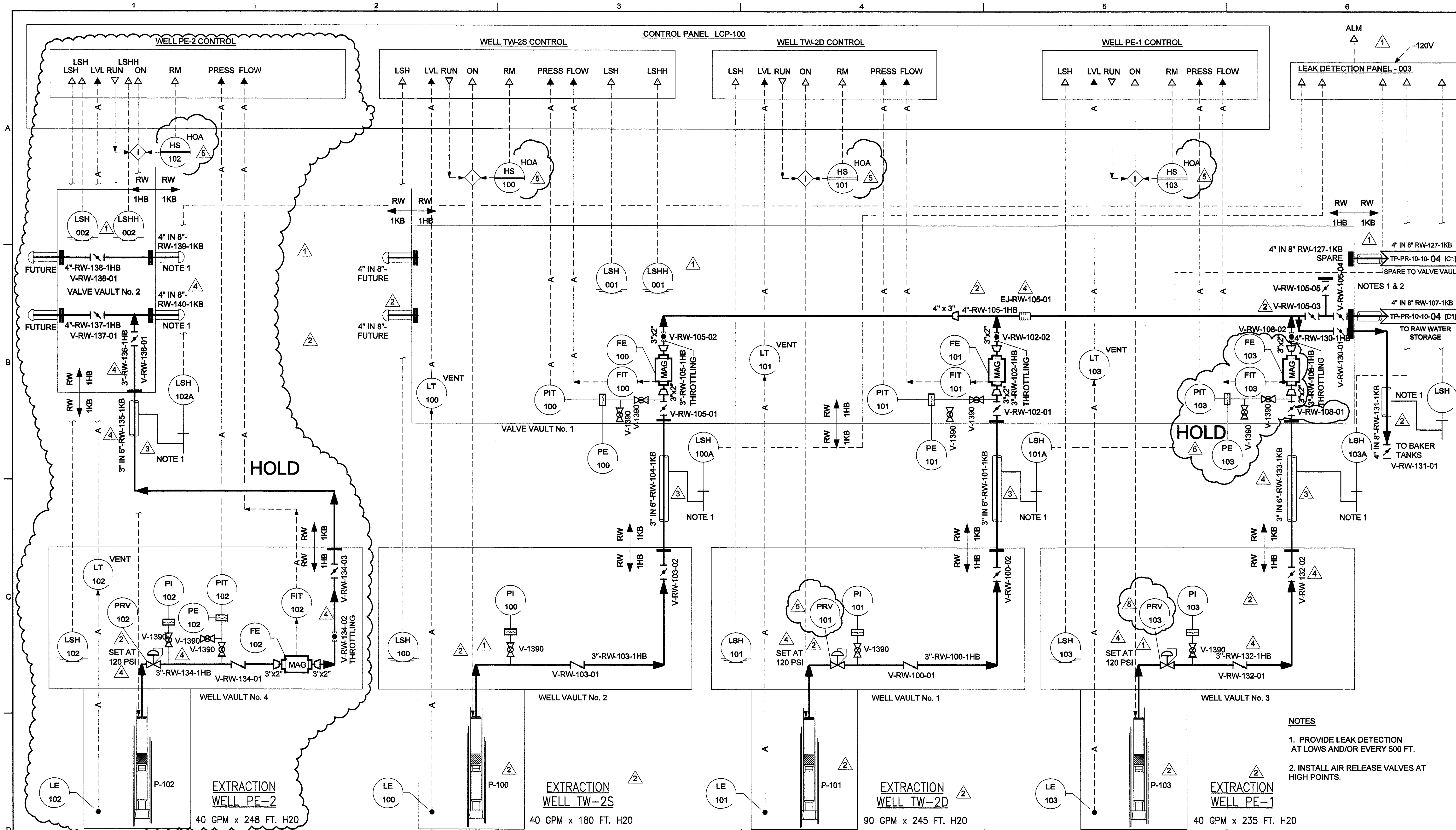
CH2MHILL

PROCESS AND INSTRUMENTATION DIAGRAM
SHEET 02
SYMBOLS AND NOMENCLATURE
LEGEND 2 OF 2

DWG. NO. TP-PR-10-10-02 REV. 4

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

FILENAME: tppr101002.dwg PLOT DATE: 27-SEP-2005 PLOT TIME:



NOTES

1. PROVIDE LEAK DETECTION AT LOWS AND/OR EVERY 500 FT.
2. INSTALL AIR RELEASE VALVES AT HIGH POINTS.

REGISTERED PROFESSIONAL ENGINEER, Kenneth L. Martins, CHEMICAL, STATE OF CALIFORNIA

RESPONSIBLE ENGINEER: Kenneth L. Martins
PE # CH4876 Exp. 6-30-05

NO.	DATE	REVISION	BY	CHK
D	07/28/04	FOR INTERNAL REVIEW	EFC	AJ
0	09/03/04	APPROVED FOR CONSTRUCTION	EFC	AJ
1	10/13/04	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
2	01/23/05	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
3	03/16/05	DELETED NOTES. APPROVED FOR CONSTRUCTION	EFC	AJ
4	07/20/05	RELIEF VALVE SETTINGS. WELL PE-1 LINE TAGS. HOLDS REMOVED. APPROVED FOR CONSTRUCTION	EFC	AJ
5	09/27/05	FINAL RECORD ISSUE		

REVISION APPROVAL REV 5 DATE 09/27/05

DISCIPLINE	REVIEWED	DISCIPLINE	REVIEWED	PRINT DISTRIBUTION
CIVIL	—	ELECTRICAL	KCM	DATE
STRUCTURAL	—	INST & CONTROL	KCM	STATUS
MECHANICAL	AJ	ARCHITECTURAL	—	REV.
PROCESS	AJ KLM	ENVIRONMENTAL	—	CLIENT
PIPING	SDH	GEN. ARRANG.		FIELD
				INTRA CO.

STATUS

ISSUED	REV	DATE	SDE	PEM
PRELIMINARY				
FOR REVIEW AND APPROVAL	D	07/28/04		
APPROVED FOR CONSTRUCTION	0	09/03/04	KLM	TP
REVISED & APPROVED FOR CONSTRUCTION	5	10/03/05	AJ for KLM	AJ

SCALE NONE

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURE 3
EXPANDED GROUNDWATER EXTRACTION
AND TREATMENT SYSTEM

PROJ NO. 315994

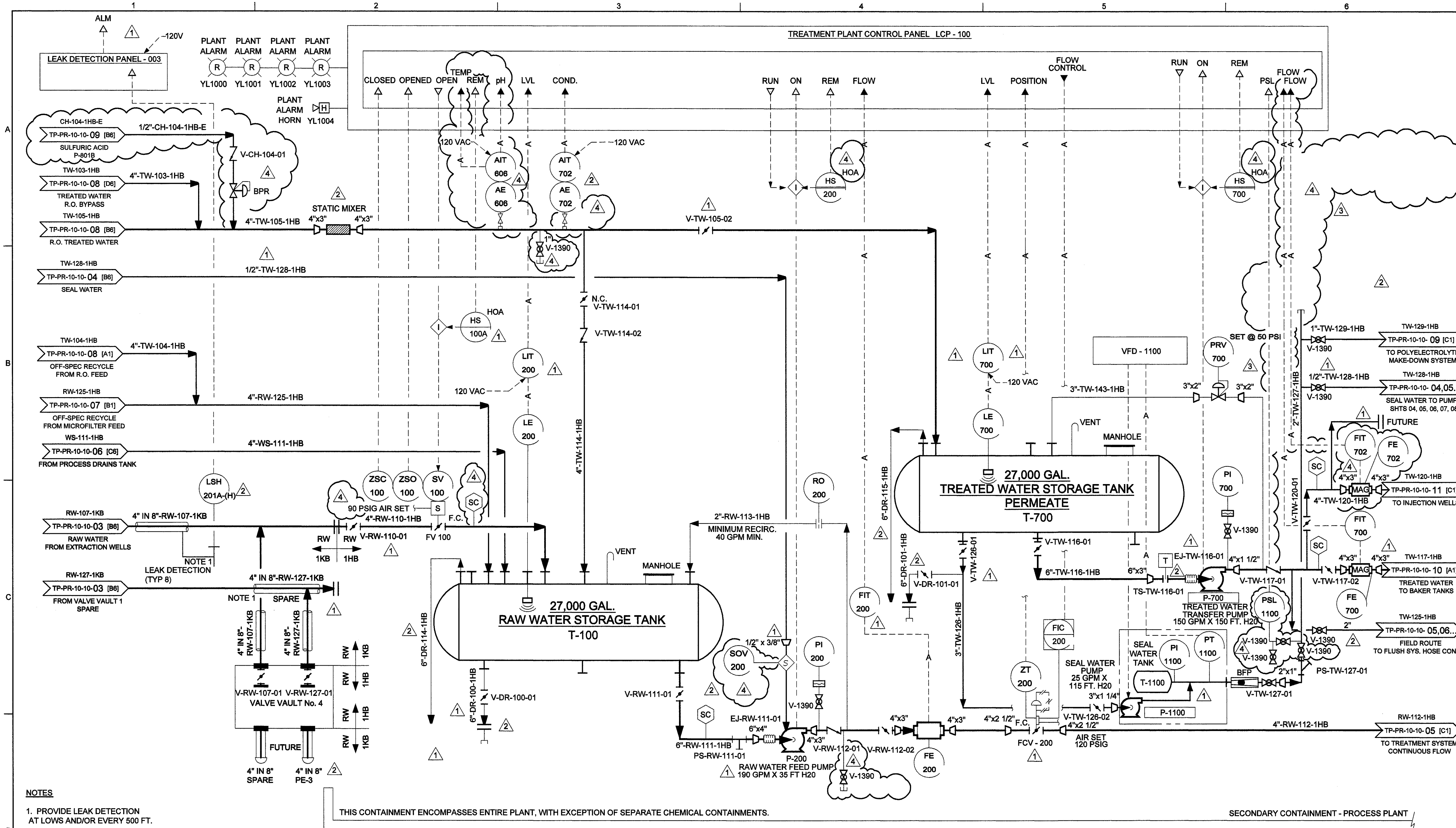
CH2MHILL

PROCESS AND INSTRUMENTATION DIAGRAM
SHEET 03
EXTRACTION WELLS
PE-1, PE-2, TW-2D AND TW-2S

DWG. NO. TP-PR-10-10-03 REV. 5

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

FILENAME: tppr101003.dwg PLOT DATE: 27-SEP-2005 PLOT TIME:



NOTES

1. PROVIDE LEAK DETECTION AT LOWS AND/OR EVERY 500 FT.

REUSE OF DOCUMENTS: THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF CH2M HILL AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CH2M HILL. ©CH2M HILL

RESPONSIBLE ENGINEER: Kenneth L. Martins
PE # CH4876 Exp. 6-30-05

NO.	DATE	REVISION	BY	CHK
D	07/28/04	FOR INTERNAL REVIEW	EFC	AJ
0	09/03/04	APPROVED FOR CONSTRUCTION	EFC	AJ
1	10/13/04	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
2	01/23/05	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
3	02/14/05	ADDED RECIRC. LINE AND PRV VALVE TO T-700 - APPROVED FOR CONSTRUCTION	EFC	AJ
4	09/27/05	FINAL RECORD ISSUE	EFC	AJ

REVISION APPROVAL REV 4 DATE 09/27/05

DISCIPLINE	REVIEWED	DISCIPLINE	REVIEWED
CIVIL	—	ELECTRICAL	KCM
STRUCTURAL	—	INST & CONTROL	KCM
MECHANICAL	AJ	ARCHITECTURAL	—
PROCESS	AJ for KLM	ENVIRONMENTAL	—
PIPING	SDH	GEN. ARRANG.	

PRINT DISTRIBUTION: DATE, STATUS, REV., CLIENT, FIELD, INTRA CO.

STATUS

ISSUED	REV	DATE	SDE	PEM
PRELIMINARY				
FOR REVIEW AND APPROVAL	D	07/28/04		
APPROVED FOR CONSTRUCTION	0	09/03/04	KLM	TP
REVISED & APPROVED FOR CONSTRUCTION	4	10/03/05	AJ for KLM	AJ

SCALE NONE

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURE 3
EXPANDED GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

PROJ NO. 315994

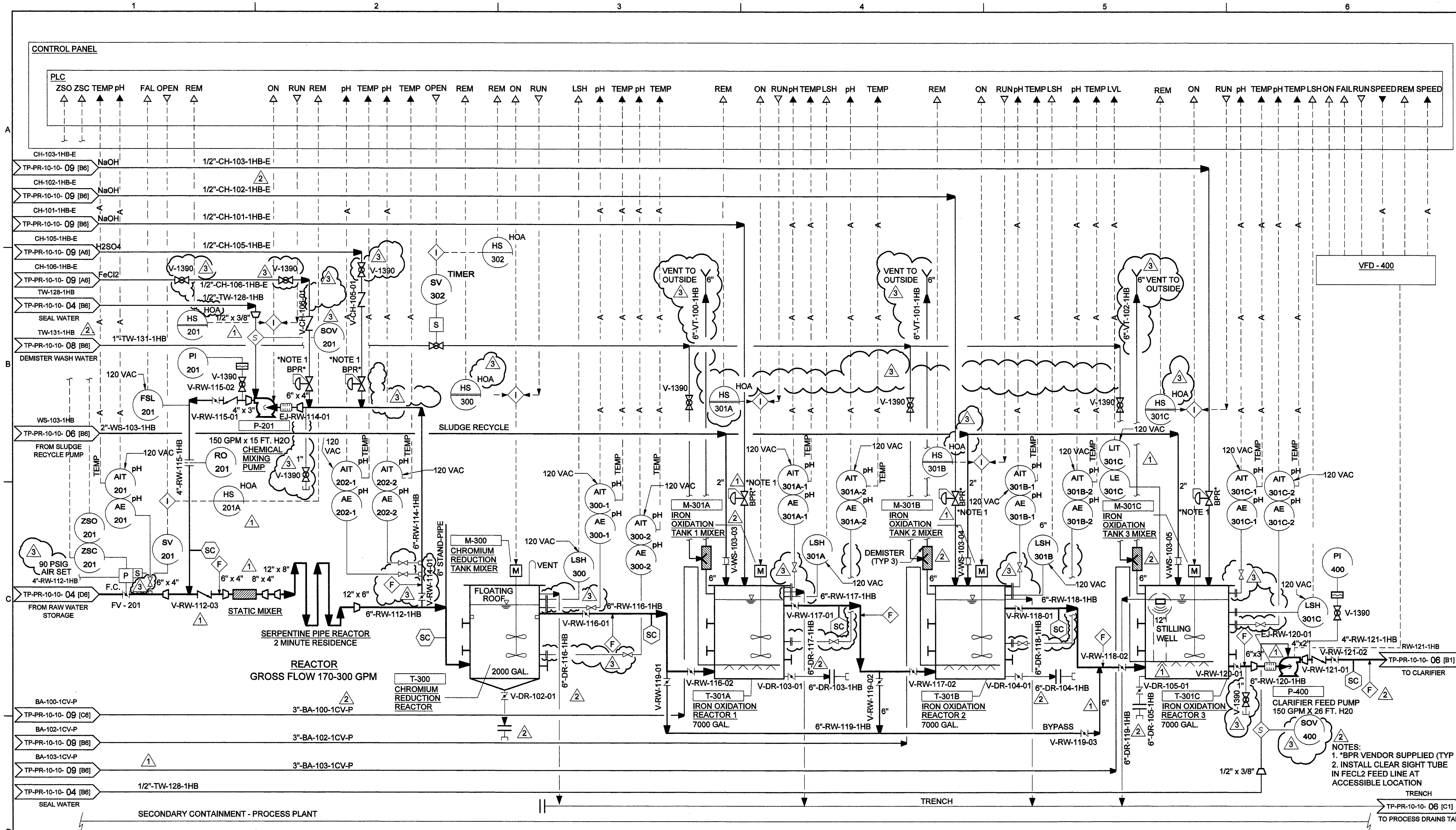
CH2MHILL

PROCESS AND INSTRUMENTATION DIAGRAM
SHEET 04
STORAGE AREA

DWG. NO. TP-PR-10-10-04 REV. 4

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

FILENAME: tppr101004.dwg PLOT DATE: 27-SEP-2005 PLOT TIME:



NO.	DATE	REVISION	BY	CHK
D	07/28/04	FOR INTERNAL REVIEW	EFC	AJ
0	09/03/04	APPROVED FOR CONSTRUCTION	EFC	AJ
1	10/13/04	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
2	01/23/05	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
3	09/27/05	FINAL RECORD ISSUE	EFC	AJ

RESPONSIBLE ENGINEER: Kenneth L. Martins Exp. 6-30-05
PE # CH4876

REVISION APPROVAL	REV 3		DATE 09/27/05	PRINT DISTRIBUTION
DISCIPLINE	REVIEWED	DISCIPLINE	REVIEWED	DATE
CIVIL	—	ELECTRICAL	KCM	STATUS
STRUCTURAL	—	INST & CONTROL	KCM	REV.
MECHANICAL	AJ	ARCHITECTURAL	—	CLIENT
PROCESS	AJ for KLM	ENVIRONMENTAL	—	FIELD
PIPING	SDH	GEN. ARRANG.		INTRA CO.

ISSUED	REV	DATE	SDE	PEM
PRELIMINARY				
FOR REVIEW AND APPROVAL	D	07/28/04		
APPROVED FOR CONSTRUCTION	0	09/03/04	KLM	TP
REVISED & APPROVED FOR CONSTRUCTION	3	10/03/05	AJ for KLM	AJ

SCALE NONE

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURE 3
EXPANDED GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

PROJ NO. 315994

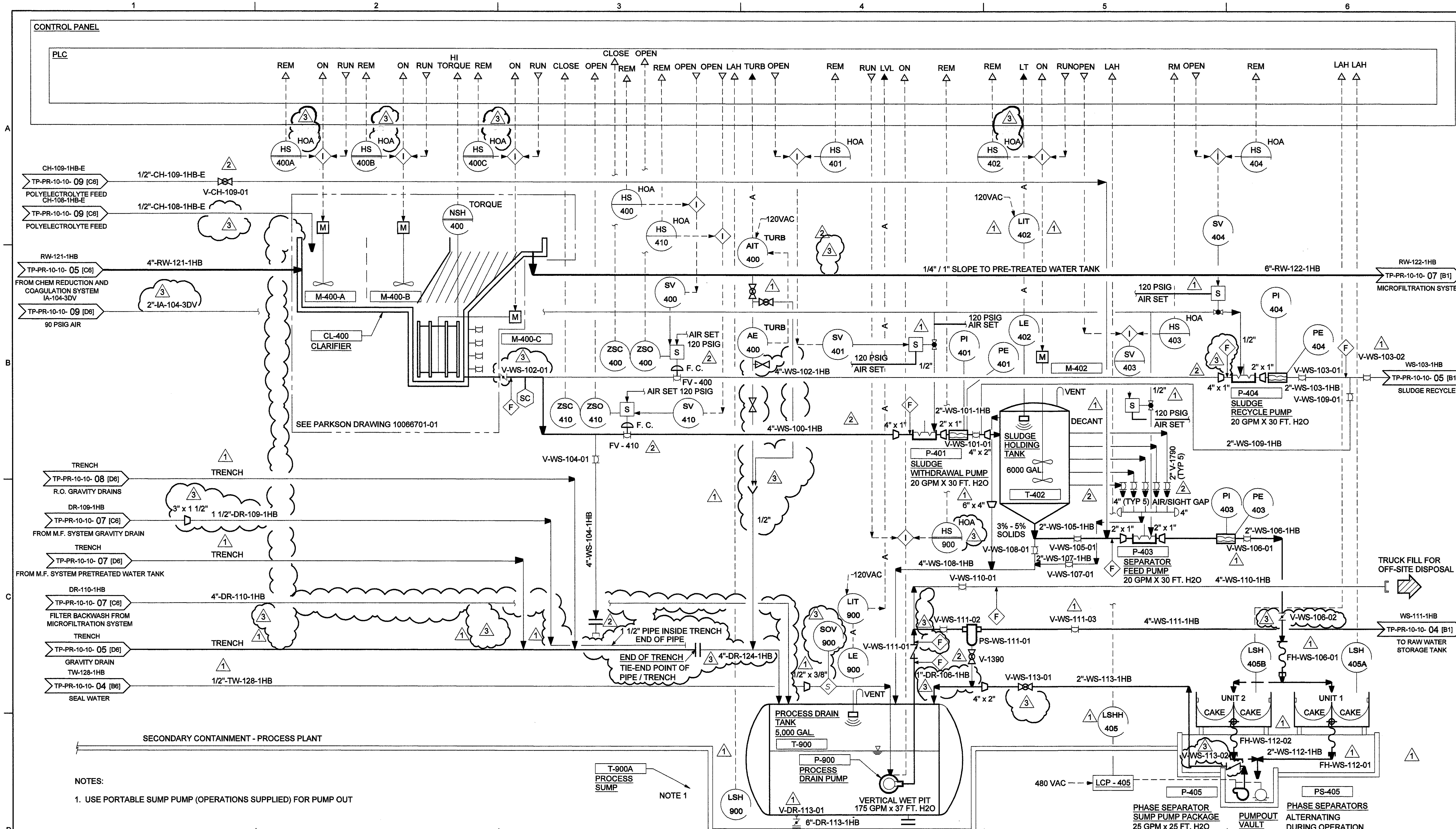
CH2MHILL

PROCESS AND INSTRUMENTATION DIAGRAM
SHEET 05
CHEMICAL REDUCTION AND COAGULATION SYSTEM

DWG. NO. TP-PR-10-10-05 REV. 3

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

FILENAME: tppr101005.dwg PLOT DATE: 27-SEP-2005 PLOT TIME:



NOTES:

1. USE PORTABLE SUMP PUMP (OPERATIONS SUPPLIED) FOR PUMP OUT

RESPONSIBLE ENGINEER: Kenneth L. Martins Exp. 6-30-05 PE # CH4876

REGISTERED PROFESSIONAL ENGINEER KENNETH L. MARTINS No. CH004876 Exp. 6/30/2007 CHEMICAL STATE OF CALIFORNIA

NO.	DATE	REVISION	BY	CHK
D	07/28/04	FOR INTERNAL REVIEW	EFC	AJ
0	09/03/04	APPROVED FOR CONSTRUCTION	EFC	AJ
1	10/13/04	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
2	01/23/05	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
3	09/27/05	FINAL RECORD ISSUE	EFC	AJ

REVISION APPROVAL — REV 3 — DATE 09/27/05

DISCIPLINE	REVIEWED	DISCIPLINE	REVIEWED
CIVIL	——	ELECTRICAL	KCM
STRUCTURAL	——	INST & CONTROL	KCM
MECHANICAL	AJ	ARCHITECTURAL	——
PROCESS	AJ for KLM	ENVIRONMENTAL	——
PIPING	SDH	GEN. ARRANG.	RP

PRINT DISTRIBUTION

DATE	
STATUS	
REV.	
CLIENT	
FIELD	
INTRA CO.	

STATUS

ISSUED	REV	DATE	SDE	PEM
PRELIMINARY				
FOR REVIEW AND APPROVAL	D	07/28/04		
APPROVED FOR CONSTRUCTION	0	09/03/04	KLM	TP
REVISED & APPROVED FOR CONSTRUCTION	3	10/03/05	AJ for KLM	AJ

SCALE NONE

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURE 3
EXPANDED GROUNDWATER EXTRACTION
AND TREATMENT SYSTEM

PROJ NO. 315994

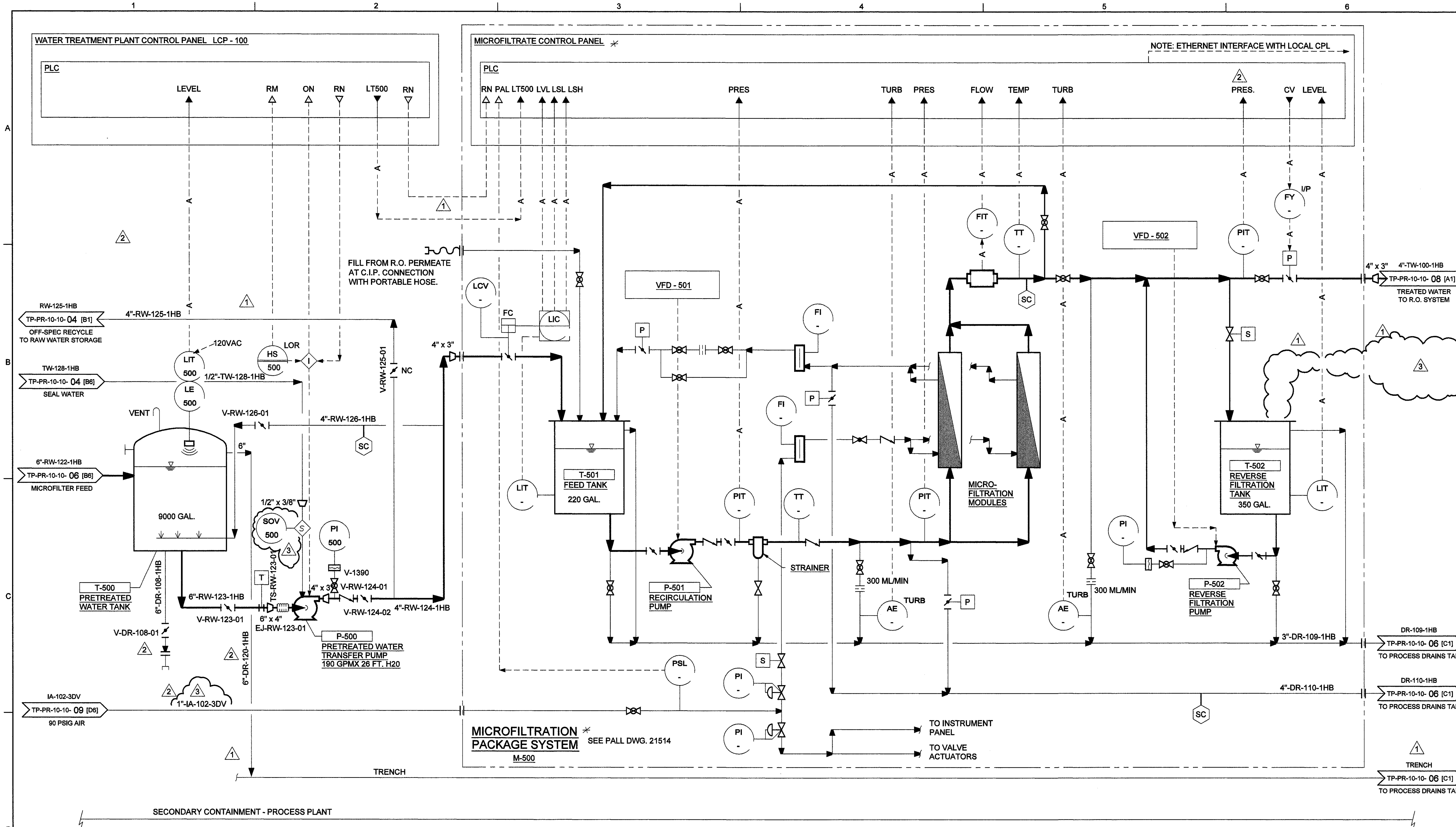
CH2MHILL

PROCESS AND INSTRUMENTATION DIAGRAM
SHEET 06
CLARIFICATION AND
SLUDGE REMOVAL

DWG. NO. TP-PR-10-10-06 | REV. 3

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

FILENAME: tppr101006.dwg PLOT DATE: 27-SEP-2005 PLOT TIME:



REGISTERED PROFESSIONAL ENGINEER
KENNETH L. MARTINS
No. CH004876
Exp. 6/30/2007
CHEMICAL
STATE OF CALIFORNIA

RESPONSIBLE ENGINEER: Kenneth L. Martins Exp. 6-30-05
PE # CH4876

NO.	DATE	REVISION	BY	CHK
D	07/28/04	FOR INTERNAL REVIEW	EFC	AJ
0	09/03/04	APPROVED FOR CONSTRUCTION	EFC	AJ
1	10/13/04	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
2	01/23/05	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
3	09/27/05	FINAL RECORD ISSUE	EFC	AJ

REVISION APPROVAL		REV 3	DATE 09/27/05
DISCIPLINE	REVIEWED	DISCIPLINE	REVIEWED
CIVIL	—	ELECTRICAL	KCM
STRUCTURAL	—	INST & CONTROL	KCM
MECHANICAL	AJ	ARCHITECTURAL	—
PROCESS	AJ for KLM	ENVIRONMENTAL	—
PIPING	SDH	GEN. ARRANG.	[illegible]

PRINT DISTRIBUTION	
DATE	
STATUS	
REV.	
CLIENT	
FIELD	
INTRA CO.	

ISSUED	REV	DATE	SDE	PEM
PRELIMINARY				
FOR REVIEW AND APPROVAL	D	07/28/04		
APPROVED FOR CONSTRUCTION	0	09/03/04	KLM	TP
REVISED & APPROVED FOR CONSTRUCTION	3	10/03/05	AJ for KLM	AJ

SCALE NONE

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURE 3
EXPANDED GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

PROJ NO. 315994

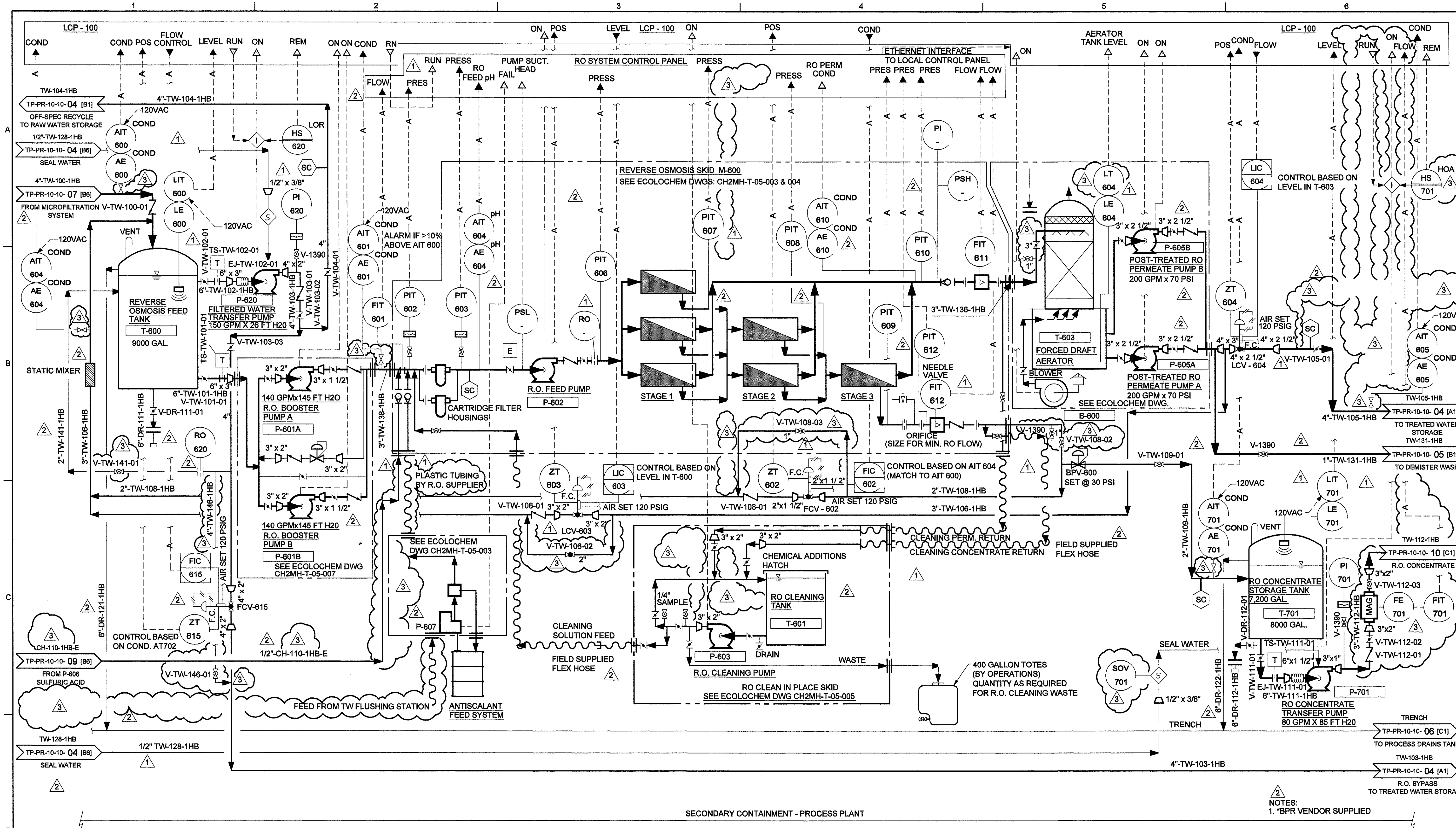
CH2MHILL

PROCESS AND INSTRUMENTATION DIAGRAM
SHEET 07
MICROFILTRATION SYSTEM

DWG. NO. TP-PR-10-10-07 REV. 3

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

FILENAME: tppr101007.dwg PLOT DATE: 27-SEP-2005 PLOT TIME:



RESPONSIBLE ENGINEER: Kenneth L. Martins
PE # CH4876 Exp. 6-30-05

NO.	DATE	REVISION	BY	CHK
D	07/28/04	FOR INTERNAL REVIEW	EFC	AJ
0	09/03/04	APPROVED FOR CONSTRUCTION	EFC	AJ
1	10/13/04	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
2	01/23/05	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
3	09/27/05	FINAL RECORD ISSUE	EFC	AJ

REVISION APPROVAL REV 3 DATE 09/27/05

DISCIPLINE	REVIEWED	DISCIPLINE	REVIEWED	PRINT DISTRIBUTION
CIVIL	—	ELECTRICAL	KCM	DATE
STRUCTURAL	—	INST & CONTROL	KCM	STATUS
MECHANICAL	AJ	ARCHITECTURAL	—	REV.
PROCESS	AJ for KLM	ENVIRONMENTAL	—	CLIENT
PIPING	SDH	GEN. ARRANG.	EP	FIELD
				INTRA CO.

STATUS

ISSUED	REV	DATE	SDE	PEM
PRELIMINARY				
FOR REVIEW AND APPROVAL	D	07/28/04		
APPROVED FOR CONSTRUCTION	0	09/03/04	KLM	TP
REVISED & APPROVED FOR CONSTRUCTION	3	10/03/05	AJ for KLM	AJ

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURE 3
EXPANDED GROUNDWATER EXTRACTION
AND TREATMENT SYSTEM
PROJ NO. 315994

CH2MHILL

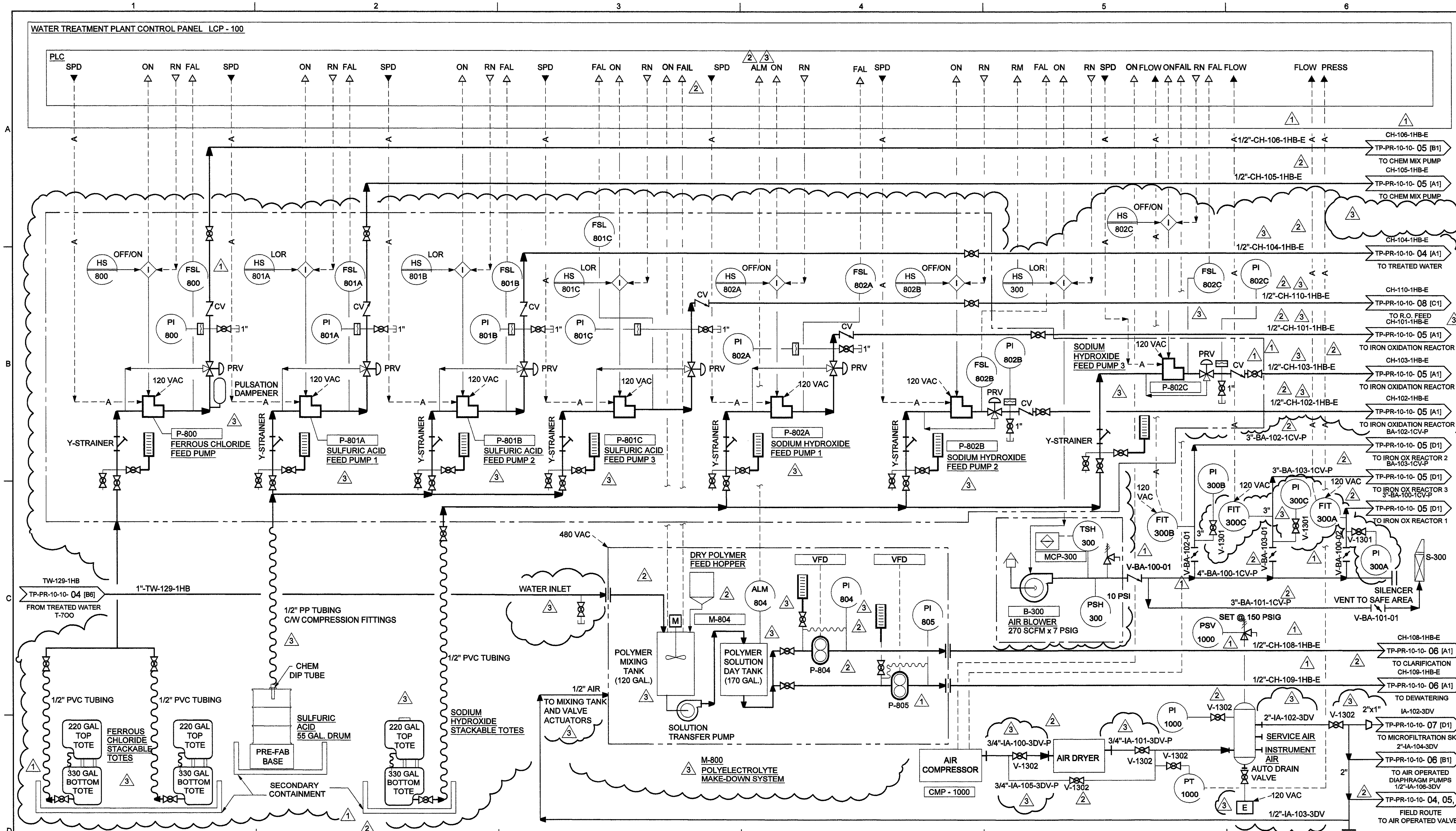
PROCESS AND INSTRUMENTATION DIAGRAM
SHEET 08
REVERSE OSMOSIS SYSTEM

SCALE NONE

DWG. NO. TP-PR-10-10-08 REV. 3

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

FILENAME: tppr101008.dwg PLOT DATE: 27-SEP-2005 PLOT TIME:



REGISTERED PROFESSIONAL ENGINEER KENNETH L. MARTINS No. CH004876 Exp. 6/30/2007 CHEMICAL STATE OF CALIFORNIA

RESPONSIBLE ENGINEER: Kenneth L. Martins Exp. 6-30-05
PE # CH4876

NO.	DATE	REVISION	BY	CHK
D	07/28/04	FOR INTERNAL REVIEW	EFC	AJ
0	09/03/04	APPROVED FOR CONSTRUCTION	EFC	AJ
1	10/13/04	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
2	01/23/05	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
3	09/27/05	FINAL RECORD ISSUE	EFC	AJ

REVISION APPROVAL		REV 3	DATE 09/27/05
DISCIPLINE	REVIEWED	DISCIPLINE	REVIEWED
CIVIL	—	ELECTRICAL	KCM
STRUCTURAL	—	INST & CONTROL	KCM
MECHANICAL	AJ	ARCHITECTURAL	—
PROCESS	AJ for KLM	ENVIRONMENTAL	—
PIPING	SDH	GEN. ARRANG.	RP

PRINT DISTRIBUTION	
DATE	
STATUS	
REV.	
CLIENT	
FIELD	
INTRA CO.	

STATUS				
ISSUED	REV	DATE	SDE	PEM
PRELIMINARY				
FOR REVIEW AND APPROVAL	D	07/28/04		
APPROVED FOR CONSTRUCTION	0	09/03/04	KLM	TP
REVISED & APPROVED FOR CONSTRUCTION	3	10/03/05	AJ for KLM	AJ

SCALE NONE

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURE 3
EXPANDED GROUNDWATER EXTRACTION
AND TREATMENT SYSTEM

PROJ NO. 315994

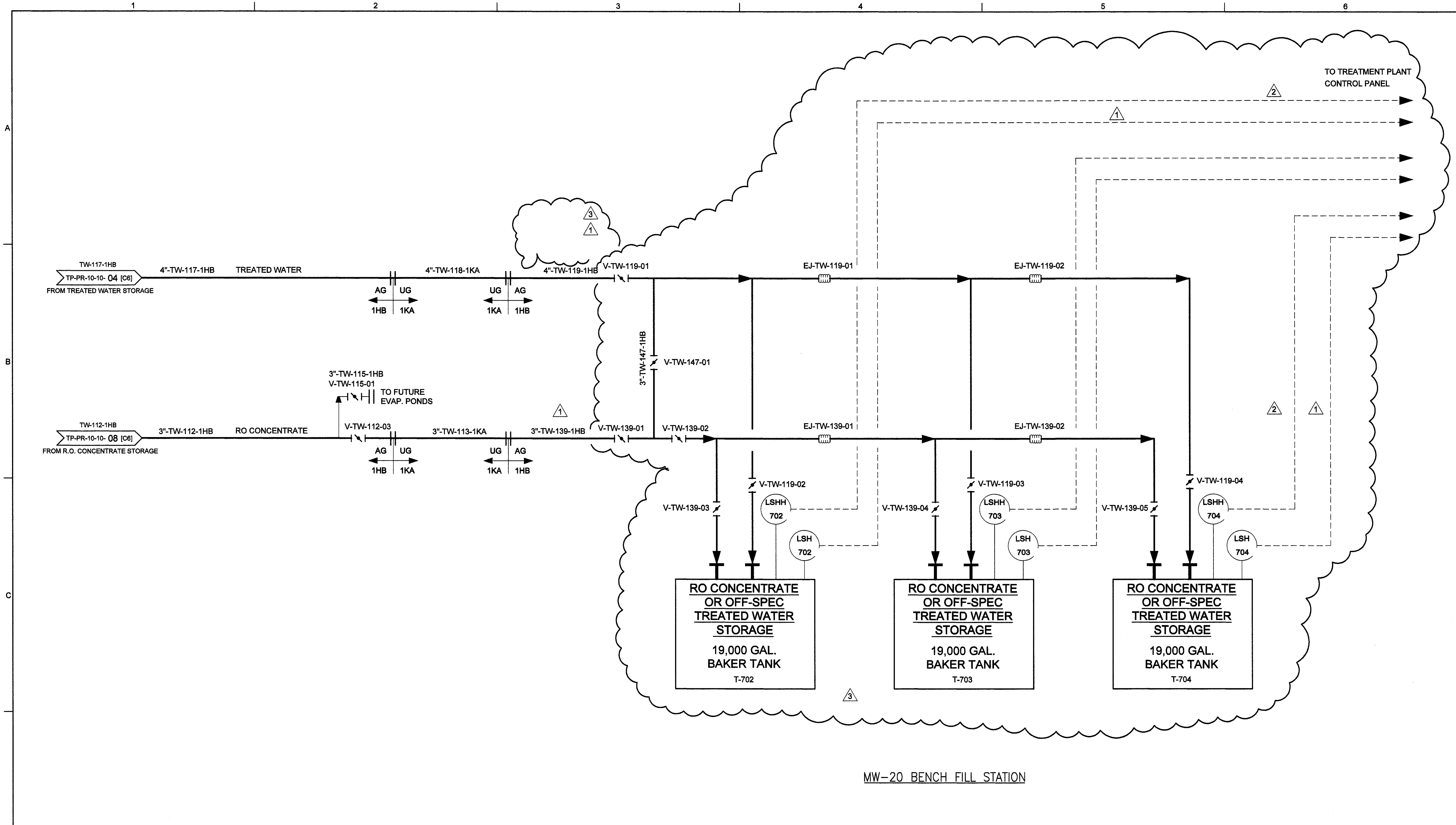
CH2MHILL

PROCESS AND INSTRUMENTATION DIAGRAM
SHEET 09
CHEMICAL FEED AND
AIR BLOWER SYSTEMS

DWG. NO. TP-PR-10-10-09 REV. 3

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

FILENAME: tppr101009.dwg PLOT DATE: 27-SEP-2005 PLOT TIME:



REGISTERED PROFESSIONAL ENGINEER KENNETH L. MARTINS No. CH004876 Exp. 6/30/2007 CHEMICAL STATE OF CALIFORNIA

RESPONSIBLE ENGINEER: Kenneth L. Martins PE # CH4876 Exp. 6-30-05

NO.	DATE	REVISION	BY	CHK
D	07/28/04	FOR INTERNAL REVIEW	EFC	AJ
0	09/03/04	APPROVED FOR CONSTRUCTION	EFC	AJ
1	10/13/04	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
2	02/15/04	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
3	09/27/05	FINAL RECORD ISSUE	EFC	AJ

REVISION APPROVAL		REV 3	DATE 09/27/05
DISCIPLINE	REVIEWED	DISCIPLINE	REVIEWED
CIVIL	—	ELECTRICAL	KCM
STRUCTURAL	—	INST & CONTROL	KCM
MECHANICAL	AJ	ARCHITECTURAL	—
PROCESS	AJ for KLM	ENVIRONMENTAL	—
PIPING	SDH	GEN. ARRANG.	RP

PRINT DISTRIBUTION	
DATE	
STATUS	
REV.	
CLIENT	
FIELD	
INTRA CO.	

STATUS				
ISSUED	REV	DATE	SDE	PEM
PRELIMINARY				
FOR REVIEW AND APPROVAL	D	07/28/04		
APPROVED FOR CONSTRUCTION	0	09/03/04	KLM	TP
REVISED & APPROVED FOR CONSTRUCTION	3	10/03/05	AJ for KLM	AJ

SCALE NONE

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURE 3
EXPANDED GROUNDWATER EXTRACTION
AND TREATMENT SYSTEM

PROJ NO. 315994

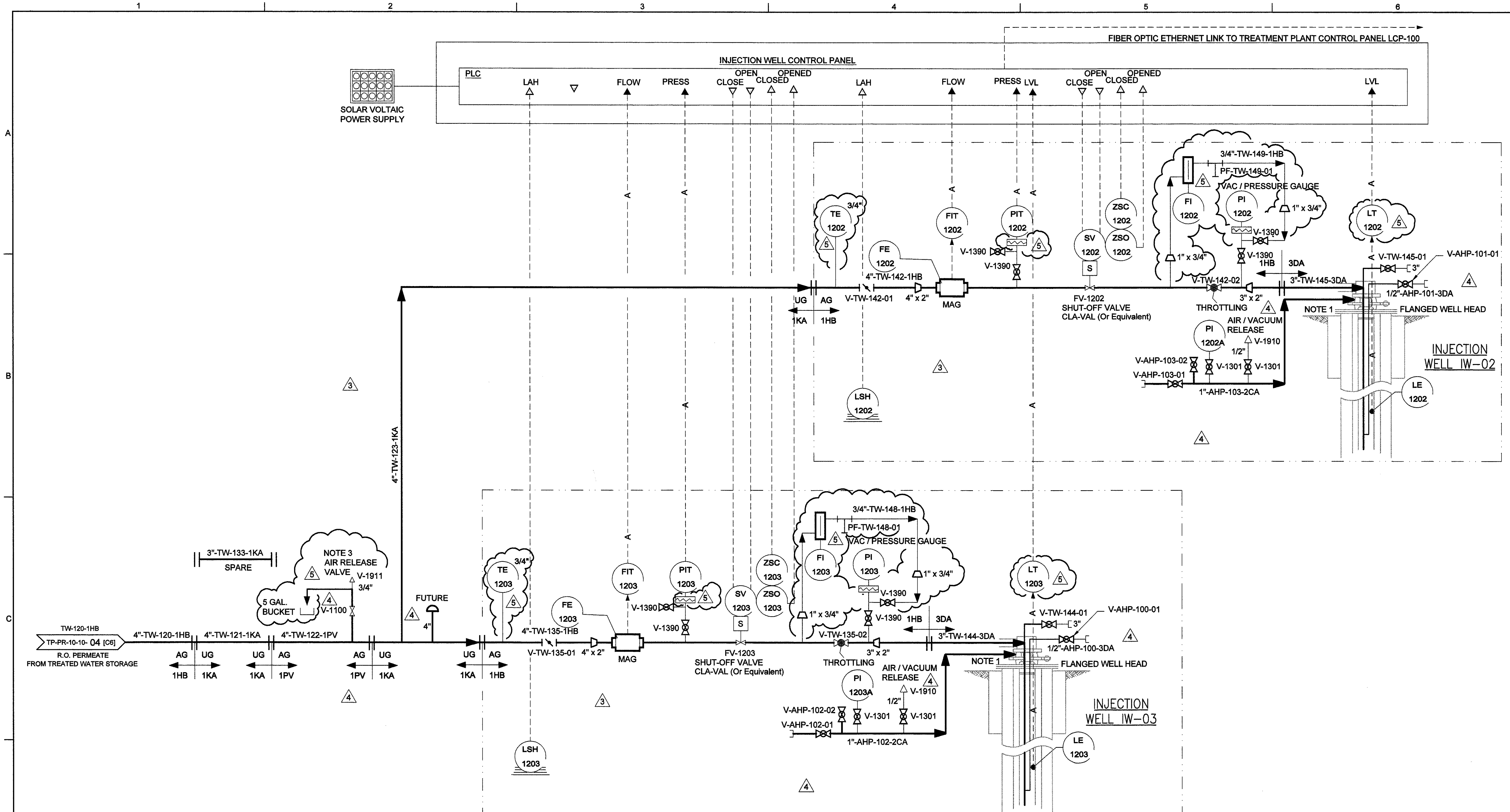
CH2MHILL

PROCESS AND INSTRUMENTATION DIAGRAM
SHEET 10
MW-20 BENCH FILL STATION

DWG. NO. TP-PR-10-10-10 REV. 3

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

FILENAME: tppr101010.dwg PLOT DATE: 27-SEP-2005 PLOT TIME:



NOTES:

1. FLANGE REQUIRES PORT FOR MANUAL WATER LEVEL GAUGING ON WELLHEAD FLANGE.
2. ALL VALVES AND INSTRUMENTATION INSTALLED IN SUBSURFACE, LOW PROFILE VAULT.
3. INSTALL AIR RELEASE VALVES AT ALL HIGH POINTS IN LINE TW-122-1PV.

REGISTERED PROFESSIONAL ENGINEER KENNETH L. MARTINS No. CH004876 Exp. 6/30/2007 CHEMICAL STATE OF CALIFORNIA

RESPONSIBLE ENGINEER: Kenneth L. Martins Exp. 6-30-05 PE # CH4876

NO.	DATE	REVISION	BY	CHK
A	07/28/04	FOR INTERNAL REVIEW	EFC	AJ
0	09/03/04	APPROVED FOR CONSTRUCTION	EFC	AJ
1	10/13/04	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
2	01/23/05	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
3	02/14/05	REVISED AND APPROVED FOR CONSTRUCTION	EFC	AJ
4	03/10/05	REMOVED HOLD AND APPROVED FOR CONSTRUCTION	EFC	AJ
5	09/27/05	FINAL RECORD ISSUE	EFC	AJ

REVISION APPROVAL — REV 5 — DATE 09/27/05

DISCIPLINE	REVIEWED	DISCIPLINE	REVIEWED
CIVIL	—	ELECTRICAL	KCM
STRUCTURAL	—	INST & CONTROL	KCM
MECHANICAL	AJ	ARCHITECTURAL	—
PROCESS	AJ for KLM	ENVIRONMENTAL	—
PIPING	SDH	GEN. ARRANG.	[illegible]

PRINT DISTRIBUTION: DATE, STATUS, REV., CLIENT, FIELD, INTRA CO.

STATUS

ISSUED	REV	DATE	SDE	PEM
PRELIMINARY				
FOR REVIEW AND APPROVAL	A	07/28/04		
APPROVED FOR CONSTRUCTION	0	09/03/04	KLM	TP
REVISED & APPROVED FOR CONSTRUCTION	5	10/03/05	AJ for KLM	AJ

SCALE NONE

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURE 3
EXPANDED GROUNDWATER EXTRACTION
AND TREATMENT SYSTEM

PROJ NO. 315994

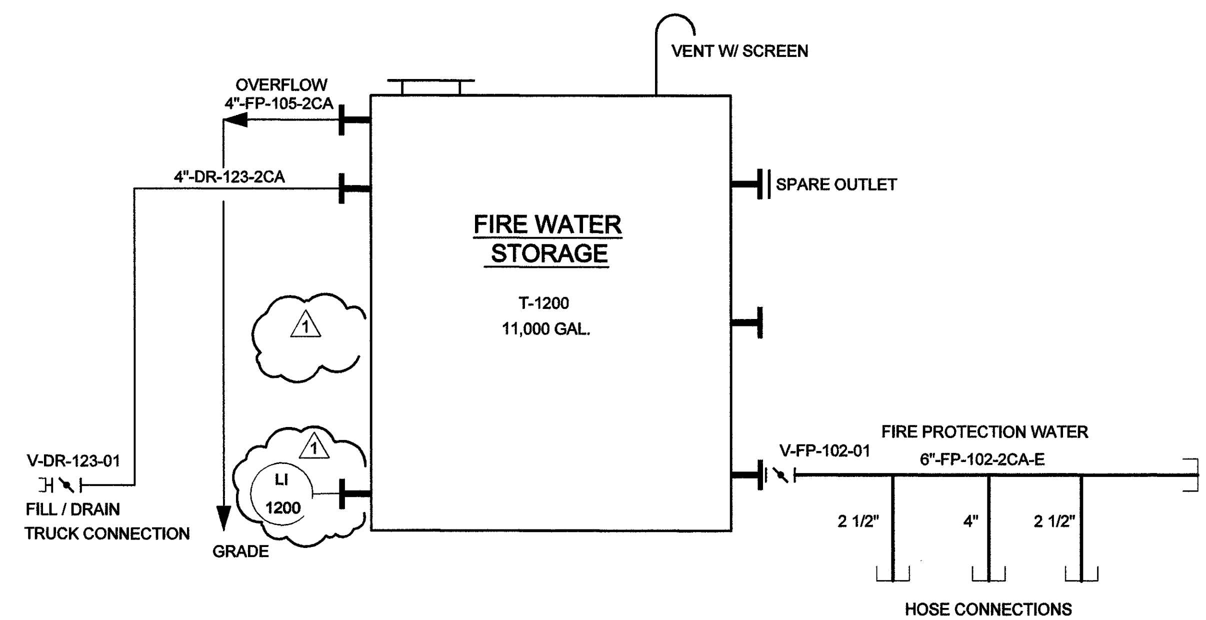
CH2MHILL

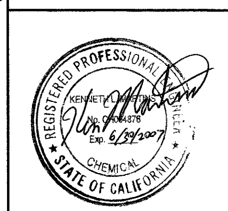
PROCESS AND INSTRUMENTATION DIAGRAM
SHEET 11
INJECTION WELLS

DWG. NO. TP-PR-10-10-11 REV. 5

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

FILENAME: tppr101011.dwg PLOT DATE: 27-SEP-2005 PLOT TIME:





RESPONSIBLE ENGINEER: Kenneth L. Martins
PE # CH4876 Exp. 6-30-05

NO.	DATE	REVISION	BY	CHK
C	01/13/05	FOR INTERNAL REVIEW	EFC	AJ
0	02/24/05	APPROVED FOR CONSTRUCTION	EFC	AJ
1	09/27/05	FINAL RECORD ISSUE	EFC	AJ

REVISION APPROVAL		REV 1	DATE 09/27/05
DISCIPLINE	REVIEWED	DISCIPLINE	REVIEWED
CIVIL	—	ELECTRICAL	KLM
STRUCTURAL	—	INST & CONTROL	KLM
MECHANICAL	AJ	ARCHITECTURAL	—
PROCESS	AJ for KLM	ENVIRONMENTAL	—
PIPING	SDH	GEN. ARRANG.	RP

PRINT DISTRIBUTION	
DATE	
STATUS	
REV.	
CLIENT	
FIELD	
INTRA CO.	

STATUS

ISSUED	REV	DATE	SDE	PEM
PRELIMINARY				
FOR REVIEW AND APPROVAL	C	01/13/05		
APPROVED FOR CONSTRUCTION	0	03/03/05	KLM	AJ
REVISED & APPROVED FOR CONSTRUCTION	1	10/03/05	AJ for KLM	AJ

SCALE NONE

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURE 3
EXPANDED GROUNDWATER EXTRACTION
AND TREATMENT SYSTEM

PROJ NO. 315994

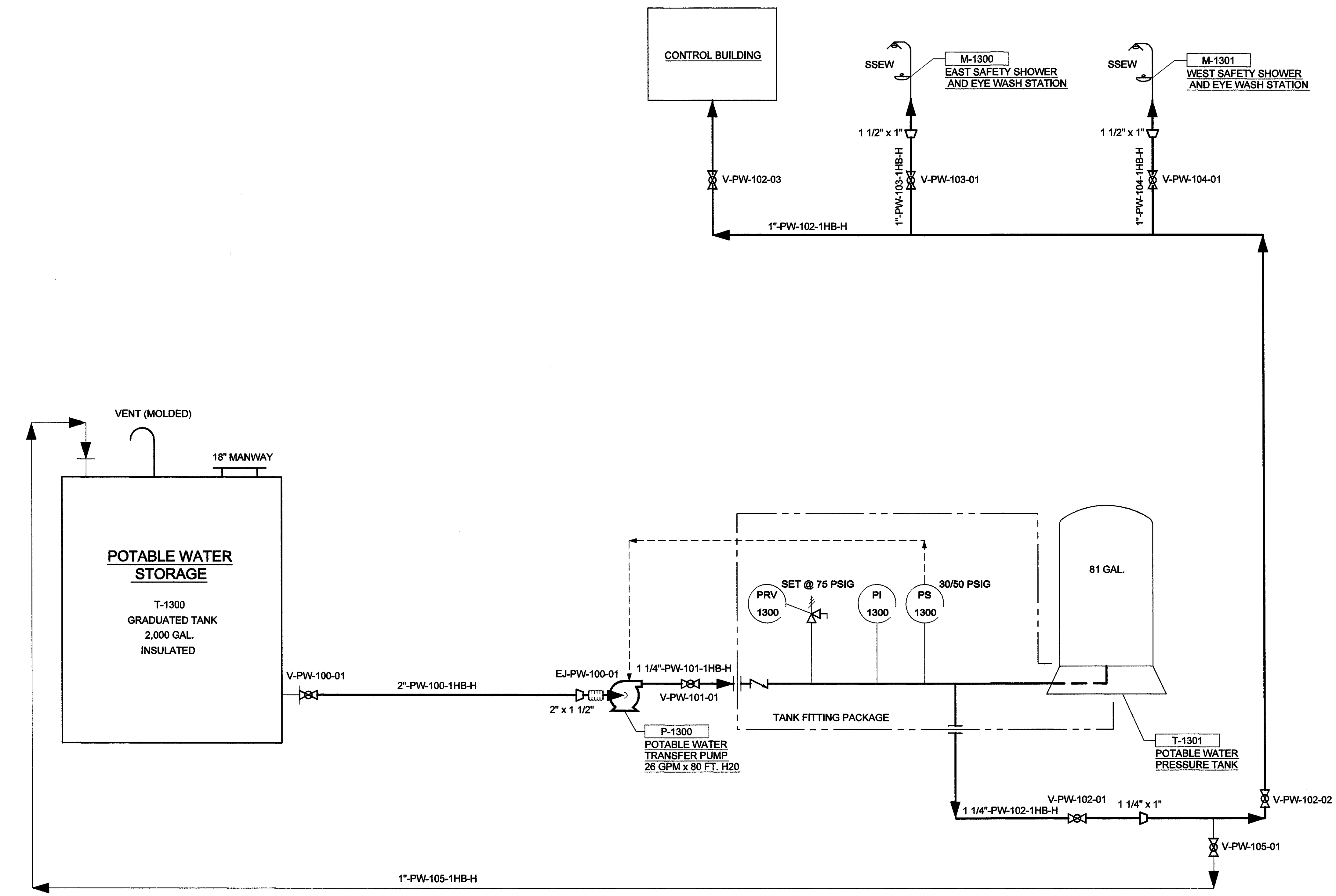
CH2MHILL

PROCESS AND INSTRUMENTATION DIAGRAM
SHEET 12
FIRE PROTECTION

DWG. NO. TP-PR-10-10-12 REV. 1

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

FILENAME: tppr101012.dwg PLOT DATE: 27-SEP-2005 PLOT TIME:



REGISTERED PROFESSIONAL ENGINEER
KENNETH L. MARTINS
No. CH004876
Exp. 6/30/2007
CHEMICAL
STATE OF CALIFORNIA

RESPONSIBLE ENGINEER: Kenneth L. Martins
PE # CH4876 Exp. 6-30-05

NO.	DATE	REVISION	BY	CHK
0	09/27/05	FINAL RECORD ISSUE/APPROVED FOR CONSTRUCTION	EFC	AJ
A	03/17/05	FOR APPROVAL	EFC	AJ
.	/ /	.		

REVISION APPROVAL		REV 0	DATE 09/27/05	PRINT DISTRIBUTION	
DISCIPLINE	REVIEWED	DISCIPLINE	REVIEWED	DATE	
CIVIL	—	ELECTRICAL	KCM	STATUS	
STRUCTURAL	—	INST & CONTROL	KCM	REV.	
MECHANICAL	AJ	ARCHITECTURAL	—	CLIENT	
PROCESS	AJ for KLM	ENVIRONMENTAL	—	FIELD	
PIPING	SDH	GEN. ARRANG.	RP	INTRA CO.	

STATUS

ISSUED	REV	DATE	SDE	PEM
PRELIMINARY				
FOR REVIEW AND APPROVAL	A	03/17/05	KLM	AJ
APPROVED FOR CONSTRUCTION	0	09/27/05	KLM	AJ
REVISED & APPROVED FOR CONSTRUCTION	.	10/03/05	AJ for KLM	AJ

SCALE NONE

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURE 3
EXPANDED GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

PROJ NO. 315994

CH2MHILL

PROCESS AND INSTRUMENTATION DIAGRAM
SHEET 13
POTABLE WATER

DWG. NO. TP-PR-10-10-13 REV. 0

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

FILENAME: tppr101013.dwg PLOT DATE: 27-SEP-2005 PLOT TIME:

Appendix D
Control System Operations Manual

Pacific Gas & Electric

Needles, CA

INTERIM MEASURES No.3

Process Control Systems

OPERATIONS MANUAL

CH2MHILL

Project No. 315994

INTRODUCTION

The purpose of this document is to assist the reader in understanding the control system operation of the Water Treatment Plant (Interim Measures No.3) for the PG&E Topock Compressor Station located in Needles, California. The system is monitored and controlled by two Allen-Bradley SLC5/05™ Programmable Logic Controllers (**PLC**s) provided by CH2M HILL and two Allen-Bradley MicroLogix™ 1500 PLCs provided by equipment vendors (MicroFilter and Reverse Osmosis skids). The system operations from extraction wells through water treatment and back out to injection wells are monitored and controlled by PG&E personnel via two WonderWare® Human Machine Interface (**HMI**) operator consoles running on Dell™ Workstation personal computers (**WS**).

CONTENTS

There are 11 sections in this manual covering the following topics:

1. Components of the Water Treatment System (**WTS**) [by CH2MHill]
2. Components of the Injection Well System (**IWS**) [by CH2MHill]
3. Components of the Micro-Filter System (**MFS**) [by Others]
4. Components of the Reverse Osmosis System (**ROS**) [by Others]
5. Components of the HMI
6. Process Graphics List
7. Logging into the system and display navigation
8. Monitoring and Control
9. Trending
10. Alarming and the Alarm Printer
11. SCADAlarm™ (Auto-dialer)
12. Service and Support

1. COMPONENTS OF THE WATER TREATMENT SYSTEM

The WTS consists of the WTS PLC (designated “TOPOCK1” and located in the LCP100 cabinet), the instrumentation that connects directly into the WTS PLC, and the hardwired interface signals between the WTS and other PLCs.

2. COMPONENTS OF THE INJECTION WELL SYSTEM

The IWS consists of the IWS PLC (designated “TOPOCK2” and located in the remote injection well control cabinet) and the instrumentation that connects directly into the IWS PLC (the injection wells).

3. COMPONENTS OF THE MICRO FILTER SYSTEM

The MFS primarily consists of the MFS PLC (designated “TOPOCKMF”) and the instrumentation that connects directly into the MFS PLC (the MF Skid). The MFS is a skid package system provided by PALL Corporation. Please reference the PALL O&M manual for details regarding the operation of the MFS.

4. COMPONENTS OF THE REVERSE OSMOSIS SYSTEM

The ROS primarily consists of the ROS PLC and the instrumentation that connects directly into the ROS PLC (the RO Skid). The ROS is a skid package system provided by Ionics. Please reference the Ionics O&M manual for details regarding the operation of the ROS.

5. COMPONENTS OF THE HMI

The HMI consists of two DELL™ workstation computers linked to the PLCs and each other through an industrial Ethernet switch located in the LCP100 cabinet. The workstations are designated “TOPOCK-WS1” and “TOPOCK-WS2”. TOPOCK-WS1 is both an operator workstation and is also the control system engineering development station. TOPOCK-WS1 is loaded and licensed with the following software tools:

- WonderWare® Intouch™ Runtime version 9.0
    - This is the running HMI application
- WonderWare® Intouch™ Development version 9.0
    - This is the engineering package used to modify the HMI
    - This software can only be accessed by an administrator
- WonderWare® SCADAlarm™
    - This is the auto-dialer alarm system software
    - This program runs in the background and is “transparent”
    - This software can only be accessed by an administrator
- RSLogix500™ engineering software package
    - This software is used to modify the PLC programs
    - This software can only be accessed by an administrator
- Microsoft Office™
    - This is the standard Office™ suite of utility programs
    - These programs can only be accessed by an administrator

6. HMI GRAPHICS LIST

There are 15 process graphics, 1 alarm banner, 5 popup windows and 21 trend displays. The following is a listing of the 15 process graphics:

1. Communications
2. Overview
3. Extraction Wells
4. Raw Water
5. Chrome Reactor
6. Iron Oxidation
7. Clarifier
8. Micro Filter
9. RO
10. RO2
11. Drains
12. Chemical Feed 1
13. Chemical Feed 2
14. Treated Water
15. Injection Wells

The Alarm Banner display appears at the bottom of the HMI screen and continually reports the status of any alarms in the plant process. The Alarm Banner is always shown and cannot be closed.

The 5 "popup" windows are detailed as follows:

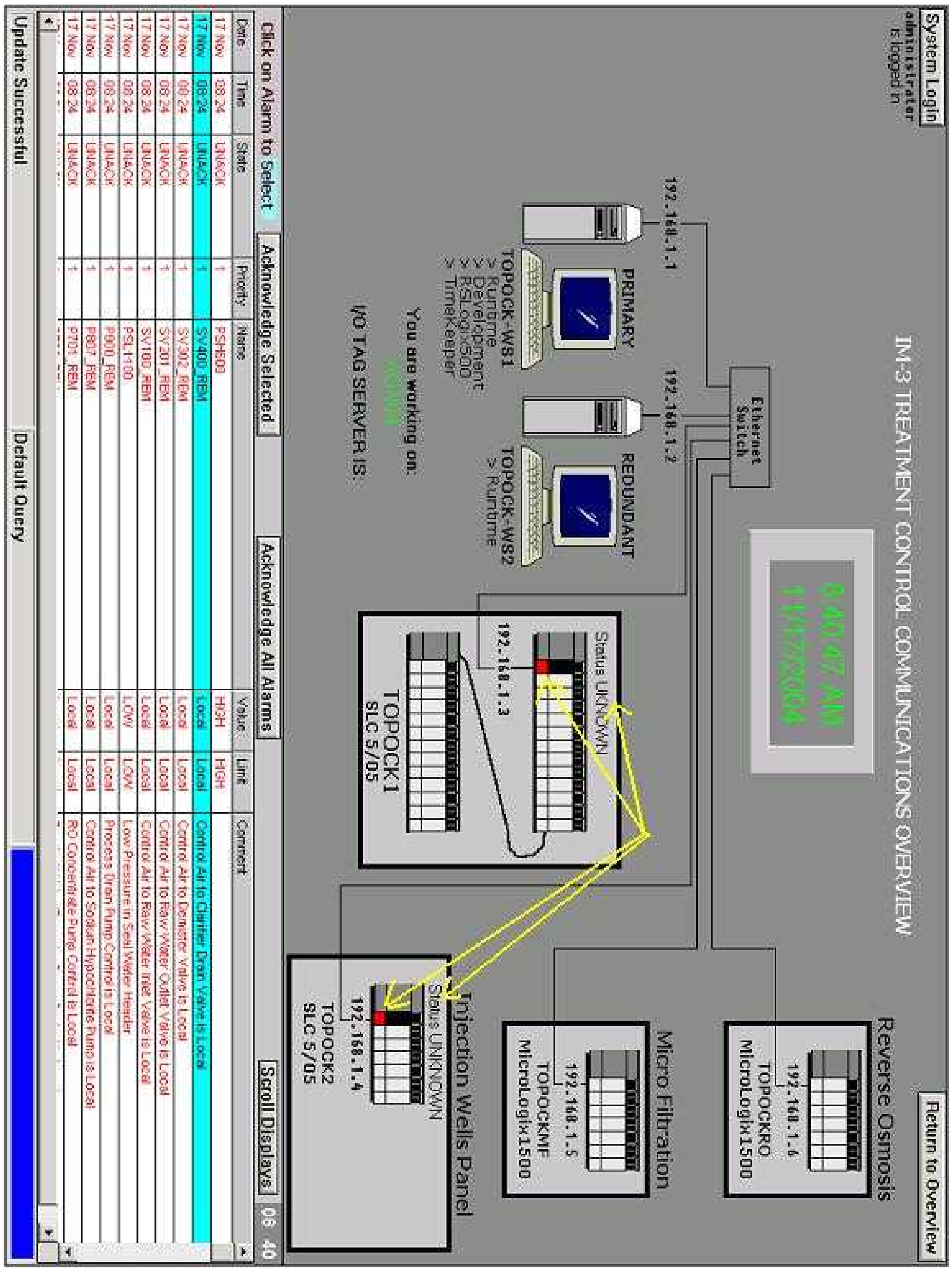
1. Password – this is the login window for operator login. The operator can also change his/her password from this window. This window is also used to logout of the system. A system administrator, once logged in, can use this window to shutdown the HMI application.
2. Select Transmitter – this popup appears when the operator clicks on one of the 10 sets of dual transmitters configured in the system (i.e., pH probes 301C-1 and 301C-2). This window allows the operator to select either one specific transmitter or the average of both transmitters for display and alarming purposes.
3. PID – this popup appears when the operator clicks on a control valve or metering pump configured in the system. The PID window allows the operator to view the process variable, control the state of the loop (Auto versus Manual) and control either the setpoint or the control output when the loop is in either Auto or Manual respectively. This window and PID functionality is explained later in this manual.
4. FDC – this popup appears when the operator clicks the ferrous chloride pump P-800. This window is used to monitor and control the dosing of ferrous into the system. This window is explained later in this manual.
5. Tag Window - this popup appears when the operator clicks on an analog tag value in the display. The tag window appears and provides the operator with specific tag information including tagname, tag description, current process variable and alarm points.

There are 21 Trend displays for calling up the historical data of the various analog signals that come into the system. The 21 displays are as follows:

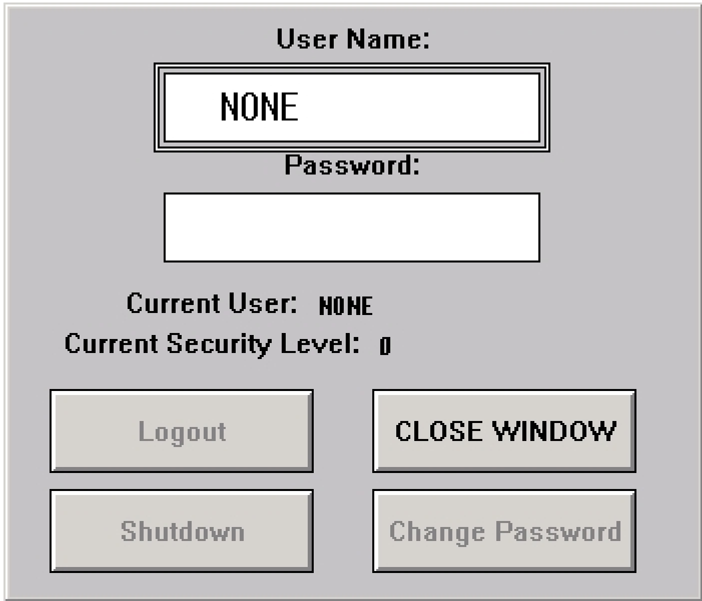
1. Trend Master – This is an overview graphic with links to each trend
2. Trend_01 - Extraction Wells 1
3. Trend_02 - Extraction Wells 2
4. Trend_03 – Raw Water
5. Trend_04 – Chrome Reactor Mixing
6. Trend_05 – Chrome Reactor
7. Trend_06 – Iron Oxidation 1
8. Trend_07 – Iron Oxidation 2
9. Trend_08 – Iron Oxidation 3
10. Trend_09 – Clarifier and Micro Filter Feed
11. Trend_10 – Micro Filter
12. Trend_11 – Reverse Osmosis 1
13. Trend_12 – Reverse Osmosis 2
14. Trend_13 – Reverse Osmosis 3
15. Trend_14 – Reverse Osmosis 4
16. Trend_15 – Treated Water
17. Trend_16 – Chemical Feed
18. Trend_17 – Injection Wells 1
19. Trend_18 – Injection Wells 2
20. Trend_19 – Injections Wells 3
21. Trend_Operator_Settable – This is an operator configurable trend

7. LOGGING INTO THE SYSTEM AND HMI DISPLAY NAVIGATION

After initial startup of the HMI WS, the System Communication graphic is displayed. The communication graphic provides an overview of the HMI/PLC control network and indicates the current status of the PLC processors as well as the status of the communications links. A green box indicates active links while a red box indicates loss of communication to the PLC. Note the yellow arrows in the screen-shot below which point out the PLC status information.

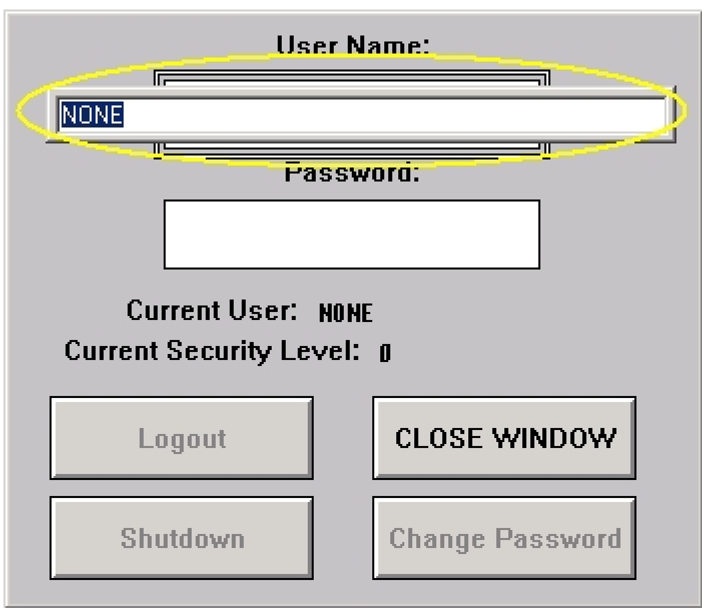


Additionally on system startup, the system login "popup" window is displayed.



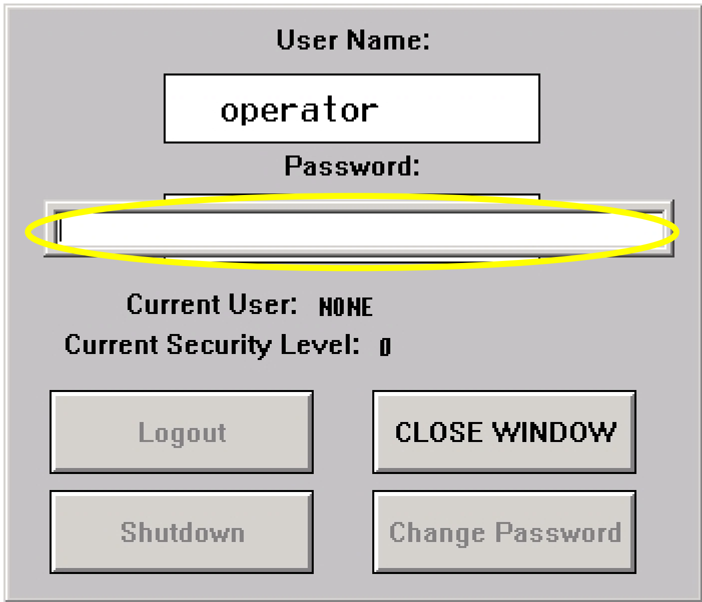
USERNAME ENTRY

This window allows the operator to log into the system. To login to the system, the operator must enter a username and password. Use the mouse to first click on the white username field and then, using the keyboard, enter a username.

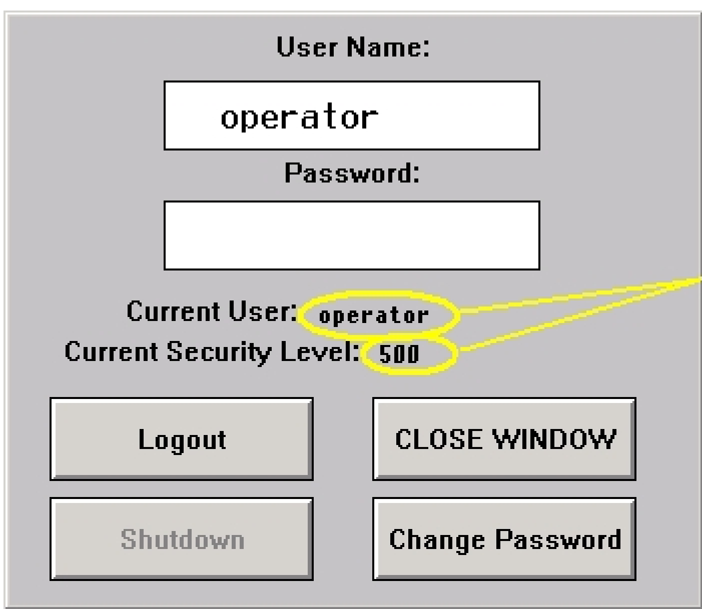


Press the <*Enter*> key after typing the username. The default username for an operator consists of first initial, last name. For example, operator "John Doe" will have a username of "jdoe".

PASSWORD ENTRY
Next, enter in the password for the user by using the mouse to click on the white password field located underneath the username entry field.

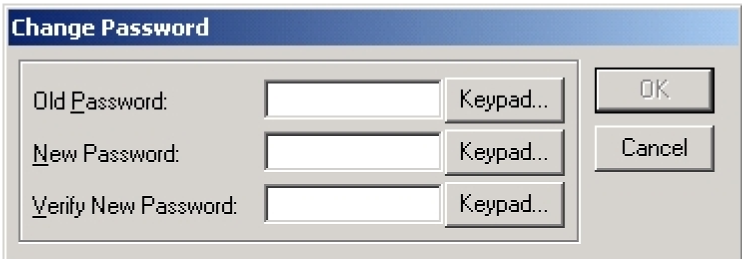


Note that keystrokes are not echoed at all in the password field. While typing the password, the password entry field will remain blank. Unlike Windows, Intouch™ does not echo an asterisk (*) character for each keystroke typed in the password field. Once again, the password entry field will remain blank. Press the <*Enter*> key after typing the password. The default password, set for an operator for the very first login, will be the operator's last name. A successful login is indicated by the operator's login name appearing in the "Current User:" field and by the security level changing to "500" as indicated below:



CHANGING PASSWORD

The operator should change their password immediately after logging into the system for the first time. While both username and password are configured to be all small letters (no capitalization), the HMI is not case-sensitive for username or password login. To change the password, click on the “Change Password” button located in the bottom right corner of the login window. Type in the old password, type the new password twice and then click “OK”



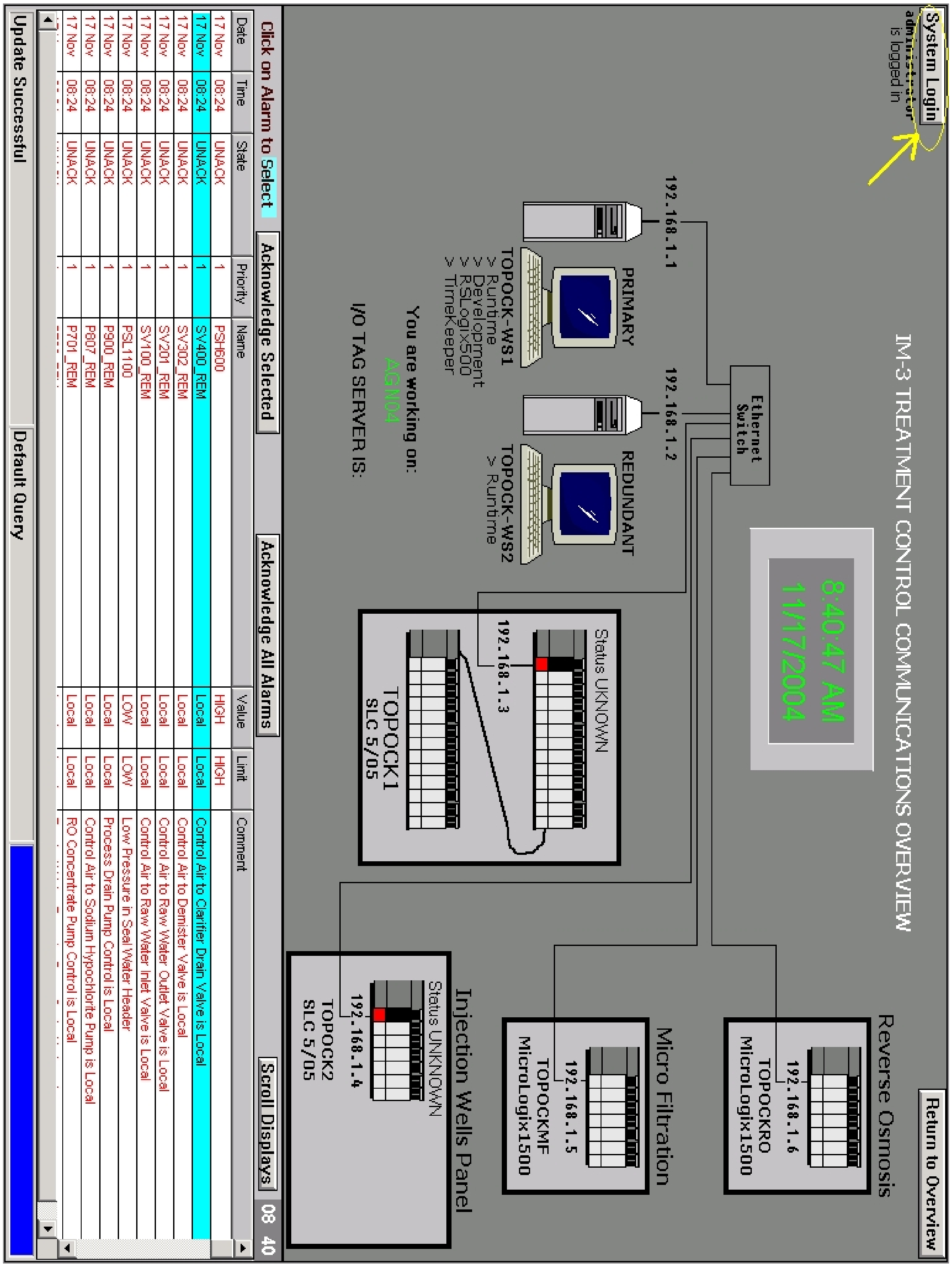
Once an operator is successfully logged into the system, the operator should click on the “CLOSE WINDOW” button of the login window in order to start navigating and monitoring the system.

It is possible to freely move through the display graphics without being logged into the system. However, system control (for instance, stopping or starting a pump or making a setpoint change) is not permitted until an operator (or administrator) is logged into the system.

Logging into the system (or logging off) can be initiated from any process area graphic by moving the mouse cursor so that it is over the “System Login” button located in the upper left corner of the HMI display. Use the left mouse button to click on the “System Login” button, which will activate the Password popup login window. From the Password window, an operator can log into the system, change their password once they are logged in, or logout of the system.
Administrators can do all of the above, plus administrators have the option to shut down the HMI application entirely (after logging into the system).

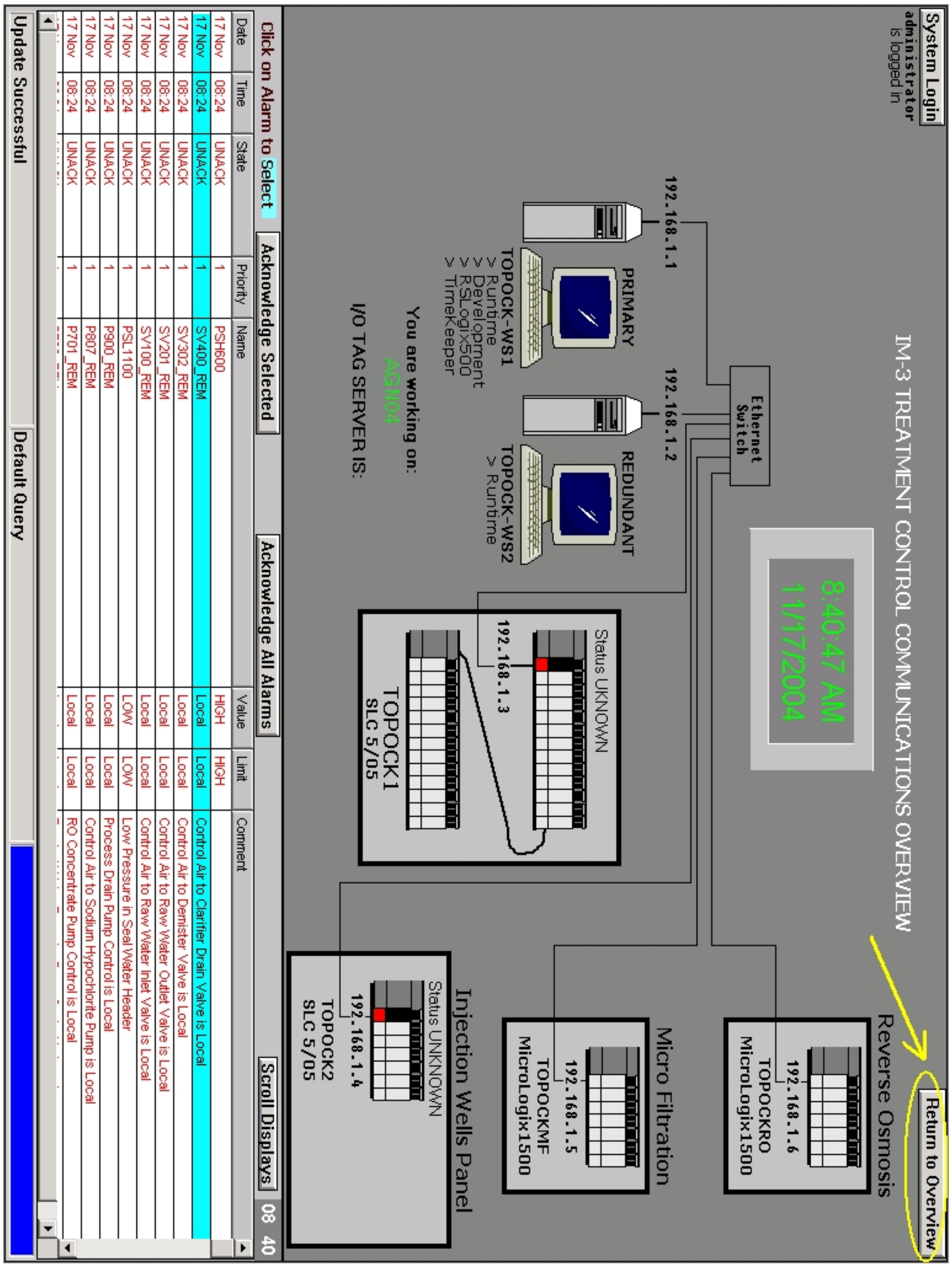
AUTO LOGOFF

As an added security precaution, the HMI will automatically logoff after two hours of in-activity. This auto-logoff feature will occur regardless of whom is logged into the system. To prevent the auto-logoff from occurring, the operator must periodically navigate to a display or click on a display process point. In-activity is defined as a lack of either keystroke or mouse-click occurring on the WS. If an operator is logged off by the system, clicking on the “System Login” button and following the login procedure easily accomplishes logging back on the system.

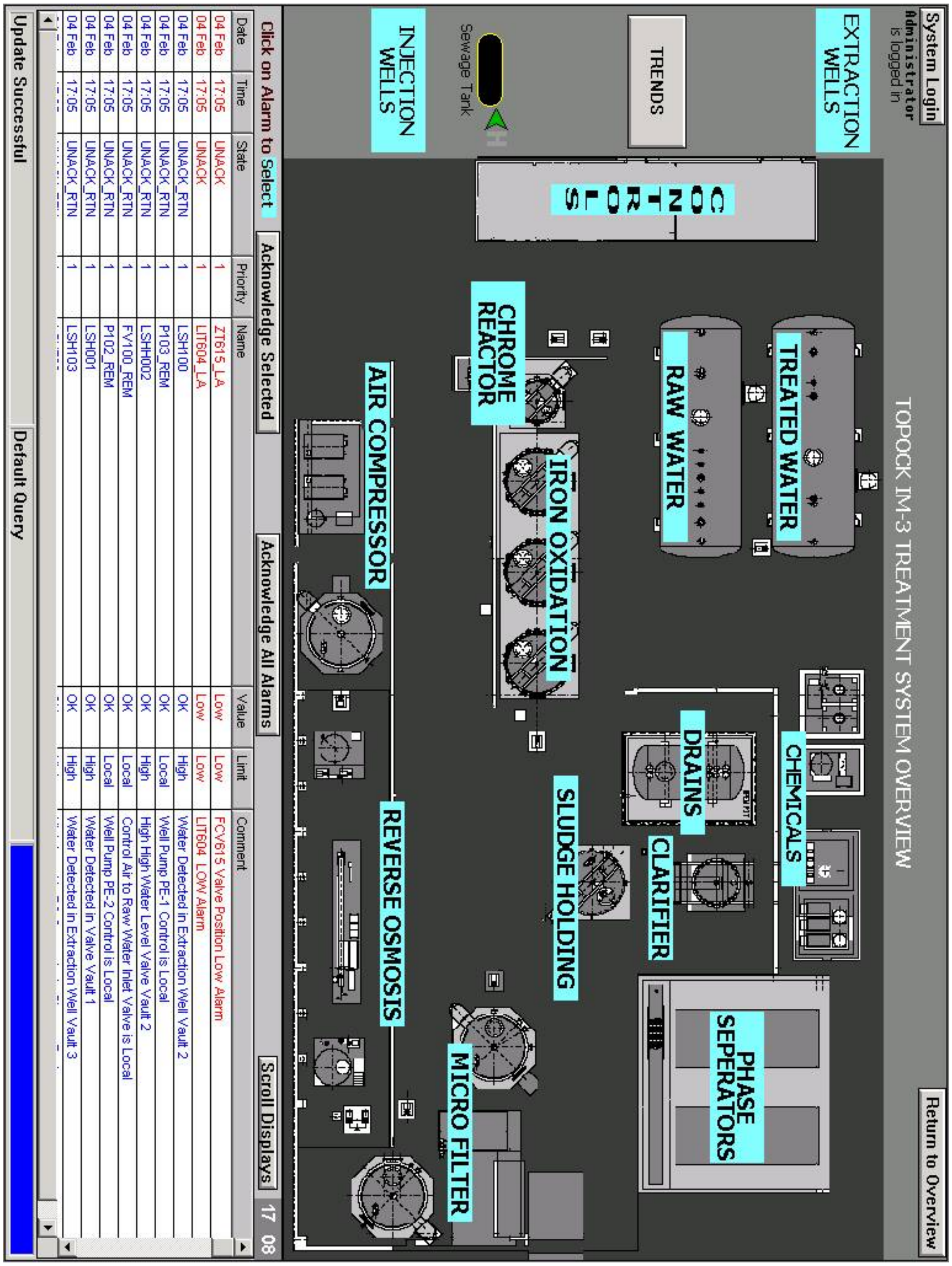


Note that every process graphic has the System Login button located in the same place in the upper left hand corner.

From the communications screen, the operator has two options to start monitoring the plant processes. The first option is to click on the "Return to Overview" button located in the upper right corner of the display.



The second option is to start scrolling the process display graphics, which will be discussed later on in this section.



By clicking on the “Return to Overview” button, the operator will call up the process overview display graphic. The overview display graphic is a master graphic that allows an operator to drill down to a specific process area by moving the mouse cursor over a desired process and then clicking the left mouse button.

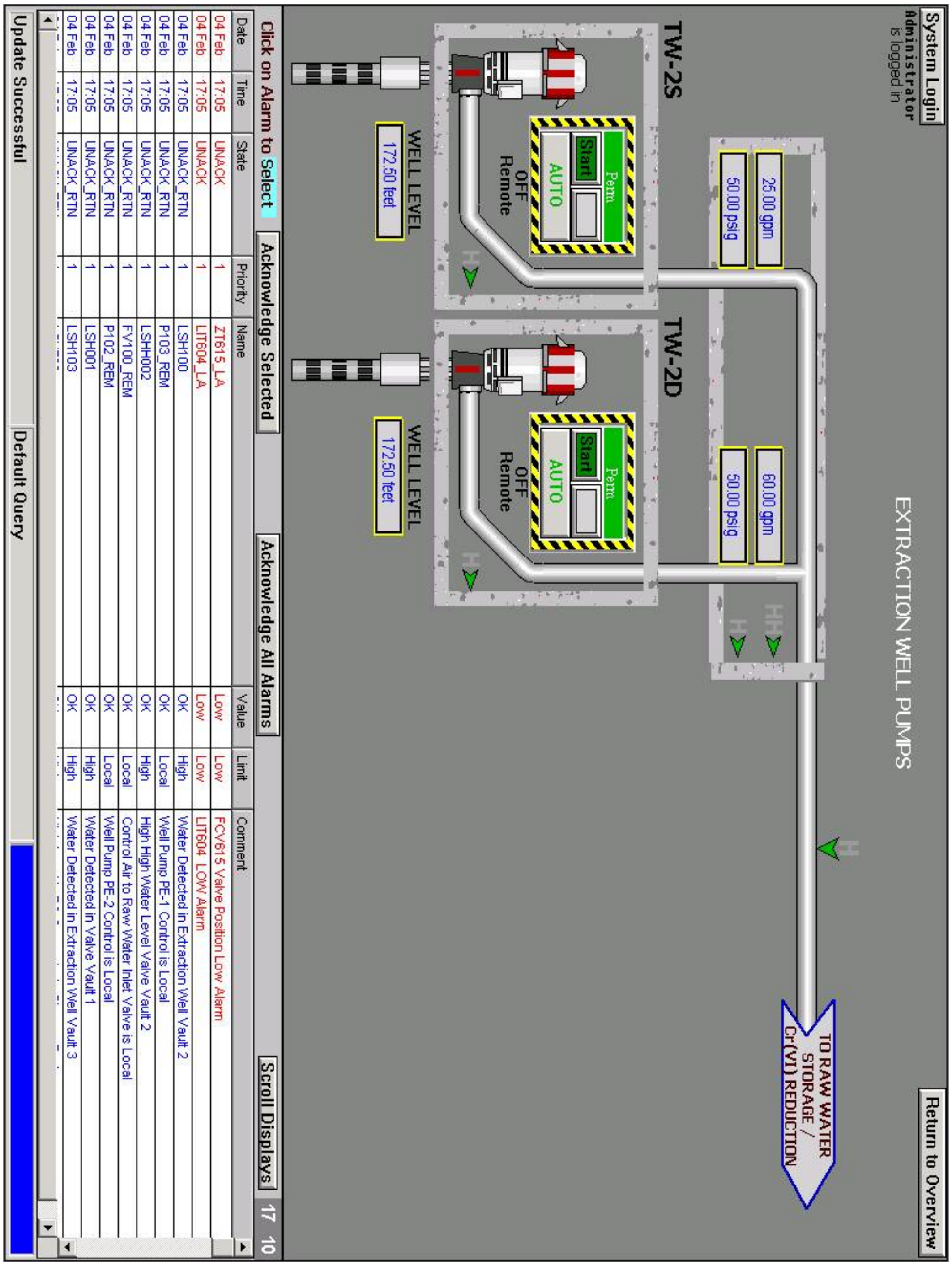
The process overview display was designed to provide an intuitive look and feel and closely mirrors the actual equipment layout of the plant.
All of the process areas are text labeled. Additionally, a white square highlight box will appear (and disappear) as the mouse is moved over the graphic display. Once the operator has selected a process area to monitor by having moved the

mouse cursor over the desired process area on the graphic, a single mouse-click will call up that graphic which will then allow the operator to see specific process details and/or control the equipment in that area. Several examples of the various process graphics are shown on the following pages.

The next several pages review the specific process graphics that are available in the system. Specific details regarding controls are described in the next section "Monitoring and Control".

Process Graphics Screens

The treatment process begins with the extraction wells pumping raw water into the plant. To access the extraction well graphic, the operator must click on the "Extraction Well" button located on the left side of the Overview graphic. The various process points include well level, pump line pressure and flow.



The operator can control how the well pumps turn on and off by clicking the control buttons for a specific pump. For the extraction pumps there are three modes of control: Remote Auto, Remote Manual, and Local.

REMOTE AUTO CONTROL

Normally, the pumps should always be run in the Remote Auto mode. Remote Auto is indicated by the HMI.

The HMI also indicates if the PLC is permitted to run the pump.

In Auto mode, the operator must still issue a start command from the HMI by clicking on the start button.

Once the start command has been issued, the pump will turn on and off automatically as dictated by the PLC programming. In the case of the well pumps, the pumps turn on and off based on level indication of the raw water storage tank T-100. Low-level indication in T-100 will turn on the pumps and high-level indication will turn off the pumps.

REMOTE MANUAL CONTROL

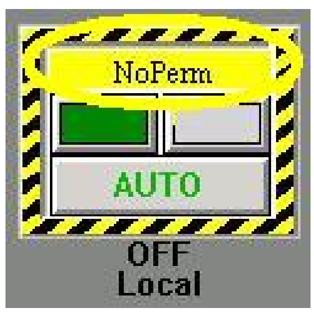
If deemed necessary, the operator can take Manual control of the pump to start and stop the pump. Remote manual control is achieved by clicking on the Auto/Manual toggle button.

Pressing the Auto/Manual toggle button will change the control from Auto to Manual and back again. The current state (Auto or Manual) is always indicated by the HMI.

With the controller in Manual, the operator is responsible for the starting and stopping of the pump.

The last mode, "Local" means that the pump is **not** in PLC control and that the pump can only be turned on/off from the MCC. Visual indication is provided on the HMI when the pump is in local control:

And

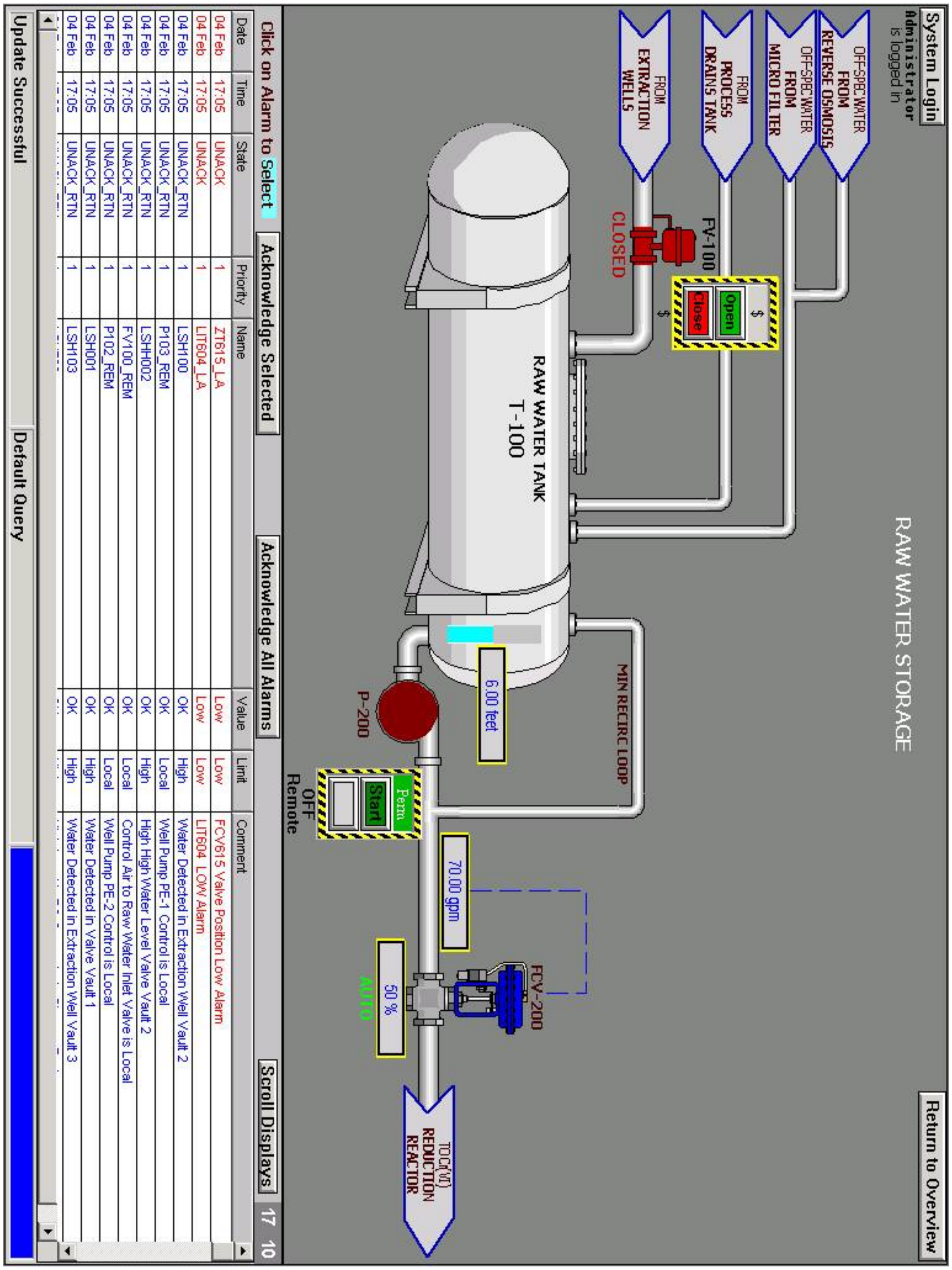


Note: the pumps can be run locally from the MCC but it is highly advisable not to do so. If an emergency interlock condition occurs that would normally stop the pump, the pump will **not** stop if it is being run "Local"

Due to possible interlocks being active, the operational status is shown as either "Perm" for permitted or "NoPerm" for not permitted. Permitted means that the operator has complete control over the output from the HMI and can open/close or start/stop at their discretion. Not permitted means that the control point (pump, motor or valve) cannot be controlled by the operator from the HMI and the operator should investigate in order to determine the cause of the loss of control.

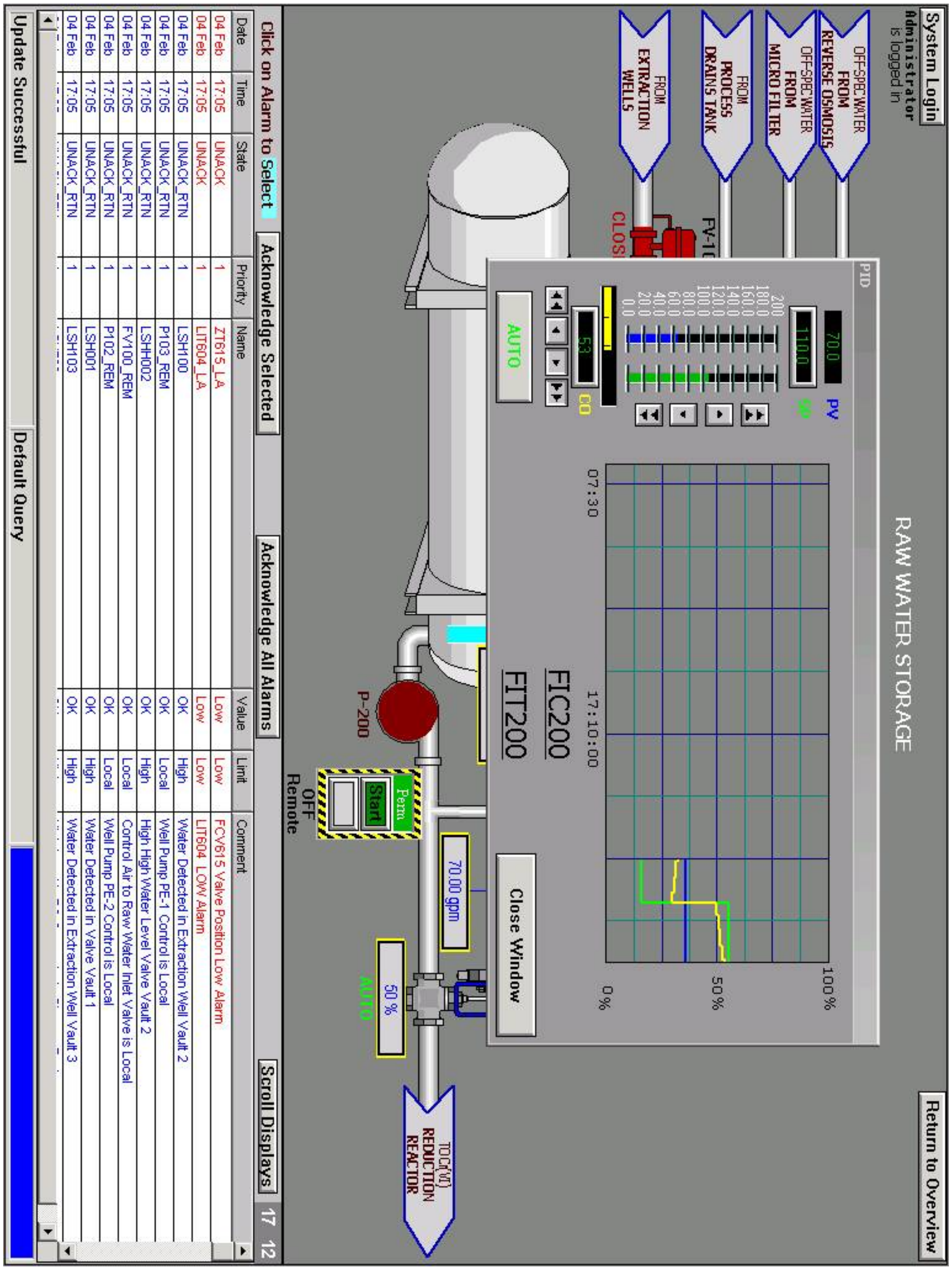
"NoPerm" also means that the PLC cannot start the pump and that PLC command output to the pump starter is held in the off position. Once the interlock(s) clear(s), then the pump can be issued a start command from the HMI.

Once pumped out of the ground, the raw water is transferred to the Raw Water storage tank. The storage tank serves to equalize flow to the treatment system and to allow the pumps to continue to extract ground water even if the plant process is temporarily stopped. The raw water tank feeds the untreated ground water into the plant treatment system via pump P-200 and flow control valve FCV-200.

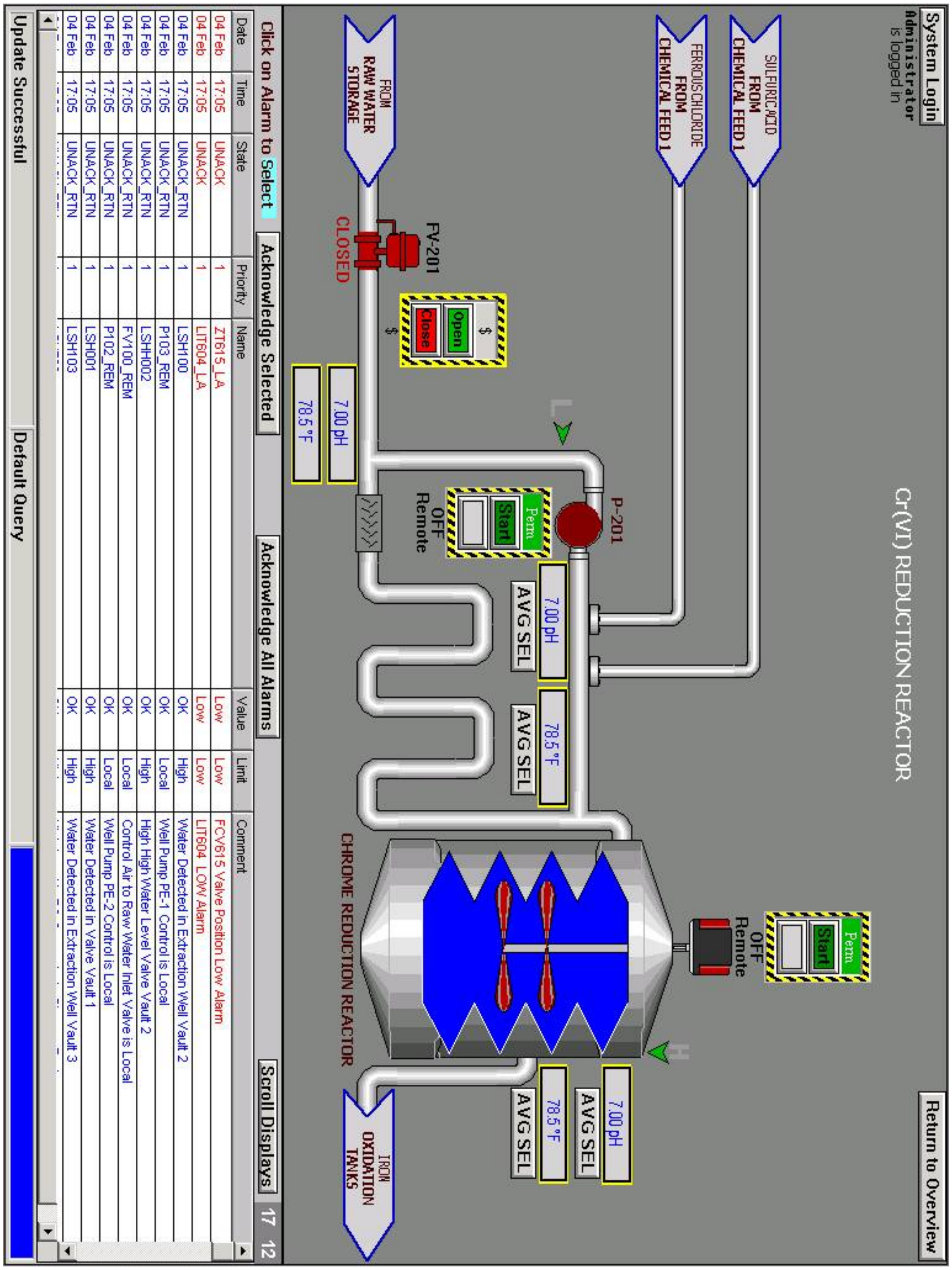


There are three control points for the operator on this screen. The first is flow block valve FV-100 that the operator sets open/closed. The second point is pump P-200 that the operator can start/stop. Note that the valve and pump operation and control buttons are nearly identical to the extraction well pumps. The only difference is that P-200 and FV-100 do not have a Remote Auto mode. The operator is responsible for the control of these two process points.

Flow into the treatment system is automatically maintained at whatever flow rate the operator has set via the HMI. To change the flow control setpoint, the operator must click on the flow control valve. This will activate the PID popup control window. PID control is discussed in Section 8.

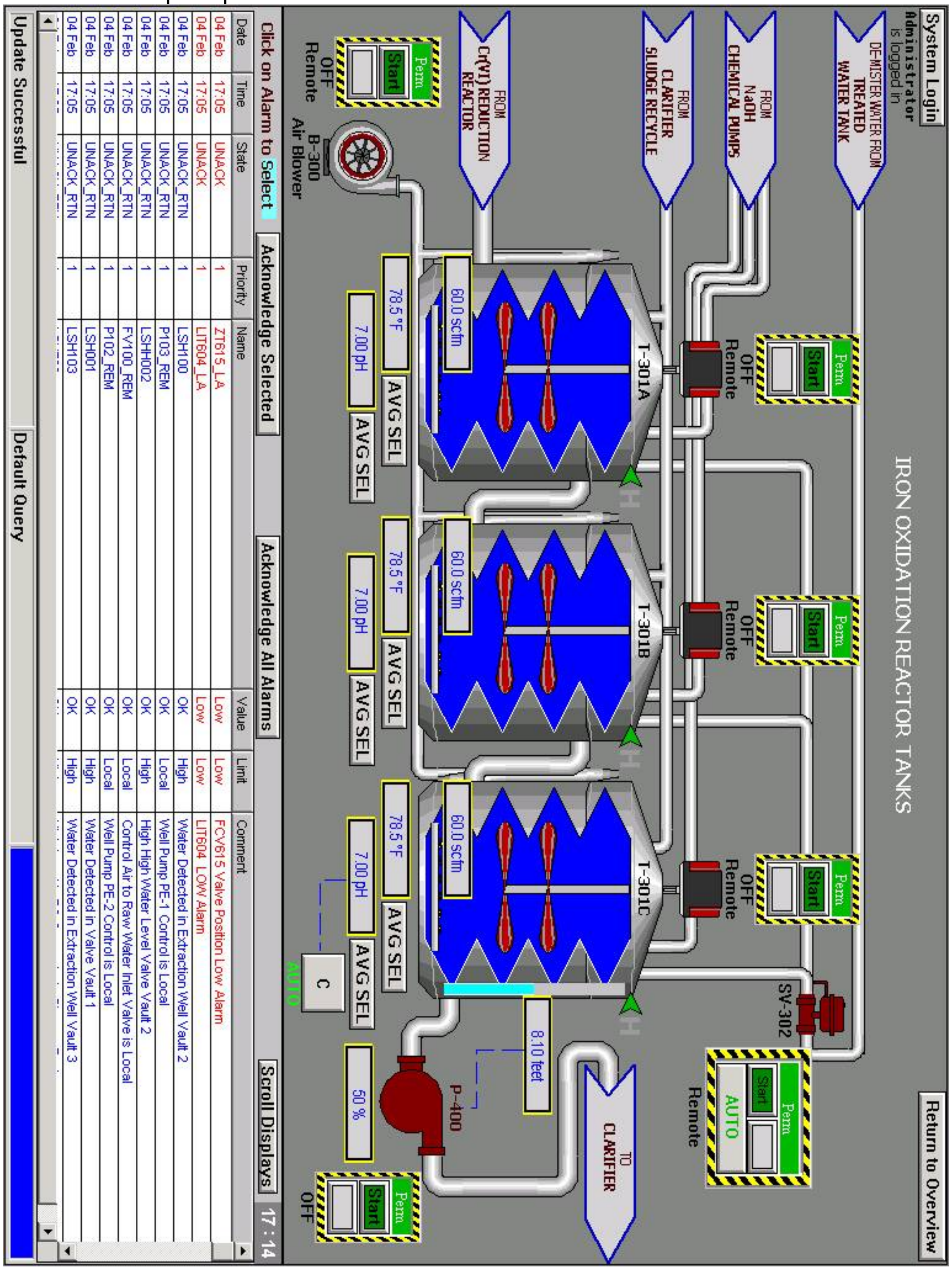


The actual water treatment process begins with the chromium reduction reactor. A ferrous chloride solution is injected into the water treatment stream feeding the chromium reduction reactor. The injection stream consists of serpentine piping that serves the purpose of increasing dwell time thus allowing the ferrous chloride time to react with the chromium.



There are three control points for the operator. The first is water block valve FV-201, the second is chemical mixing pump P-201 and the third is the mixer in the chrome reactor. The primary monitoring points are pH.

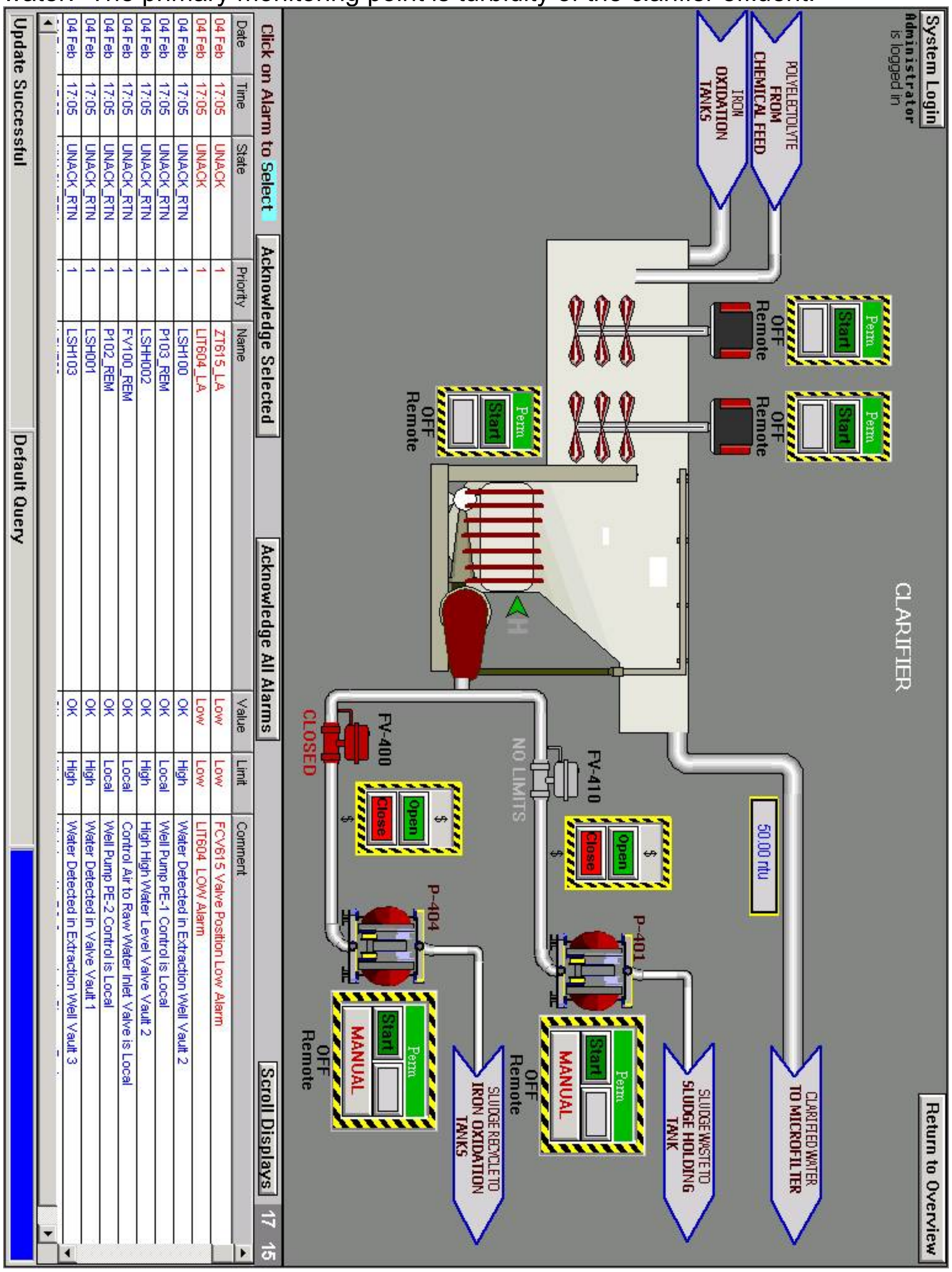
Once pumped into the chrome reactor, the water flow is gravity fed through a series of three (3) iron oxidation tanks. The iron oxidation tanks are injected with air in order to precipitate the reacted ferrous chloride.



There are seven control points for the operator monitor and control. The operator is responsible for the control of the 3 reactor tank mixers and the air blower. In addition, there is a water block valve SV-302 that controls water flow to the de-misters on each tank. SV-302 has 3 modes of operation. Remote Auto, Remote Manual, and Local.

The primary analog controls are pH and the level in reactor 3. The clarifier feed pump (P-400) is a variable speed drive that maintains a level setpoint in reactor 3 by adjusting the speed output of the pump motor.

The process stream continues through the iron oxidation tanks and ends up in a clarifier. The clarifier serves to remove the precipitated iron (the sludge) from the water. The primary monitoring point is turbidity of the clarifier effluent.



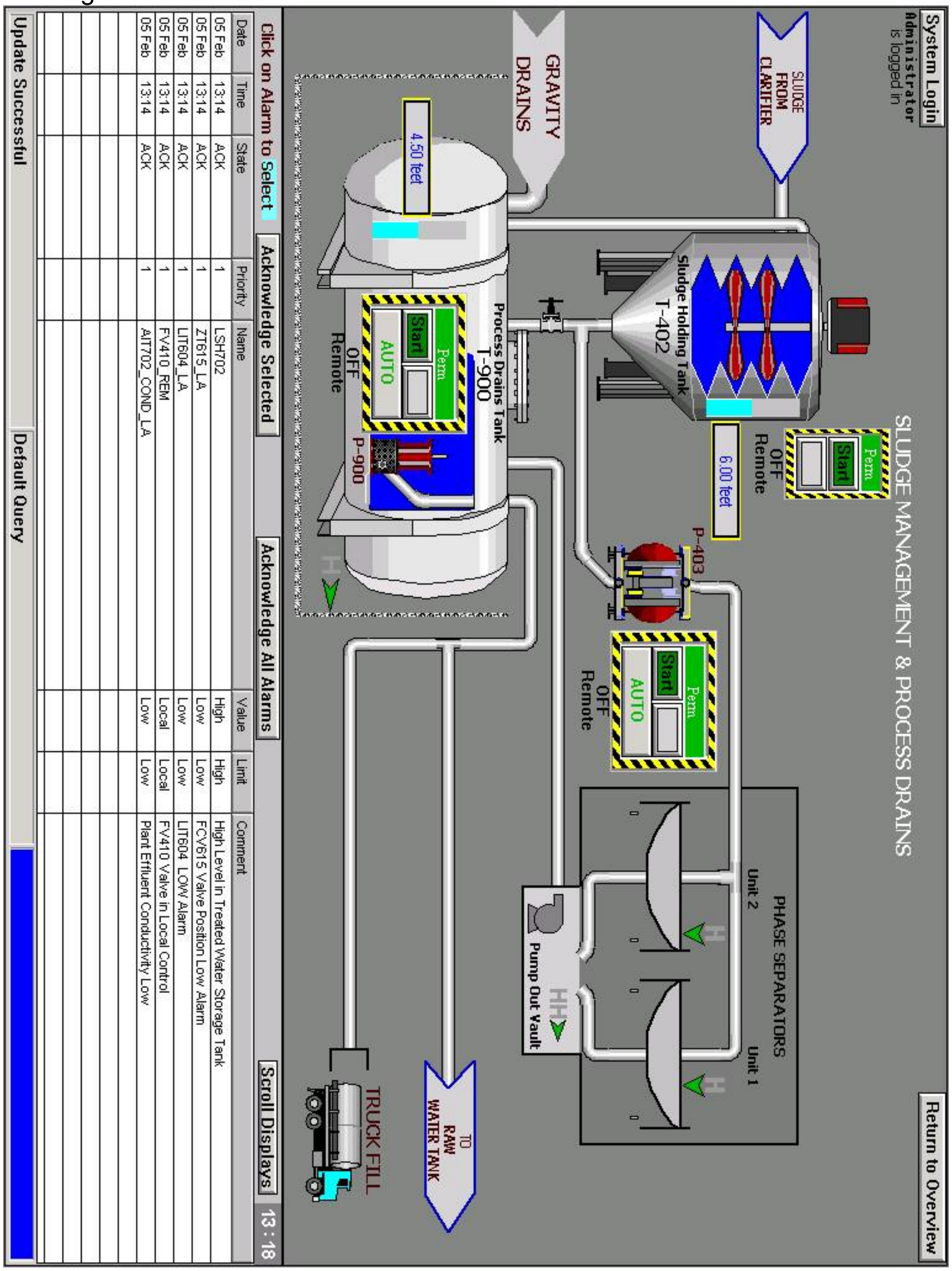
There are seven control points for the operator. There are two mixers and one rake motor on the clarifier. The two sludge block valves FV-400 and FV-410 open automatically whenever their associated pump is activated. If necessary, the operator can open/close these valves at will by clicking on the appropriate command button.

The two sludge-forwarding pumps have three modes of operation similar to the extraction well pumps. The first mode, Remote Auto, is the preferred method of operation. In this mode the pumps start and stop automatically based on limits set in the PLC programming. The second mode, Remote Manual, is available to the operator if it is determined that the pump(s) should be stopped or started independent of the PLC programming limits. The last mode, Local, should not be used to operate the pumps as this mode should only be used for maintenance and troubleshooting.

The primary process flow is the clarifier effluent, which passes on to the MicroFilter skid system for further cleaning.

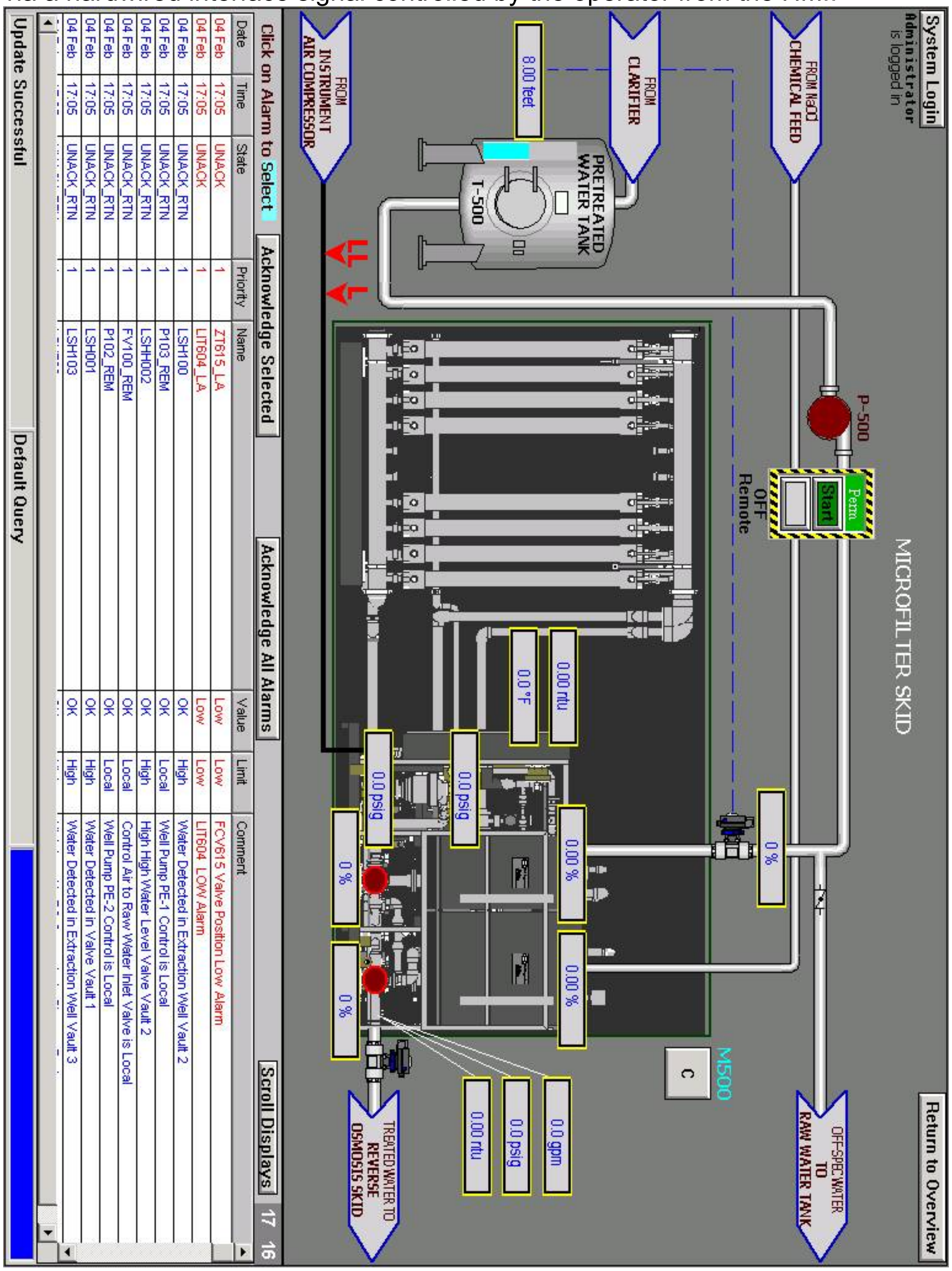
The clarifier sludge is either re-circulated back to the iron oxidation tanks or is sent to the sludge holding tank for further processing and removal.

The sludge holding tank takes the sludge from the clarifier and sends it to the phase separators, which remove most of the suspended solids. Water is then pumped from the separators over to the process drains tank. The process drains tank will be emptied periodically by pumping back to the raw water tank and/or by trucking off-site.



The main points monitored and controlled are the tank levels, the sludge-forwarding pump P-403; the drains pump P-900 and the holding tank mixer. Additionally, the phase separators are monitored for excessive level by 3 different level switches. Tank level is maintained within a specific range by the pumps when the pumps are in Remote Auto control. In Remote Auto, the pumps start and stop automatically based on level indication from the appropriate tank. Remote Auto is the preferred method of operation.

The main process flow (effluent) from the clarifier continues on to the PALL MicroFilter skid. The MicroFilter continues to clean the water stream by filtering out particulate matter. The skid is controlled by a MicroLogix PLC located in the skid panel. The skid receives a remote run/stop command from the main PLC via a hardwired interface signal controlled by the operator from the HMI.

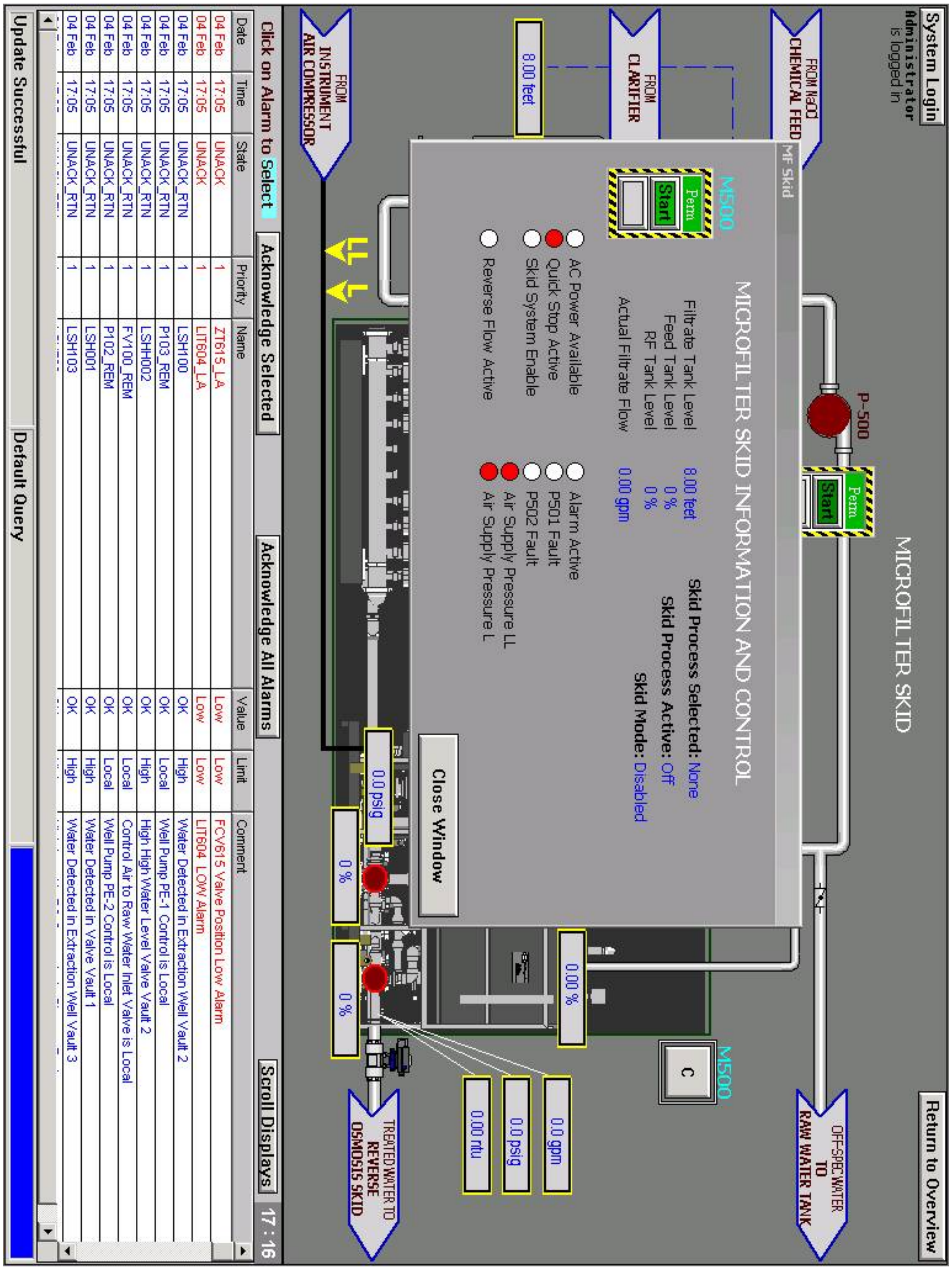


There is only one control point for the operator, the start/stop of pump P-500. The MicroFilter skid PLC controls all other points. The operator cannot directly control the level in the pre-treated water tank T-500. This tank level is maintained by a setpoint set in the MicroFilter skid PLC and can only be changed at the local PLC panel.

Specific details regarding the operation of the MicroFilter skid including the HMI start/stop command output is available by calling up the MicroFilter skid popup skid control window. This window is called up by clicking the "C" control button located under the M500 tag.

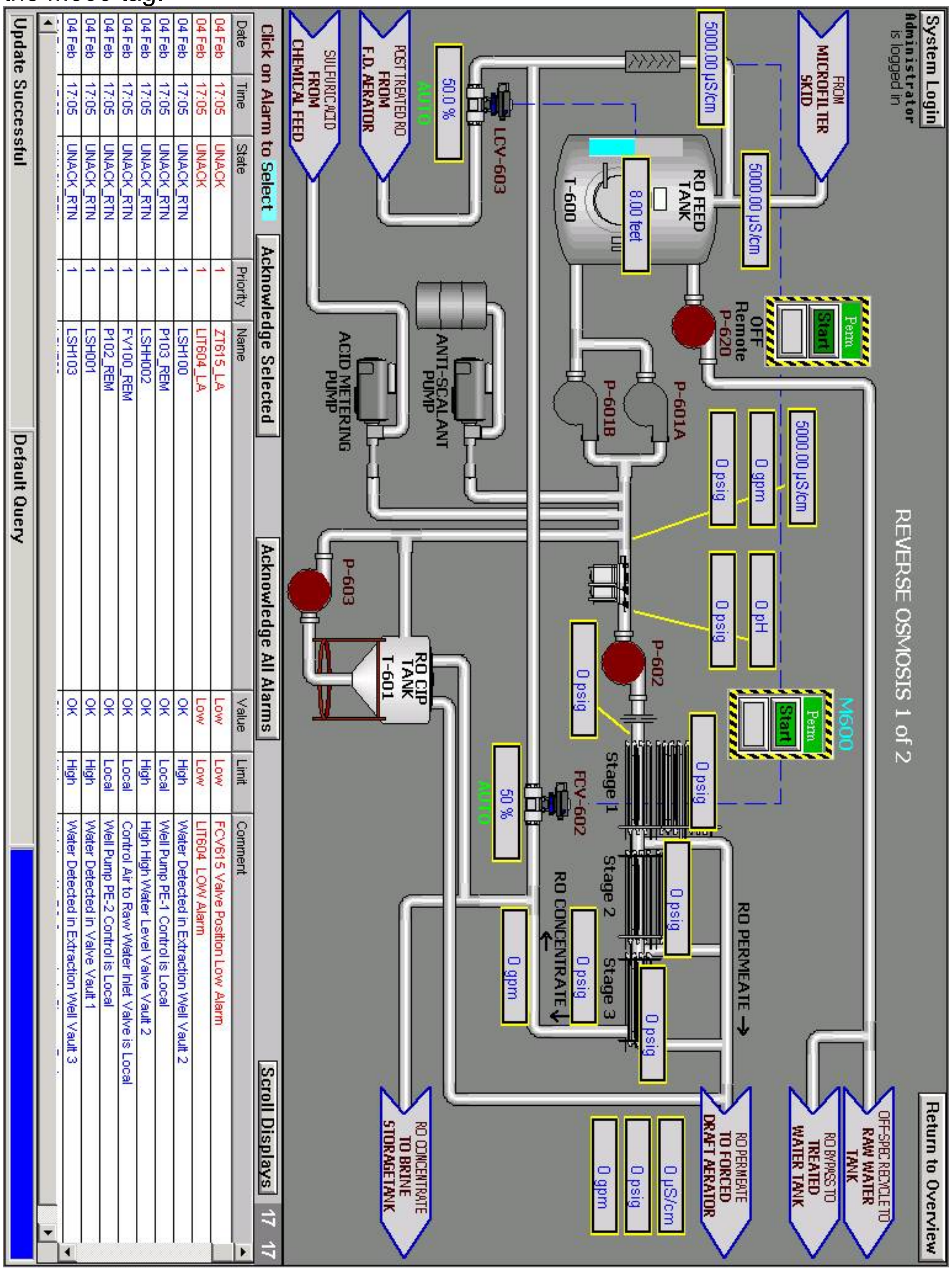
For additional details concerning the operation and control of the MicroFilter system, please refer to the PALL O&M manual.

To remotely start the MF skid, the operator must call up the skid control window and select “Start” from the control button macro.



The main process stream flows through the MicroFilter and continues to the reverse osmosis system.

The reverse osmosis skid is a self-contained skid package that is controlled by a MicroLogix PLC located in the skid panel. The RO skid receives a run/stop command from the main PLC via a hardwired interface signal controlled by the operator from the HMI. The operator can issue a remote skid start/stop command by clicking on the command buttons in the control macro located under the M600 tag.



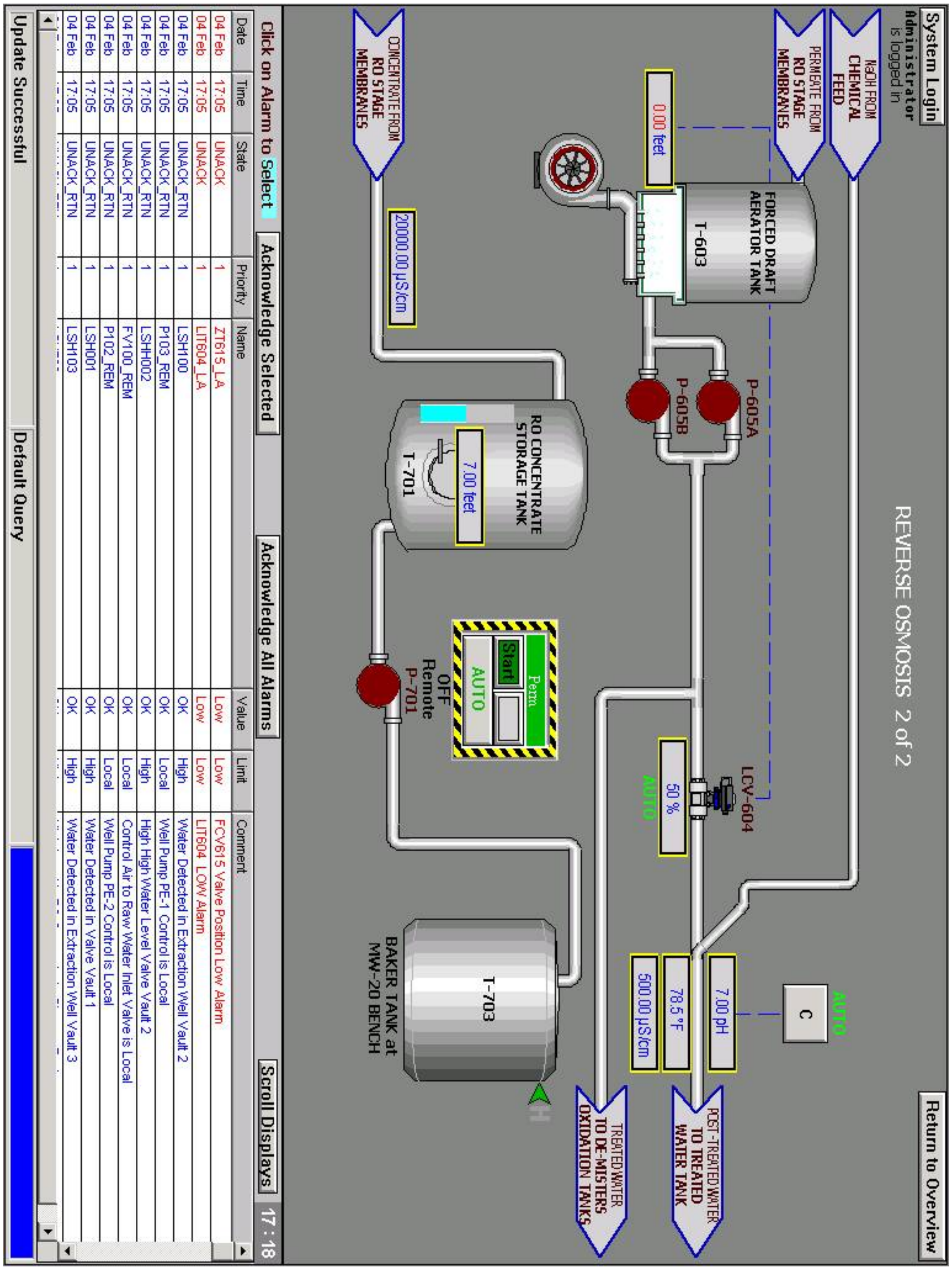
There are two main control points for the operator on the first RO screen. The first control point is the RO feed tank level in tank T-600, which is controlled by

LCV-603. The second control point is RO recirculation conductivity, which is controlled by FCV-602, which regulates RO concentrate flow back into the feed tank in order to match the recirculation conductivity to the process influent conductivity. The operator can access the PID controls for these two points by clicking on the appropriate control valve on the HMI screen.

The other control points for the operator are the remote start/stop of the skid and the control of the P-620 pump.

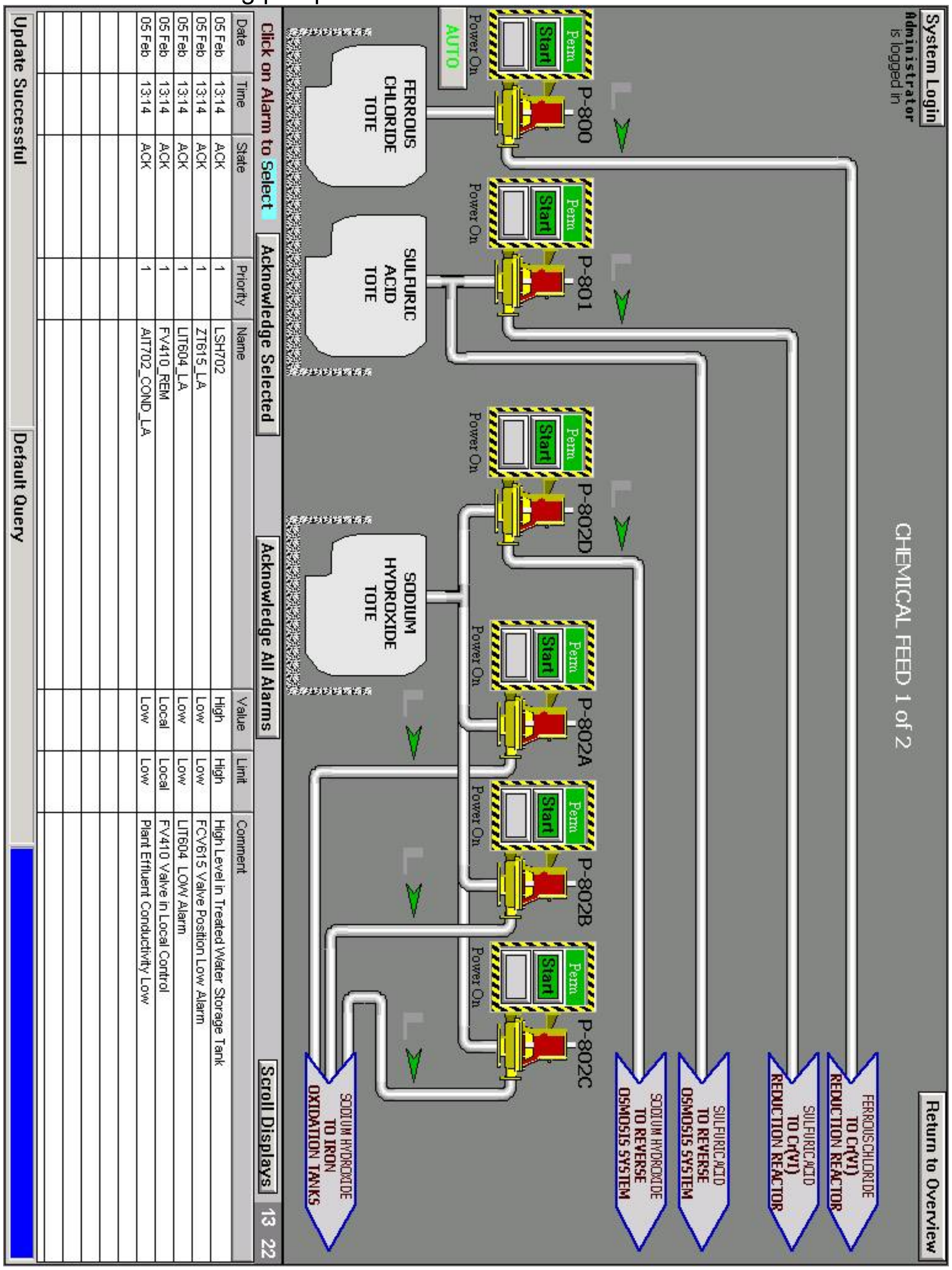
The main purpose of the RO system is to remove salts and other impurities from the water. One of the primary monitors of the RO system is conductivity. In addition, pH, flow and pressure are monitored.

Due to the size of the RO skid, the process is displayed across two process graphics. The RO permeate (clean stream) is sent through a forced draft aerator. The RO concentrate (waste stream or brine) is sent to a small interim storage tank from which, it is pumped into a Baker tank at the MW-20 bench. The brine is manually transferred to transfer trucks for off-site disposal.



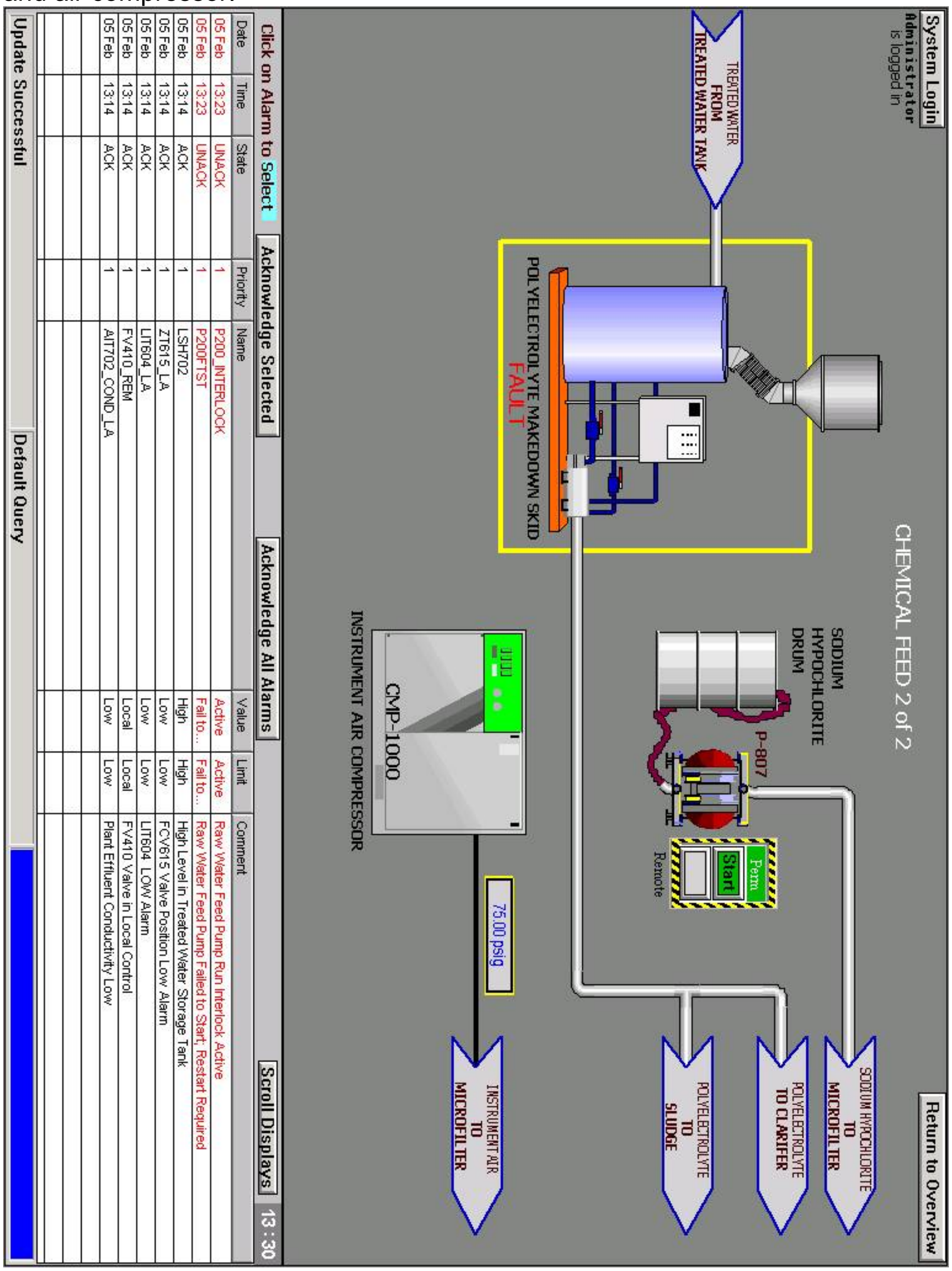
There are two primary control points for the operator. The first is the T-603 tank level, which is controlled by LCV-604. To access the PID control, the operator clicks on the LCV-604 valve. The second control point is permeate pH, which is controlled by metering sodium hydroxide using pump P-802D. To access the PID control, the operator clicks on the "C" control button. PID control of the P-802D is also available from the metering pump HMI screen.

Several chemicals are used during the treatment process. Access to the chemical screens is via page connector links from the appropriate process that uses chemicals or from the overview graphic. The first chemical screen is for the six chemical metering pumps.



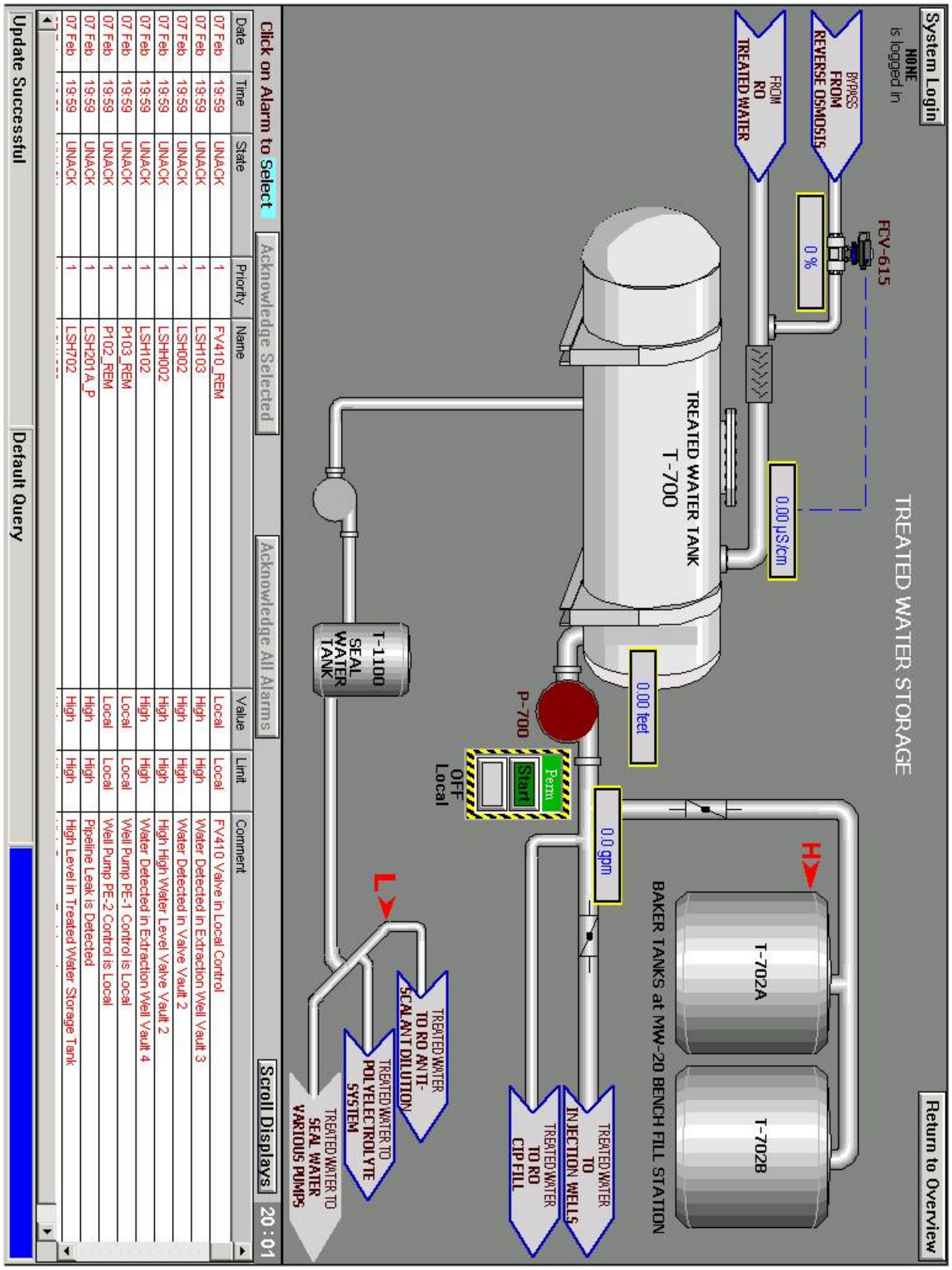
Each metering pump has a control window associated with it. To access a pumps control window, click on the desired metering pump. All pumps must be started/stopped by the operator. The ferrous chloride pump P-800 also has Auto/Manual capability. In the Auto mode, the pump starts and stops by itself based on raw water influent flow (FIT-200) and programming limits set in the PLC program. In Manual mode, the pump is started and stopped by the operator. Specific details regarding chemical metering controls are provided in Section 8.

The second chemical graphic is for the polyelectrolyte skid, sodium hypochlorite and air compressor.



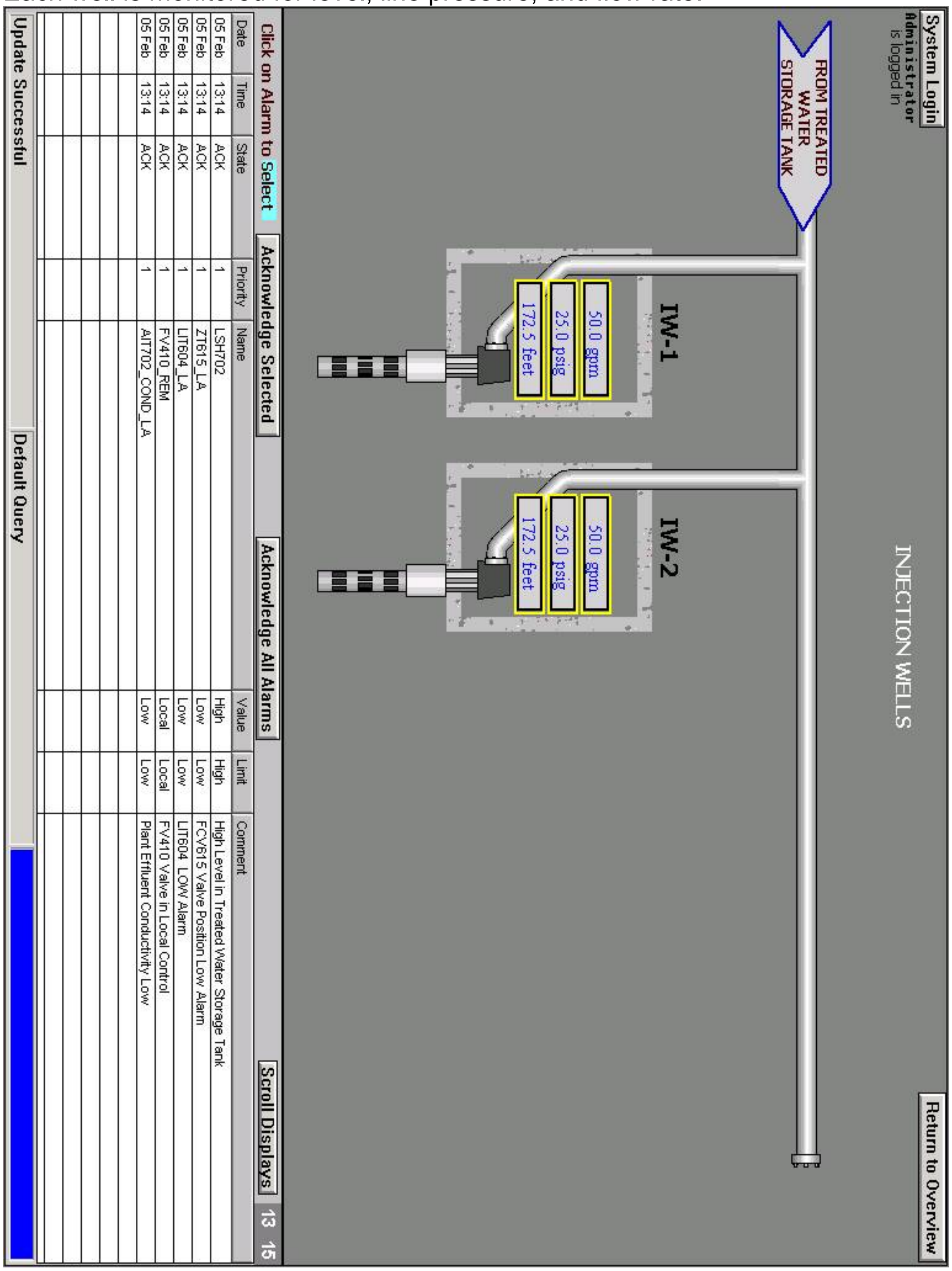
There is only one control point pump P-807. Air pressure is monitored and the compressor and polyelectrolyte skid have fault indication if a skid failure occurs.

After passing through the forced draft aerator, the permeate is stored temporarily in the treated water storage tank. From the treated water storage tank, the RO permeate is either pumped to Baker storage tanks at the MW-20 bench, or it is pumped back into the ground via the injection wells. Flow to either the injection wells or the Baker tanks is controlled manually by the operator adjusting block valves in the field.



The main control points for the operator are the transfer pump control P-700 and the treated water conductivity PID control via FCV-615.

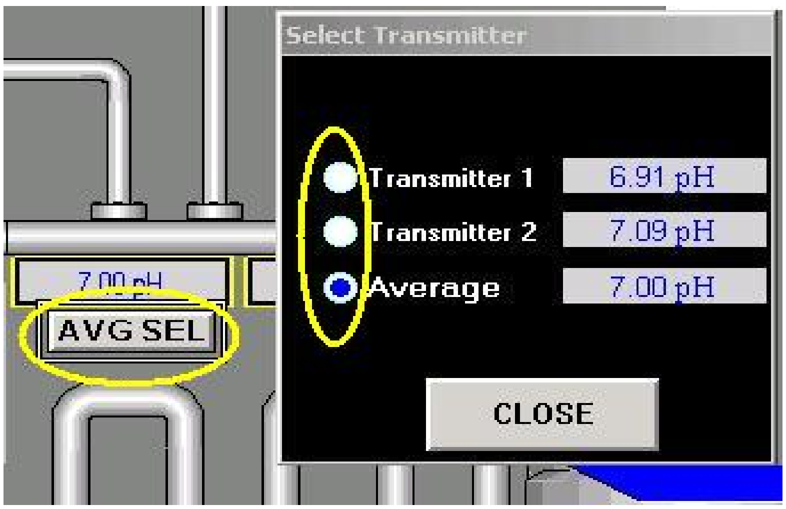
The injection wells take the treated water from the treated water storage tank. Each well is monitored for level, line pressure, and flow rate.



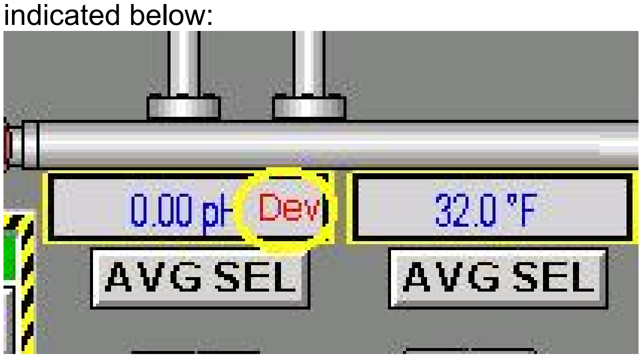
8. MONITORING AND CONTROL

There are numerous process points that can be monitored by the operator. These principally include water flows, pressures and temperatures as well as conductivity and pH.

For critical pH, dual transmitters have been provided. There are three modes available to the operator for these dual transmitters. The operator has the ability to select the transmitter that should be displayed and alarmed on the HMI or the operator can select to display and alarm the average of both transmitters. Average is the preferred operating state. Normally, the dual transmitters should be set to "AVG" from the HMI.



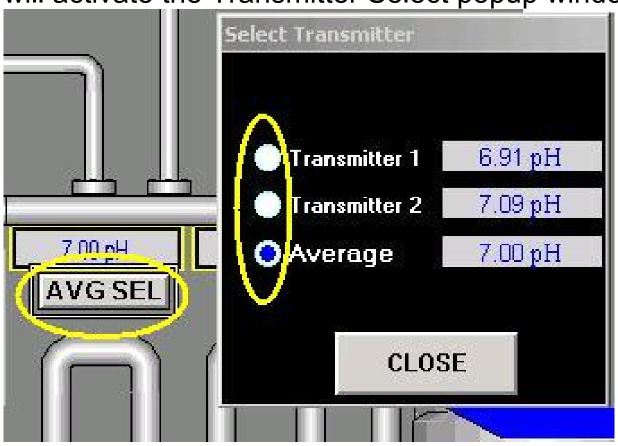
The PLC will alarm the HMI if the two transmitters in a dual transmitter pair deviate from each other by 5% of transmitter span. If a deviation alarm is received by the HMI, the operator should immediately investigate the cause of the deviation. Visual indication of the deviation alarm occurs both on the Alarm Summary found on the bottom of every screen and at the transmitter readout as indicated below:



It may be necessary to take a transmitter out of service in order to repair or replace a defective transmitter. In order to minimize nuisance alarming, the operator can select to display and alarm the good transmitter, which allows the temporary removal from service of the defective transmitter. The defective transmitter should be repaired or replaced as soon as possible and the transmitter selection should then be returned to “AVG”. No control action other than alarming occurs as the result of the transmitter deviation. The system does not automatically transfer from one transmitter to another transmitter.

The operator can always see which transmitter is selected from the HMI by looking at the text displayed in the transmitter select button.

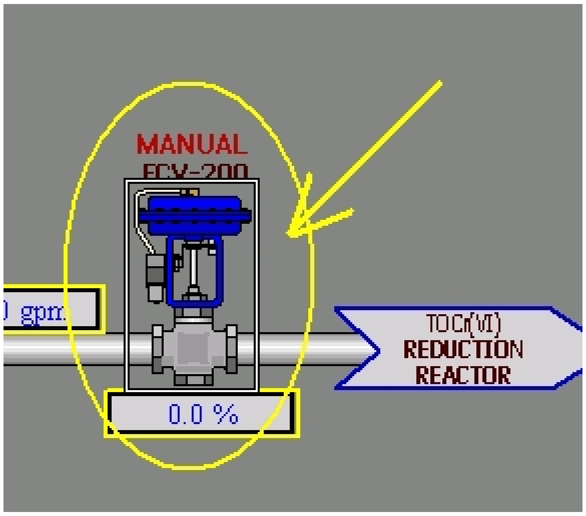
To select the display and alarming of the dual transmitter pairs, the operator must click on the grey transmitter select button under a dual transmitter display, which will activate the Transmitter Select popup window.



The operator then selects one of two transmitters or the average by clicking on the white radial button for the appropriate selection. Once a selection has been made, the operator should then close out the popup window by clicking on the “CLOSE” button.

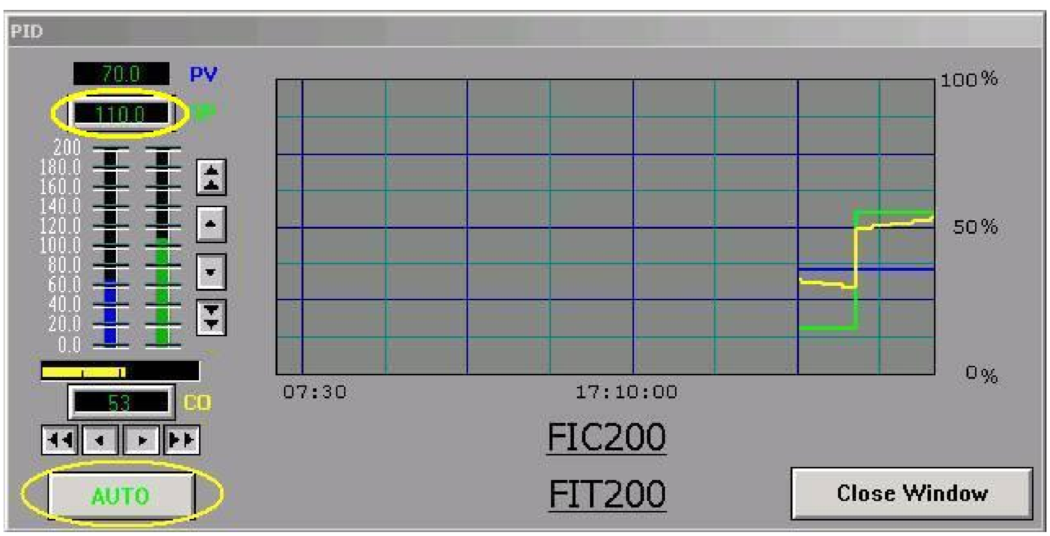
ANALOG CONTROL

There are a few analog control loops that require monitoring and setpoint adjustment by an operator. Analog control loops are controlled from the HMI by using a PID popup window. PID is an acronym for Proportional Integral Derivative, which describes the standard control algorithm. To activate the PID popup window, the operator must click on the control valve on the HMI screen that is to be controlled. In the following example, the PID popup for control valve

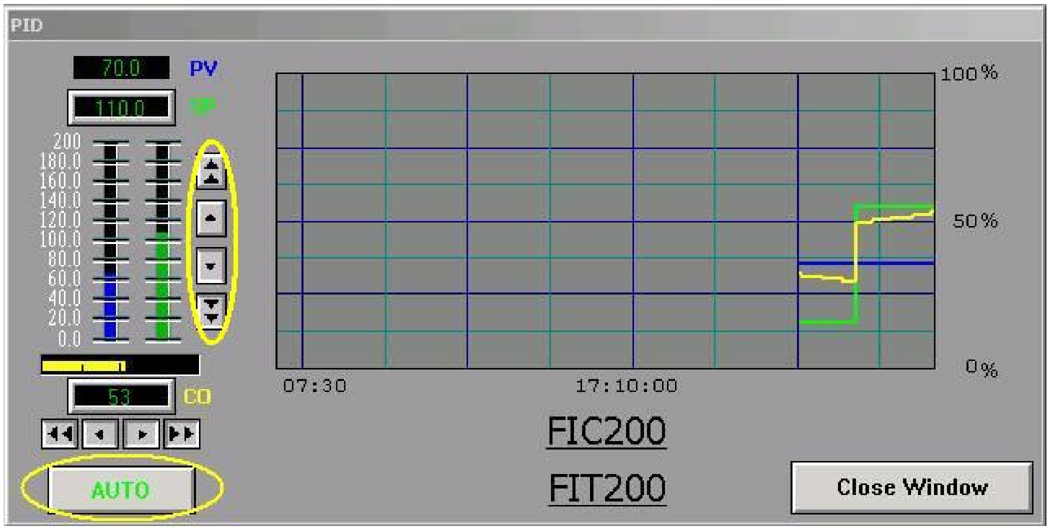


FCV-200 is activated when the mouse is clicked anywhere on top of the FCV-200 valve.

Once the PID popup window is displayed the operator can change the setpoint by entering a specific setpoint value in the setpoint box (circled on top).



Or, the setpoint can also be changed incrementally by bumping the setpoint using the increment buttons (circled on the side).

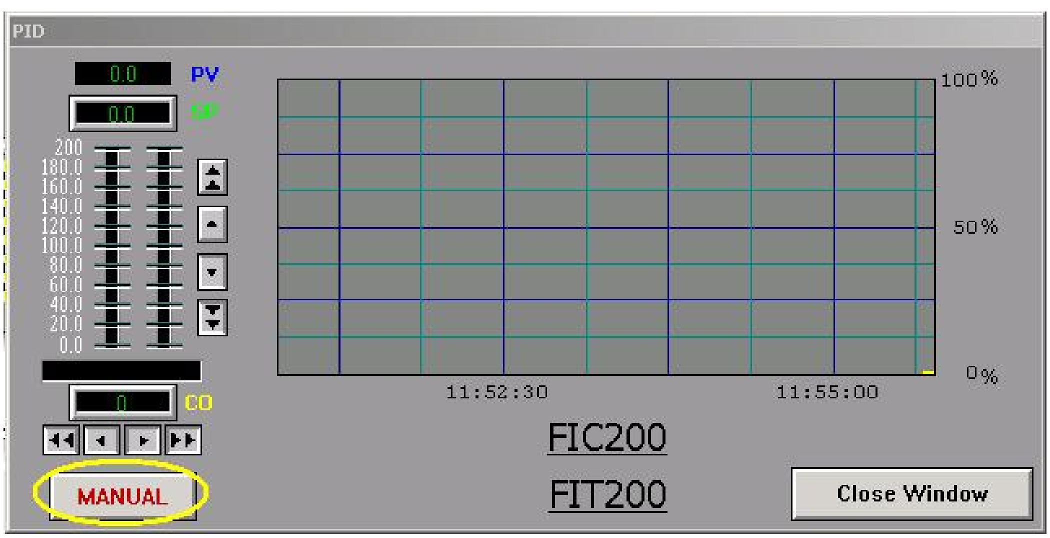


The up arrows increase the setpoint value, while the down arrows will decrease the setpoint value. Once the operator has established the desired setpoint in the controller, the "CLOSE" button should be clicked to close out the PID window.

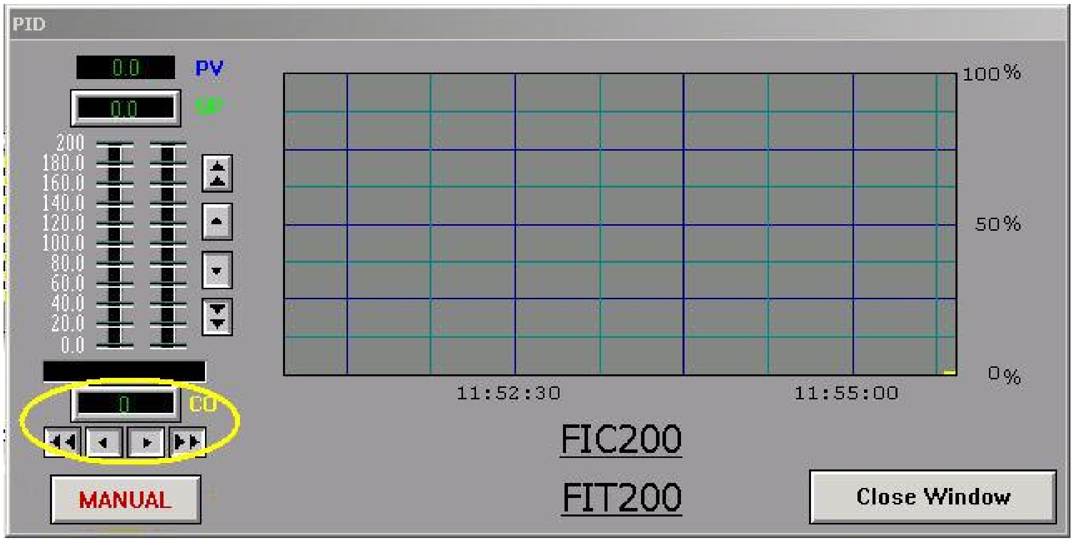
In Auto control, the PLC system continually adjusts the control output (i.e. the control signal to the flow regulating valve) making changes necessary in order to match the process variable signal with the operator-entered setpoint.

In rare cases, the controller may have to be taken out of Auto control and placed into Manual control.

In Manual control, the output to the control valve stays fixed unless changed by the operator. To change between Auto and Manual control, click the Auto/Manual toggle button located on the bottom left of the PID control window.



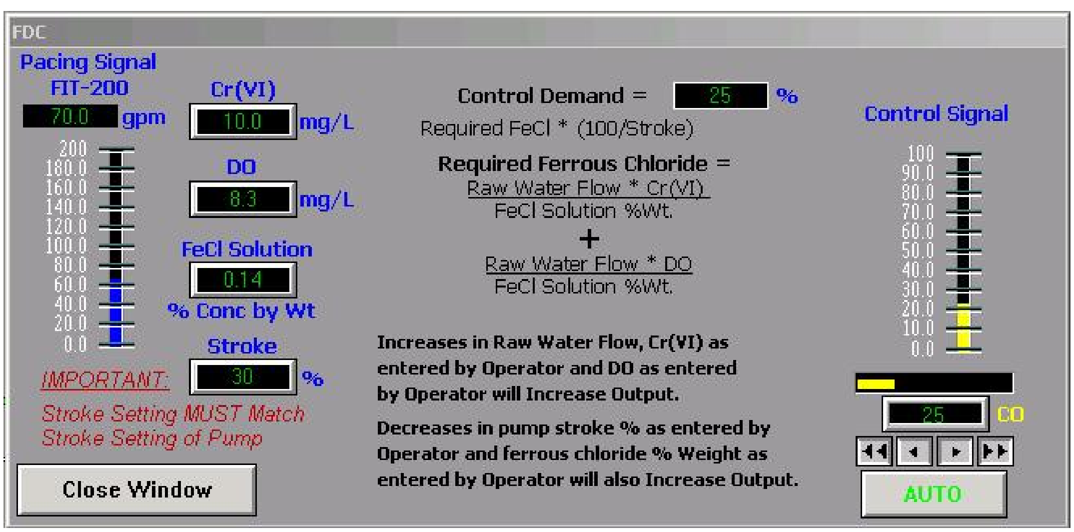
Once the controller is in Manual, the operator can manipulate the output directly by either setting a manual output (as 0-100%) or by incrementally bumping the output up or down using the arrow buttons.



Manual control should only be used for maintenance or troubleshooting purposes.

Ferrous Dosing

Special note should be made regarding the ferrous dosing control. Ferrous dosing control is called up by clicking on the ferrous metering pump P-800 located on the chemical metering pump graphic. Clicking on the metering pump activates the ferrous dosing control popup window.



The flow of ferrous is automatically regulated based on the pacing signal factored by several operator-entered setpoints. The control output signal, which drives the speed of the dosing pump, will change as follows:

The output will increase under the following conditions:

- When the pacing signal (flow rate measured by FIT-200) increases ↑
- When the operator entered value for measured chrome increases ↑
- When the operator entered value for Dissolved Oxygen increases ↑
- When the operator entered value for concentration of ferrous decreases ↓
- When the operator entered value for pump stroke decreases ↓

Special Note: It is very important that the stroke setting value entered into the HMI be the same value that is manually set on the pump. Failure to match the HMI setting to the physical pump setting will result in incorrect dosing of ferrous.

Auto control is the preferred operational method. However, the operator can switch the controller to Manual and set a specific output to the metering pump if necessary for maintenance or troubleshooting.

DISCRETE CONTROL

As previously indicated, the operator can start and stop various pumps by clicking on the start button associated with a pump. Once started, the stop button becomes available. To stop the pump, the operator must click on the stop button. The on/off valves are controlled in a similar manner.

The pump start/stop stations and on/off valves can only be controlled when an operator is logged into the system and then, only when the local hand-switch (LOR) is in the remote position. Control from the HMI is not possible when the field hand-switch is either off or in the local position. Both motor run status and local/remote status are displayed on the HMI:

The on/off valves are controlled in a similar manner. They also have a yellow/black control box. The valves also clearly indicate valve status including “Open”, “Closed”, “No Limits”, “Double Limits”, “Fail to Open”, and “Fail to Close”. Full mismatch logic on valves with limit switches is employed. The valve status will not indicate “Open” unless the open limit switch (ZSO) is closed **and** the closed limit switch (ZSC) is open. “Closed” is not indicated unless the closed limit is closed and the open limit is open. If no limit switch is closed after a 10sec timeout, an alarm is generated and the valve status indicates “No Limits”. If both limit switches indicate closed, then an alarm is immediately generated and the status indicates “Double Limits”.

As with the pump/motor control, if the valve field switch is not in the Remote position, no HMI control is possible.

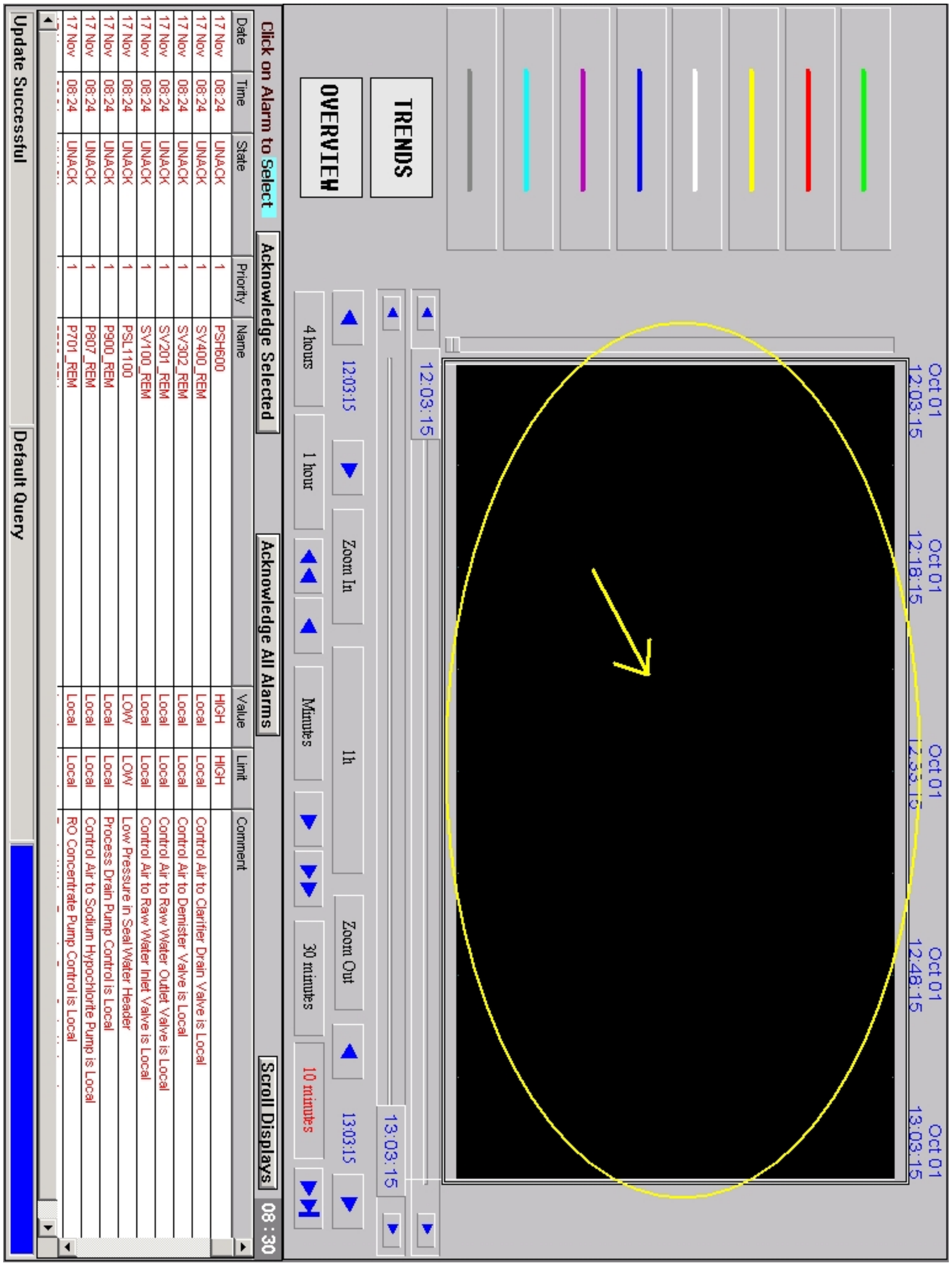
9. TRENDING

There are 20 trend displays available for viewing historical system data. 19 of the 20 displays are fixed with regard to the data points that are called up by the display. 1 trend display is operator-configurable and can be changed at any time by an operator. The configurable trend display can be configured to show any combination of data variables, including discrete on/off data, which are configured to be historically logged in the system.

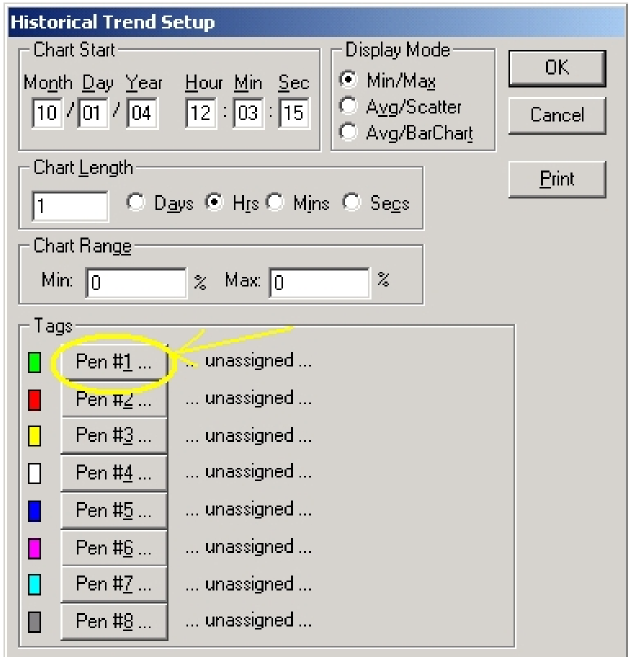
CONFIGURABLE TRENDING

The operator-configurable trend allows the operator to pick up to eight historically trended (logged) tags available from the HMI database for display and comparison purposes.

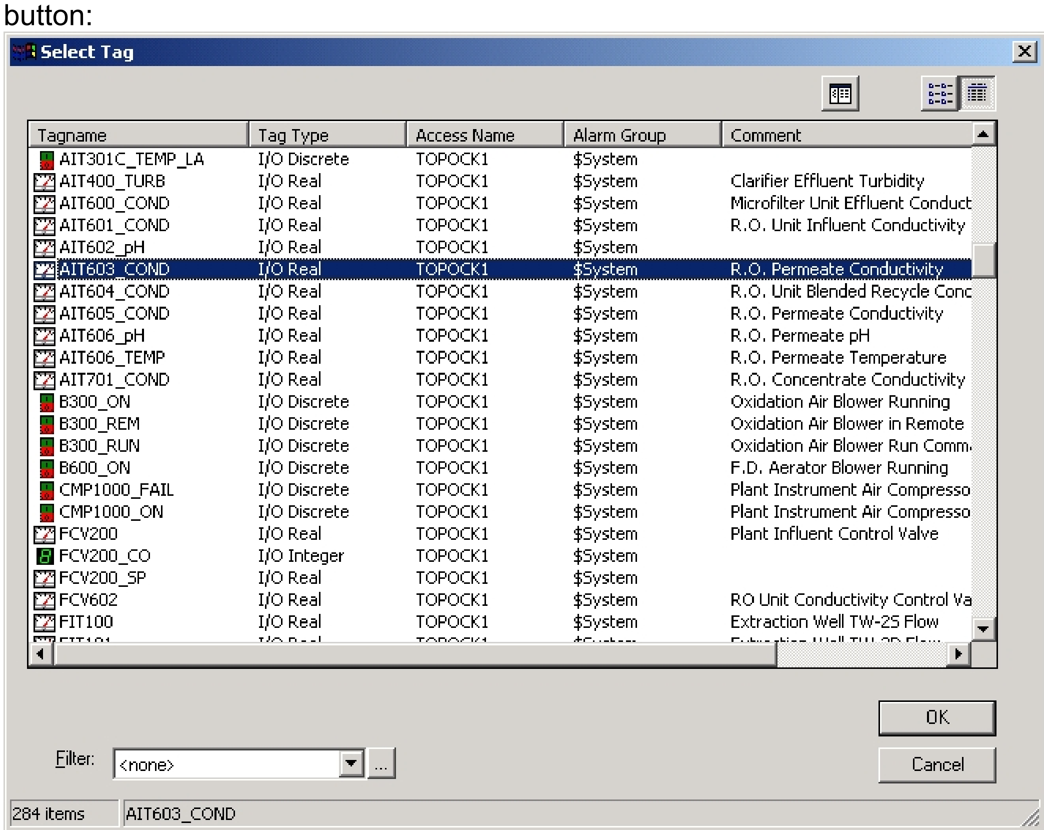
To select tags for display in the settable trend, navigate to the “Operator Settable” trend display from the Master Trend display. When started for the very first time, the trend display will have no tags selected. To view historical trend data, tags must first be selected for display by the operator. Select tags for the trend display by clicking the mouse inside the large trend trace display area (black area) as shown on the next page:



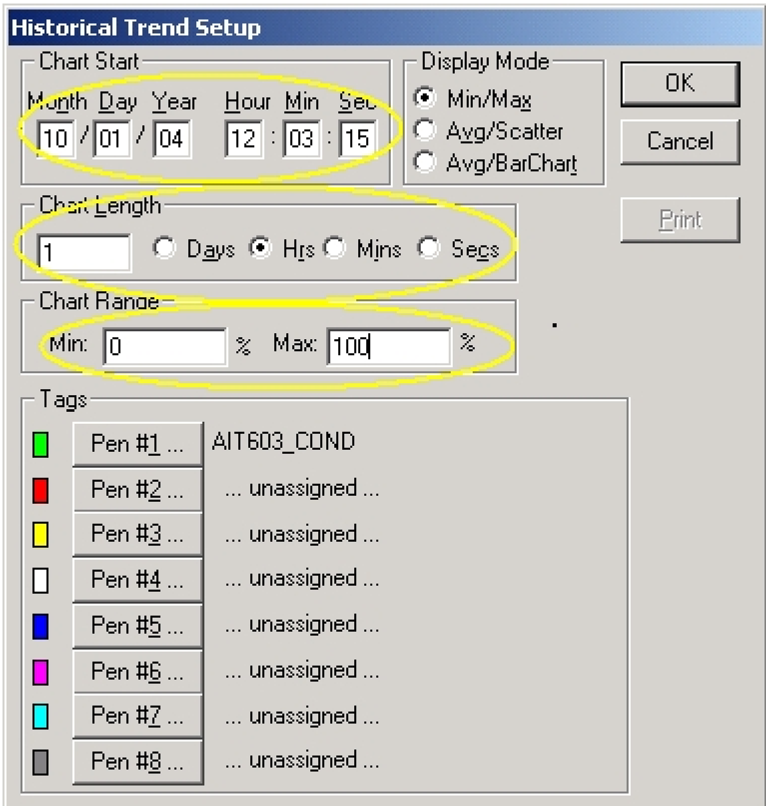
When you click in the trace area of the user configurable trend, a popup widow will appear that can be used to configure trend points for display.



An operator can assign a tag to a pen trace by clicking on any one of the trend "Pen #x" buttons as indicated above. Clicking on the button will cause a second popup window to appear that will allow the operator to select a tag for that button:

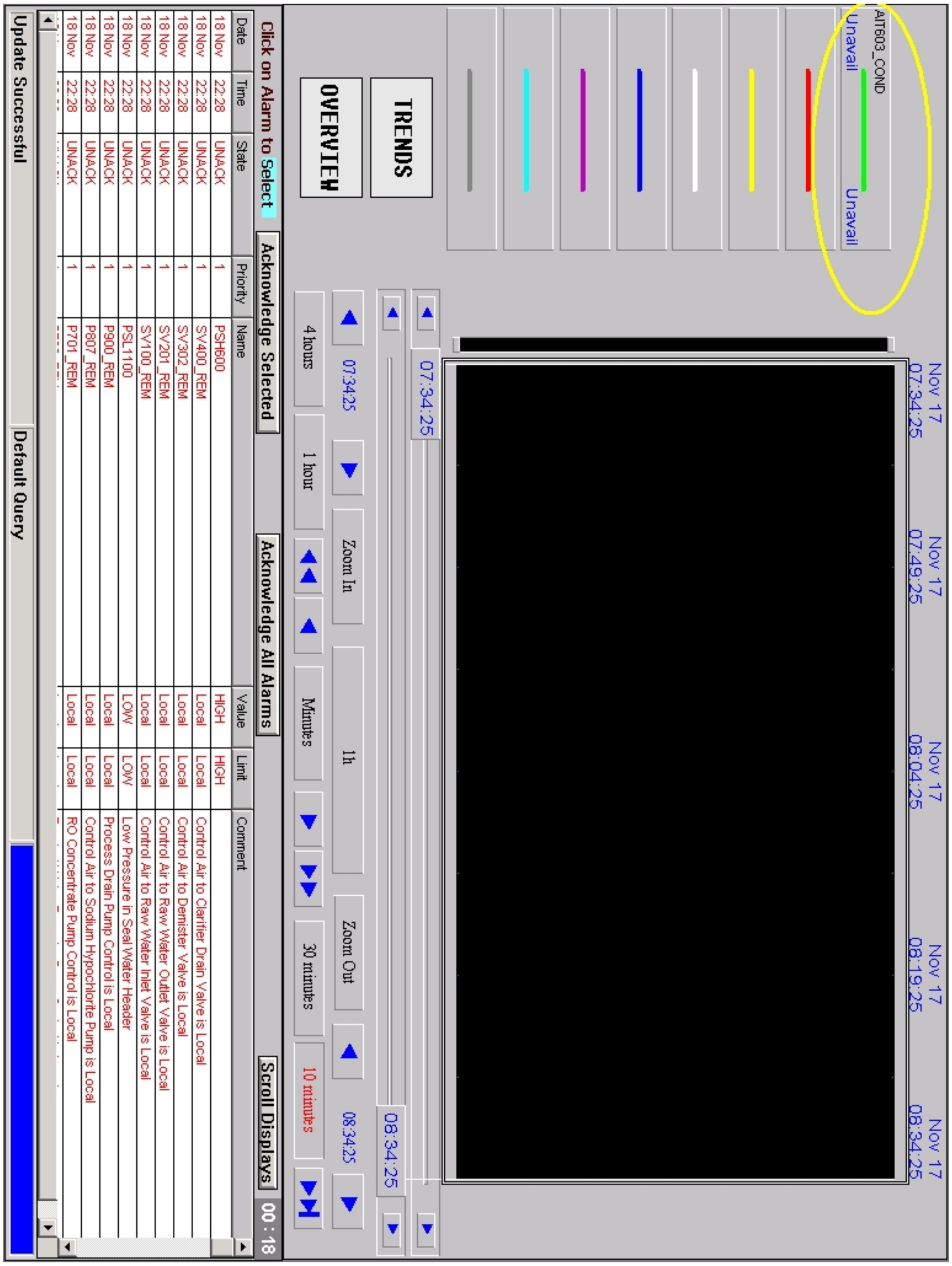


Use the side scroll bar to scroll through the list until the tag that is to be trended is found. Select the tag by clicking on the row for the tag in the list. The tag row will become highlighted in blue (as shown above). Once the tag has been selected, the operator must click on the “OK” button, which will close the tag selection window and return to the trend setup window.



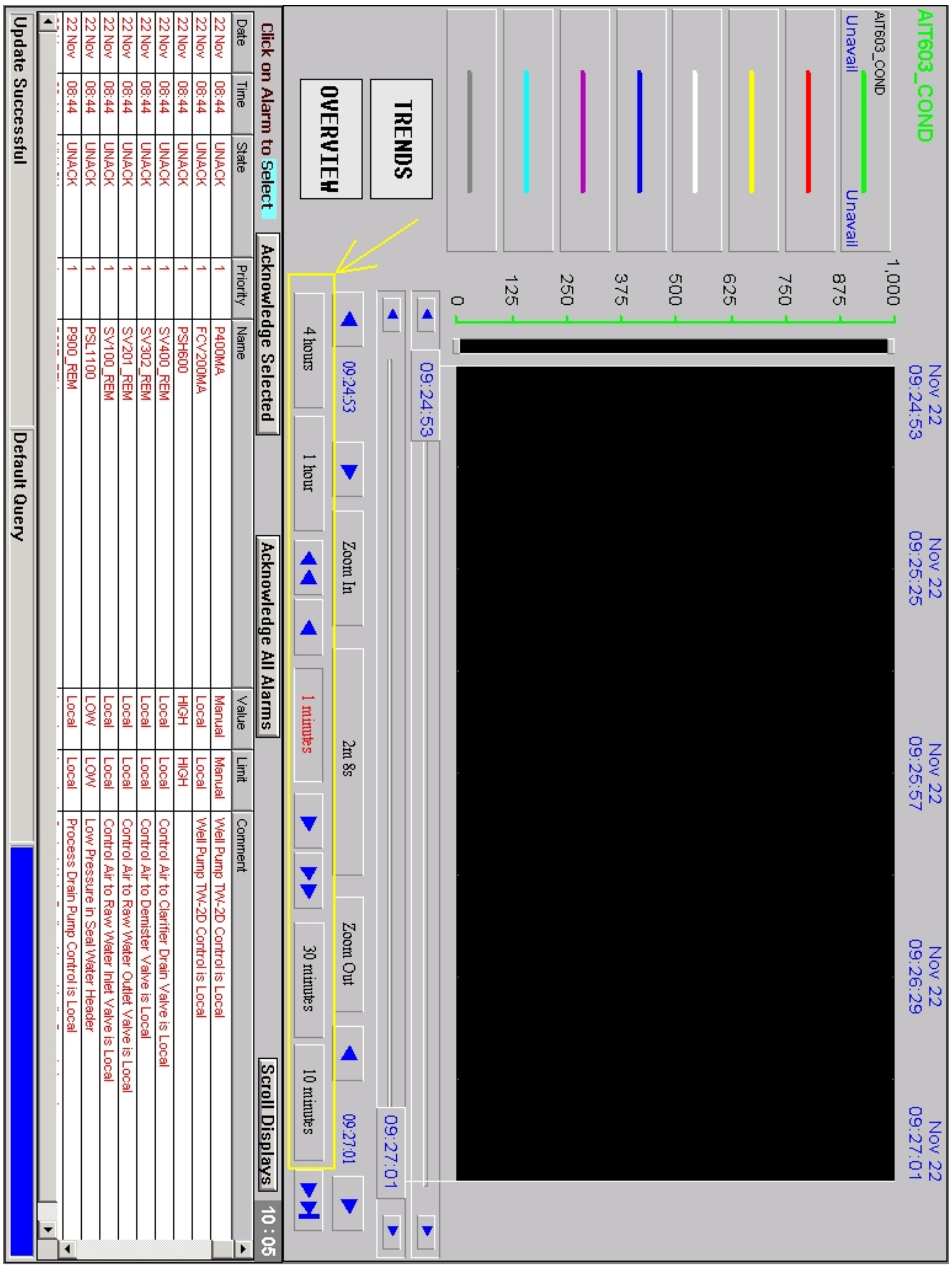
The tag that was selected is now shown next to the pen button. The operator may want to confirm the date, length and range of the chart data to be displayed. These values can be changed by simply clicking in the white entry fields and then by typing a new value for that field.

When all of the tags to be displayed have been selected, click the OK button in the upper right side of the Historical Trend Setup window. The selected trends are now displayed in the trend window. The points selected for the trend will remain until the operator makes changes.

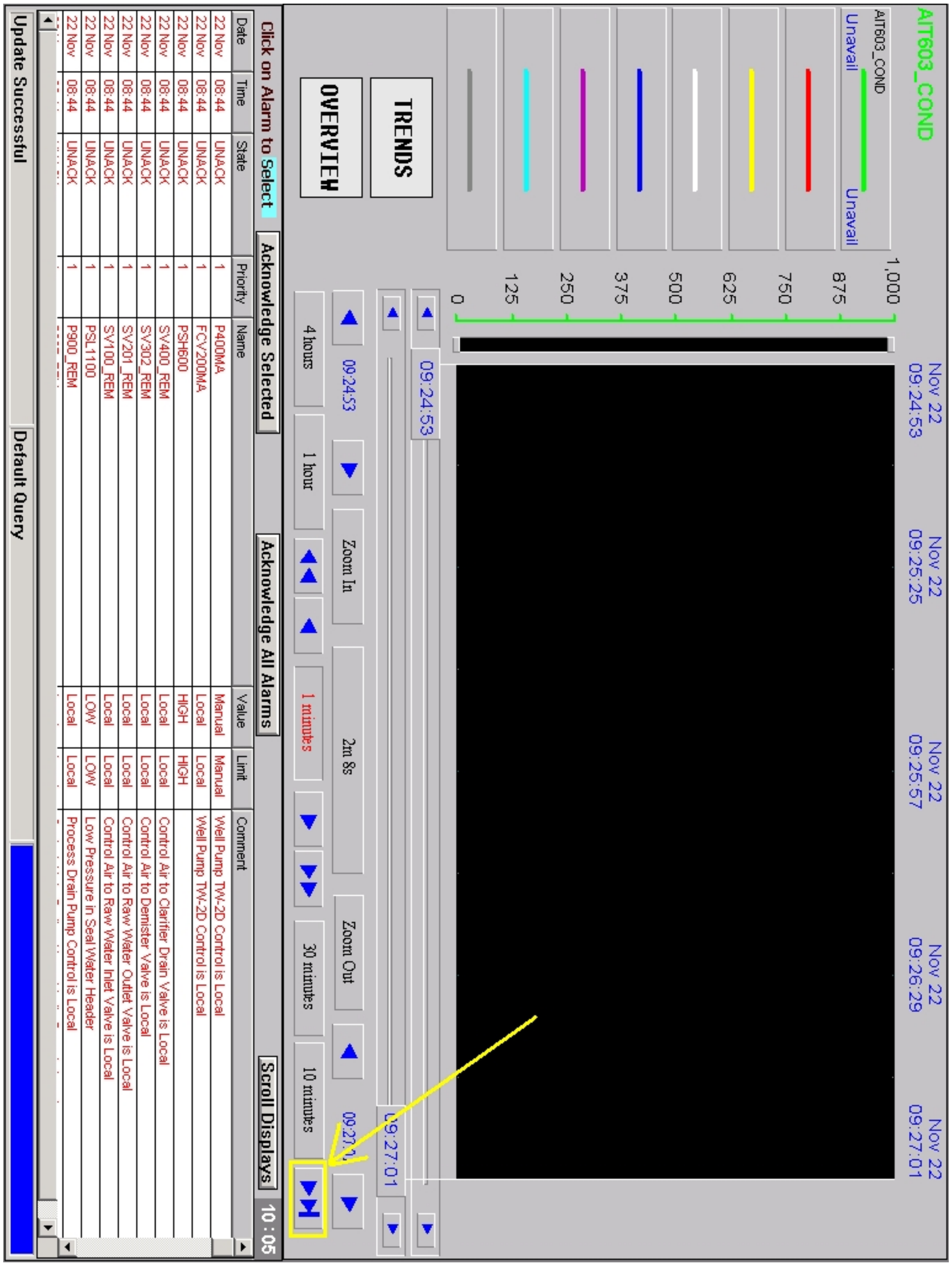


TREND NAVIGATION

The operator can use the buttons on the bottom to move backwards and forward in time. Clicking on the time buttons (4 hours; 1 hour; 30 minutes; 10 minutes) will set the time span increments. The time span increment setting dictates the amount of time that will be panned when the pan buttons (single arrows and



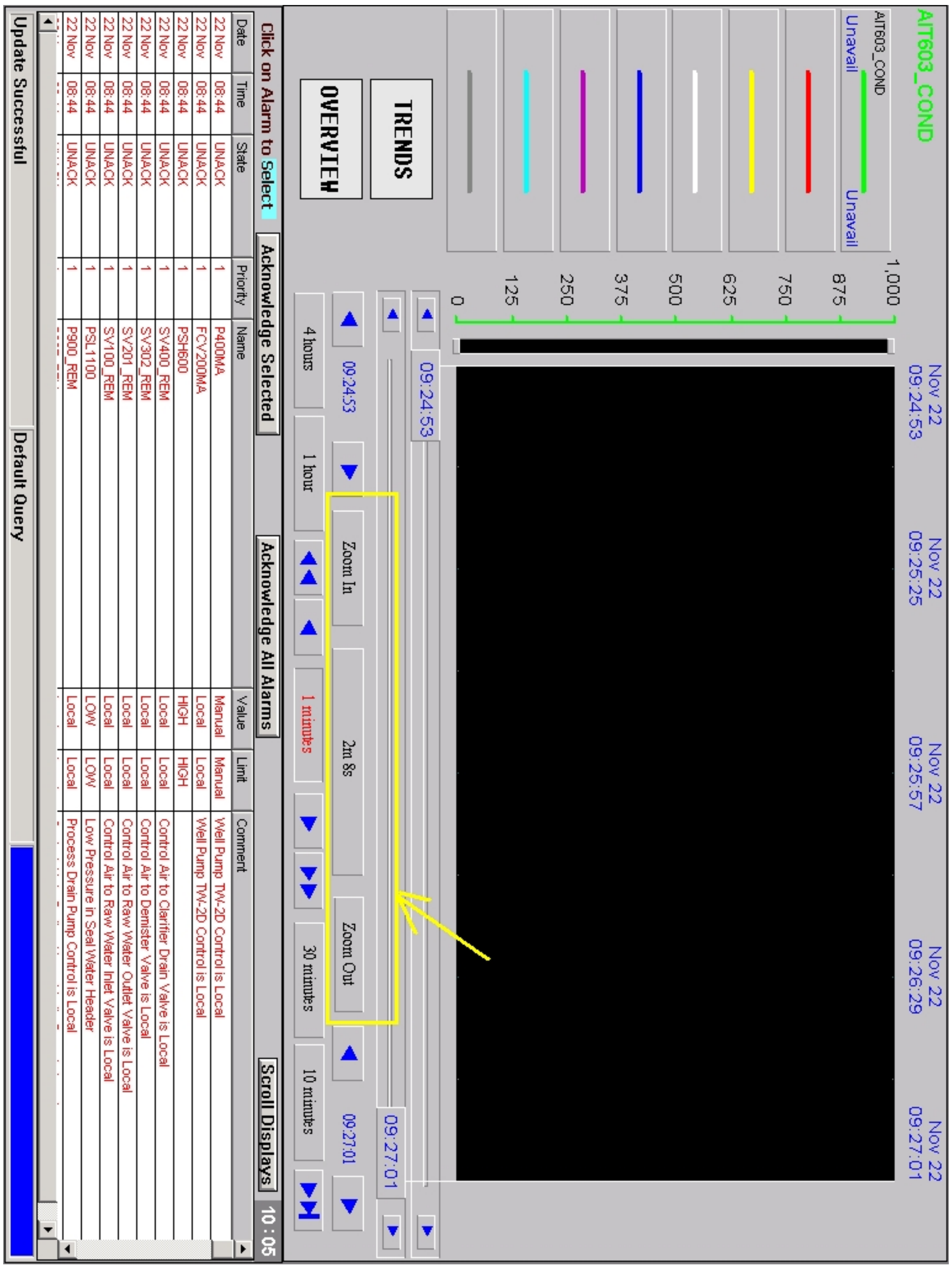
double arrows) are pressed. When the pan buttons are pressed, the historical data shown on the trend moves either backwards in time or forwards in time depending upon whether a backward arrow or forward arrow is pressed. Clicking on a single arrow moves the time slice by the amount indicated in the middle display box. Clicking a double arrow moves the time slice by two times the amount indicated in the middle display box. To display the most recent data, the operator can click on the double arrow bar button located on the far right of the



pan buttons.

The operator can further refine the trend display by zooming in and out.

To zoom the trend display, the “Zoom In” and “Zoom Out” buttons can be pressed. Every press of the “Zoom In” button halves the time slice. In other words, if the time slice was displaying a 1-hour trend, clicking the “Zoom In” button will cause the trend to display a 30-minute time slice. Every press of the “Zoom Out” button doubles the time slice. The time slice value is always indicated in the middle box.



To return to the Trend Master display, the operator can click on the “TRENDS” button. Clicking on the “OVERVIEW” button activates the process overview display graphic.

10. ALARMS, WARNINGS AND THE ALARM PRINTER

The alarm/warning banner is always active and shown, regardless of the process graphic or trend that has been called up. The alarm banner lists the active alarms in the order that they are received by the system. New alarms are always indicated in the top of the list. If any alarms are present and active in the alarm banner when new alarm is generated, the new alarm appears at the top of the list and the previously existing alarms are shifted down one row. New alarms will generate an alert tone to notify the operator that a new process alarm has occurred. The operator can acknowledge alarms either selectively or all at once. To selectively acknowledge alarms, the operator simply clicks on the alarm that is displayed in the alarm banner. Clicking on the alarm once will highlight the alarm in cyan, which indicates that the alarm has been selected for acknowledgement. The operator can then proceed to acknowledge additional alarms in the same manner. Clicking on a highlighted alarm will de-select that alarm and the cyan highlighting will disappear. Once the operator has selected the alarms to be acknowledged, the “Acknowledge Selected” button must be pressed. To acknowledge all alarms at once, simply click on the “Acknowledge All” button.

An Epson dot-matrix printer is connected to the primary WS, “TOPOCK-WS1”. The alarm printer continually prints out alarms and events (for example, changing a control setpoint) as these events occur in the plant. Both HMI workstations continually record electronically not only historical data (trends) but also both the alarms and log events. Historical data is available to the operator in the form of the trend displays. Electronic log data files and the alarm log files are not directly accessible to an operator. The operator’s access to recorded log events and alarms is through review of the alarm printer’s print out. The system administrator can access the electronic files directly. Please refer to the Epson O&M manual for specific details regarding the setup and maintenance of the printer.

11. SCADAlarm™

The SCADAlarm™ system is an alarm notification system designed to alert off-site personnel to alarm conditions when they occur in the plant. The system will use the modem in the workstation to dial either a phone or pager. While the system can be used to acknowledge alarms for the plant, the design philosophy of both the control system and the alarm auto-dialer is to alert off-site personnel to a plant alarm condition with the expectation that the off-site personnel will travel on-site to personally review and correct the conditions that generated the alarm(s). The SCADAlarm™ system operates in the background and cannot be accessed by the operator. When an operator acknowledges and/or corrects an alarm condition on the HMI, the SCADAlarm system is automatically updated. Please refer to the SCADAlarm™ O&M manual for specific details regarding the configuration and capabilities of the SCADAlarm system.

12. Service and Support

For service and support of the control system equipment and software please refer to the specific vendor as detailed below:

- WonderWare® on the web: http://www.wonderware.com/support/mmi/
  - Or call **1-800-WONDER1** (800-966-3371)
- Allen-Bradley on the web at http://support.rockwellautomation.com/
  - Or call local AB office at **(714) 761- 4600**
- DELL™ on the web at http://support.dell.com/
  - Or call **1-800-624-9896**

Appendix E
Standard Operating Procedures

Interim Measures No. 3 Treatment and Extraction

Sample Collection and Laboratory Analysis Standard Operating Procedures

Topock Compressor Station Needles, California

Prepared for

Pacific Gas and Electric Company

March 2006

CH2MHILL

Contents

The following Standard Operating Procedures (SOPs) are contained herein:

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: Hexavalent Chromium Analysis by Hach Method 1560
Number: IM3-SOP-L01
Revision Date: 7/24/2005

Scope

Standard procedure for analysis of hexavalent chromium using Hach program 1560.

Procedure:

First thing each shift, calibrate the pH/COND meter (**Record the results on the calibration log sheet**)

With the first analysis of Hexavalent Chromium each shift

- **Analyze a CCV** (Continuing Calibration Verification) standard:
- Carefully measure 24 mls of DI water
- Add 1 ml of 2.5 mg/L Hexavalent Chromium (Cr^{+6}) standard.
- Add the Hexavalent Chromium reagent pillow… At the same time as your samples. (ChromVer 3 Reagent)
- Invert the CCV sample 4 – 5 times,
- Use the same 8 minute timer for CCV and Samples
- (**Record the results in the Cr^{+6} bench log book**) if the Hach reading is not between 0.075 mg/L and 0.125 mg/L re-prepare the standard and re-analyze, if still not between 0.075 mg/L and 0.125 mg/L call Shawn Duffy at 530-229-3303)

<u>SC-100B, SC-001, and SC-002</u>

- Collect the sample: (from the SC-100B/SC-001/SC-002 sampling point)
- Verify the Hach DR/4000V is set for **Hexavalent Chromium (Cr^{+6})**, program **1560**
- Take the pH (**Record the results in the Cr^{+6} bench log book**)
- Transfer 5 mls of sample SC-100B into a 100 ml volumetric flask
- Add DI water to bring the volume to 100 mls
- Mix sample (invert sample 4 – 5 times)
- Transfer 25 mls of diluted sample into sample cell
- Add ChromVer 3 Reagent to the sample

- Invert sample 4 – 5 times,
- start timer (8 min)
- Run a Blank (Zero the DR/4000V using at least 25 mls of diluted sample)
- After 8 minute timer, pour the sample into the sample port of the Hach DR/4000V
- Record the instrument reading in the Lab Bench Logbook
- Multiply the instrument reading (result) by 20 for the adjusted value

  Example: instrument reading is 0.304

  X 20

  = 6.08 mg/L (final result)

SC-605/SC-700C or SC700B/SC-701

- Collect the sample:
- Verify the Hach DR/4000V is set for **Hexavalent Chromium (Cr^{+6})**, program **1560**
- Take the pH (**Record the results in the Cr^{+6} bench log book**)
- Transfer 25 mls of sample into sample cell
- Add ChromVer 3 Reagent to sample
- Invert sample 4 – 5 times,
- start timer (8 min)
- Run a Blank (Zero the DR/4000V using at least 25 mls of DI)
- After 8 minute timer, pour the sample into the sample port of the Hach DR/4000V
- Record the instrument reading in the Lab Bench Logbook

SC-301C or SC-500

- Collect the sample:
- Verify the Hach DR/4000V is set for **Hexavalent Chromium (Cr^{+6})**, program **1560**
- Take the pH (**Record the results in the Cr^{+6} bench log book**)
- Set up the vacuum filter apparatus
- Filter ~100 mls of sample
- Transfer 25 mls of filtered sample into a sample cell
- Carefully measure 24 mls of filtered sample into a sample cell - **Matrix Spike (MS)**

- add 1 ml of 2.5 mg/L Hexavalent Chromium (Cr^{+6}) standard to the 24 mls of filtered sample
- Add ChromVer 3 Reagent to all the sample(s) / MS
- Invert sample 4 – 5 times,
- start timer (8 min)
- Run a Blank (Zero the DR/4000V using at least 25 mls of DI)
- After 8 minute timer, pour the sample(s) into the sample port of the Hach DR/4000V
- Record the instrument reading in the Lab Bench Logbook

Example: Matrix Spike (0.117 mg/L) - Sample (0.006 mg/L) = 0.111 mg/L

Concentration of Spike Standard is = 0.100 mg/L

% recovery is = 0.111/0.100

= 111% **MS % recovery must be between 75 – 125%**

or you will need to re-analyze

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: Ferrous Iron Analysis by Hach Method 2150
Number: IM3-SOP-L02
Revision Date: 7/24/2005

Scope

Standard operating procedure for analysis of ferrous iron.

Procedure:

- Take the pH (**Record the results in the Fe^{+2} bench log books**)
- Verify the Hach DR/4000V is set for Ferrous Iron, program **2150**
- Transfer 5 mls of the sample into a 100 ml volumetric flask,
- Add DI water to bring the volume to 100 mls,
- mix sample (invert sample 4 – 5 times),
- transfer 25 mls into a sample cell,
- add Ferrous Iron Reagent,
- invert sample 4 – 5 times,
- start timer (3 min)
- Analyze a Blank (Zero the DR/4000V using at least 25 mls of diluted sample)
- After 3 minute timer, pour the sample(s) into the sample port of the Hach DR/4000V
- Record the instrument reading in the Lab Bench Logbook
- Multiply the instrument reading (result) by 20 for the adjusted value– the adjusted value should be between 2 and 16 mg/L.

  Example: instrument reading is 0.704

  X 20

  = 14.08 mg/L (final result, recorded in Fe^{+2} book)

  Note: If the Fe^{+2} adjusted value is not in the 2 – 16 mg/L range notify the lead operator.

SOP-L03: Total Chromium

SC-501/SC-700C or SC700B/SC-701

- Turn on the hot plate and set to 390 degrees
- Make sure the water bath is ~ ½ inch below the top
- Verify the Hach DR/4000V is set for Chromium, Total (Cr^{+3}), program **1580**
- Transfer 25 mls of sample into a sample cell
- Carefully transfer 24 mls of the sample into a sample cell
- add 1 ml of 2.5 mg/L Chrom Cr^{+3} Standard… **Matrix Spike (MS)**

Analyze a CCV (Continuing Calibration Verification) standard:

- Carefully measure 24 mls of DI water
- Add 1 ml of 2.5 mg/L Chrom Cr^{+3} Standard.
- Add Chrom 1 Reagent to each of the sample cells,
- invert sample 4 – 5 times,
- place in the hot water bath and start the 5 min timer "Heat".
- After 5 minutes, remove the sample cells
- cool to room temperature in an ice bath.
- Add Chrom 2 Reagent to each of the sample cells, invert sample 4 – 5 times.
- Add Acid Reagent to each of the sample cells, invert sample 4 – 5 times.
- Add ChromVer 3 Reagent (for 25 mls samples) to each of the sample cells, invert sample 4 – 5 times
- start the 5 min timer "wait".
- Analyze a Blank (Zero the DR/4000V using at least 25 mls of DI)
- After 5 minute timer,
- pour the sample(s) into the sample port of the Hach DR/4000V
- Record the instrument reading in the Lab Bench Logbook

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: Total Chromium Analysis by Hach Method 1580
Number: IM3-SOP-L03
Revision Date: 7/24/2005

Scope

Standard operating procedure for analysis of total chromium.

Procedure (for SC-501/SC-700C or SC700B/SC-701)

- Turn on the hot plate and set to 390 degrees
- Make sure the water bath is ~ ½ inch below the top
- Verify the Hach DR/4000V is set for Chromium, Total (Cr+3), program 1580
- Transfer 25 mls of sample into a sample cell
- Carefully transfer 24 mls of the sample into a sample cell
- add 1 ml of 2.5 mg/L Chrom Cr+3 Standard… Matrix Spike (MS)

Analyze a CCV (Continuing Calibration Verification) standard:

- Carefully measure 24 mls of DI water
- Add 1 ml of 2.5 mg/L Chrom Cr+3 Standard.
- Add Chrom 1 Reagent to each of the sample cells,
- invert sample 4 – 5 times,
- place in the hot water bath and start the 5 min timer “Heat”.
- After 5 minutes, remove the sample cells and cool to room temperature in an ice bath.
- Add Chrom 2 Reagent to each of the sample cells, invert sample 4 – 5 times.
- Add Acid Reagent to each of the sample cells, invert sample 4 – 5 times.
- Add ChromVer 3 Reagent (for 25 mls samples) to each of the sample cells, invert sample 4 – 5 times
- start the 5 min timer “wait”.
- Analyze a Blank (Zero the DR/4000V using at least 25 mls of DI)
- After 5 minute timer,
- pour the sample(s) into the sample port of the Hach DR/4000V
- Record the instrument reading in the Lab Bench Logbook.

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: Conductivity Analysis by Hach Method 8160
Number: IM3-SOP-L04
Revision Date: 10/15/2005

Samples need to be between 20°C and 25°C before conductivity is measured. Conductivity is the measure of the ability of a solution to conduct an electric current and is dependent on temperature. The conductivity can then multiplied by an empirically derived factor to calculate the amount of total dissolved solids (TDS) in the sample.

PROCEDURE

1. Verify the calibration by checking the conductivity of the 1000 μS/cm standard at the beginning of each shift.
   - Rinse the conductivity probe with distilled water and shake it to remove excess water, the meter should read below 10 μS/cm.
   - Place probe in standard/sample and swirl to remove air and provide positive contact between the probe and the standard/sample.
   - Verify the meter is in COND mode.
   - Record value after the reading stabilizes on the calibration sheet.
2. If the results are within 10% of the true value (900 to 1100 μS/cm) continue with analysis of the samples making sure to rinse the probe with distilled water after each sample. If not within 10%, recalibrate the meter following the Steps on page 5 of the HACH **Quick Reference Guide** sens**ion156** and sens**ion378** Multiparameter Meters (54650-23).
3. For each of the samples, using the steps listed above. Record the conductivity result on the bench sheet and <u>include the units</u>. The result is automatically corrected to the reference temperature of 20°C.

Note: The meter automatically changes the units from μS/cm to mS/cm above 1999 μS/cm

CALCULATIONS

To convert from mS/cm to μS/cm multiply the result by 1000.

TDS, mg/L (ppm) = Conductivity (μS/cm) * 0.63

PRECAUTIONS, TROUBLESHOOTING, & REMEDIAL ACTIONS

- Make sure the cell is properly rinsed between measurements
- Check to make sure there are no bubbles in cell – be sure to swirl probe in the solution.
- Ensure that the conductivity standard solution is not expired.
- If DI water does not clean the cell, try cleaning the cell as follows: Wash with warm water and laboratory soap and rinse with copious amounts of DI water before use. Alternatively 3% 3 HCl acid solution may be used. Solvents such as acetone or ethanol should only be used as a last resort and then the cell should not be immersed for longer than 5 minutes. Always completely rinse with DI water. Re-calibrated after these cleanings.

REAGENTS

Conductivity Standards – 1000 μS/cm, (HACH 14400-42)
Distilled water

REFERENCES

Standard Methods for the Examination of Water and Wastewater, APHA et al, 20th Edition, 1998, Method 2510.
Water Analysis Handbook, HACH Company, 4th Edition, 2003, Method 8160

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System
Title: Turbidity Analysis
Number: IM3-SOP-L05
Revision Date: 9/8/2005

PROCEDURE

1. Once, at the beginning of each shift, each operator should follow the steps in **Figure 1** to check the calibration using the Gelex Standard (0-100 NTU) instead of a sample. The result must be within +/- 10% of the true value, based off the last Calibration (as shown below). If not, the meter must be re-calibrated. (Consult instrument manual for recalibration procedure using Formazin).

Example:

	True Value	Lower Limit (-10%)	Upper Limit (+10%)
Gelex 0 – 100 NTU	45 NTU	40.5 NTU	49.5 NTU

Note: the true value for the Gelex standards must be determined each time the meter is calibrated using the Formazin standards.

2. Follow the steps in **Figure 1** below for each of the samples. Record the turbidity result on the bench sheet.

CALCULATIONS

The result is reported directly in NTU.

PRECAUTIONS, TROUBLESHOOTING, & REMEDIAL ACTIONS

- Always orient the cell the same way – diamond lining up with mark on instrument.
- Cap the sample cell to prevent spillage of sample into the instrument.
- When taking a reading, place the instrument on a level, stationary surface. It should not be held in the hand during measurement.
- Always close the sample compartment lid during measurement and storage.
- Always use clean sample cells in good condition. Properly clean cells between measurements
- Dirty, scratched, or damaged cells can cause inaccurate readings. Handle cells only by the top to minimize dirt, scratches and fingerprints in the light path.
- Avoid excess coating of oil. Oil is not needed if the sample cells are properly maintained. (Do not use a brush on the sample cell, always use chemwipes or equivalent optical wipes to dry the cells)
- Do not leave a sample cell in the cell compartment for extended periods of time. This may compress the spring in the cell holder.

- Remove sample cell and batteries from instrument if the instrument is stored for extended time period (more than a month).
- Make certain hot samples do not evaporate and condense in the sample cell.
- Avoid settling of sample prior to measurement. Allow samples to degas but do not allow settling of solids.
- Keep sample compartment lid closed to prevent dust and dirt from entering.
- If 9.99 or 99.9 are flashing on display press ‘Range’ button to change range of meter.

QUALITY CONTROL

Activities that will help ensure the accuracy and precision of this method include:

- **Using Optically matched (or single) cells for Low Level Turbidity** - Precise measurements of low turbidity (< 2 NTU) samples require using a single cell for all measurements or using optically matched cells – *see HACH instruction manual Section 2.3.3 Pages 22-25*.
- **Use Dedicated Cells –** the use of cells dedicated to Turbidity measurement is recommended
- **Removing Trapped Gases** - *see HACH instruction manual Section 2.3.3 Pages 22-25.* This would only be a problem for samples that exhibit foaming or where gas bubbles are observed.
- **Avoid Sample Dilution where possible–** Sample dilution may alter characteristics of the suspended particles and should be avoided if possible. If dilution is performed use only reagent water.
- **Calibration Checks using the Gelex standards –** Once per rotation, measure the 0 to 100 NTU Gelex standard.
- **Recalibration Using Formazin standards –** Once every two months, or sooner if the Gelex Calibration check standards indicate a problem, recalibrate using the Formazin standards - *see HACH instruction manual Section 3.6,* pages *35-54*.

APPARATUS

- Model 2100P Portable Turbidimeter
- Sample cells with caps.
- Carrying Case
- Four AA alkaline batteries

REAGENTS

- Formazin Primary Standards - HACH Part # 26594-05, StableCal Standards, <0.1, 20, 100, 800 NTU, ampoules
- Gelex™ Secondary Standards - HACH Part # 24641-05
- Reagent water – ASTM Type I water produced by de-ionization.
- Silicone Oil - HACH Part # 1269-36

QUALITY CONTROL CRITERIA

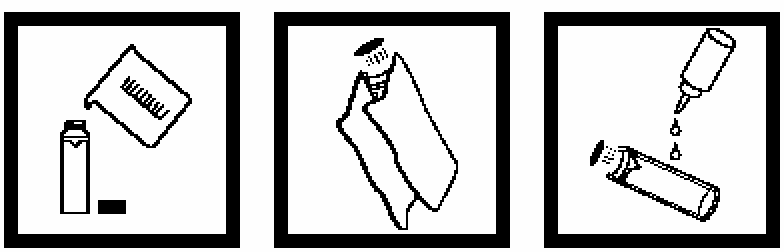
QAQC Sample	Frequency	Criteria
Gelex 0 – 100 NTU Standard Checks	Each operator checks each shift before samples are analyzed.	90%-110% of expected concentration
Primary Standard re-calibration	As needed or at least every two months	90% - 110% recovery for check of new standard

REFERENCES

Standard Methods for the Examination of Water and Wastewater, APHA et al, 20th Edition, 1998, Method 2130 B.

HACH Model 2100P, Instrument and Procedure Manual, CAT. NO. 46500-88, 2004

Figure 1
Making a Turbidity Measurement



1. Collect a representative sample in a clean container. Fill a sample cell to the line (about 15 mL), taking care to handle the sample cell by the top. Cap the cell. (See *Section 2.3* on page 22 for more information about collecting a representative sample).

Note: The instrument automatically shuts off after 5.5 minutes if no keystrokes occur. To resume operation, press I/O.

2. Wipe the cell with a soft, lint-free cloth to remove water spots and fingerprints.

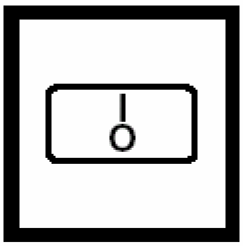
3. Apply a thin film of silicone oil. Wipe with a soft cloth to obtain an even film over the entire surface.

Analyze one sample in duplicate each shift. Results for duplicate analyses should be within 20% of each other.

Using silicone oil is optional – Call project chemist before using oil.

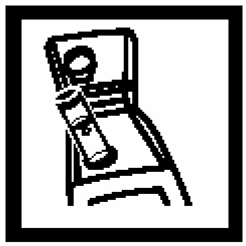
Figure 1 continued

Making a Turbidity Measurement

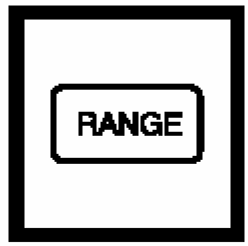


4. Press: I/O.

The instrument will turn on. Place the instrument on a flat, sturdy surface. Do not hold the instrument while making measurements.

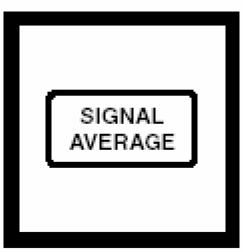


5. Insert the sample cell in the instrument cell compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment. **Close the lid.**

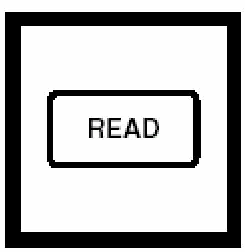


6. Select manual or automatic range selection by pressing the RANGE key. The display will show **AUTO RNG** when the instrument is in automatic range selection.

Use the automatic range mode (**AUTO RNG)** for routine measurements.



7. Select signal averaging mode by pressing the SIGNAL AVERAGE key. The display will show **SIG AVG** when the instrument is using signal averaging. Use signal average mode if the sample causes a noisy signal (display changes constantly).



8. Press: READ

The display will show **- - - - NTU**, then the turbidity in NTU. Record the turbidity after the lamp symbol turns off.

Note: The instrument defaults to the last operating mode selected. If automatic range mode and signal averaging were used on the previous measurements, these options will automatically be selected for subsequent samples.

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: Percent Solids for Clarifier Underflow
Number: IM3-SOP-L06
Revision Date: 9/8/2005

1. Obtain a clean, dry 200 ml beaker.
2. Prepare a 6" x 6" square of aluminum foil. Weigh foil and record weight on foil square.
3. Open sampling valve at Clarifier underflow pipe. Allow sample tap to flow for 3 to 5 seconds to flush out line. Drain sample tap hose into a 5-gallon pail. Capture about 150 ml of underflow sludge. Close sample tap.
4. In lab, tare a 1,000 ml beaker. Pour about 10 grams or mL of the underflow sludge sample into the tared beaker. Read directly the starting mass (M) of the underflow sludge sample (M_{sludge}). Record the mass of the sludge on the foil square.
5. Add about 5 drops of 0.2% strength polymer to a second beaker (No need to tare the other beaker). Add about 70 ml of potable tap water or RO permeate to second beaker. Pour that beaker (tap water or RO permeate with polymer) into the beaker holding the underflow sludge sample. Pour from one beaker to the another 3 or 4 times. The solids should floc.
6. Allow solids to settle and decant most of the water (typically down to 200 ml level, i.e., decant off about 75% of the water volume).
7. Prepare Pall™ vacuum filter assembly. Use a 0.45 micron Pall™ filter paper.
8. Add remainder of decanted and flocculated jar to the Pall™ vacuum filter assembly.
9. Apply vacuum and continue until all free water is removed.
10. Transfer dewatered sludge sample from the Pall™ vacuum filter assembly to the foil square.

    Note: Alternatively, the solids sample can be not fully dewatered (i.e., leave the sample as a thickened sludge, not hard and stiff) and then spread the sample across the foil. This may be dried more quickly than the other method.
11. Dry sample on foil square. Turn "on" toaster oven to 350F. Place sample on foil square and bake for 3.0 hours.
12. After the sample is dried (3 hours), weigh dried sample on foil square.
13. Subtract weight of foil (before adding sludge) and obtain the mass (M) of dried solids (M_{solids}).

    M_{solids} = Weight solids on foil (g) – foil weight (g)
14. Calculate the % Solids of the original sample as follows:

    % Solids (%) = [M_{solids} (g)/M_{sludge}(g)] * 100%

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: Total Suspended Solids (TSS) Analysis for Tank 301C Effluent
Number: IM3-SOP-L07
Revision Date: 9/8/2005

1. Obtain a clean, dry 1,000 ml beaker

2. Open sampling valve (i.e., for T301C sample at Pump P-400 [Pump from Tank 301C]). Allow sample tap to flow for 3 to 5 seconds to flush out line. Drain sample tap hose into a 5-gallon pail. Capture just over 100 mL (milliliter) in beaker. Pour back excess into 5-gallon pail such that the beaker contains 100 mL (milliliter). Close sample tap.

3. In lab, add 3 drops of 0.2% strength polymer (i.e., 4 gram polymer in 2 liter of water). Pour beaker from one to another 3 or 4 times. The solids should floc.

4. Allow solids to settle and decant most of the water (typically down to 100 ml level, i.e., ,decant off about 90% of the water volume).

5. Prepare Pall™ vacuum filter assembly. Use a 0.45 micron Pall™ filter paper.

6. Add remainder of decanted and flocculated jar to the Pall™ vacuum filter assembly.

7. Apply vacuum and continue until all free water is removed.

8. Prepare a 6″ x 6″ square of aluminum foil. Weigh foil and record foil weight onto foil.

9. Transfer dewatered sludge sample from the Pall™ vacuum filter assembly to the preweighed foil square.

   Note: Alternatively, the solids sample can be not fully dewater (i.e., leave the sample as a thickened sludge, not hard and stiff) and then spread the sample across the foil. This may be dried more quickly than the other method.

10. Dry sample on foil square. Turn "on" toaster oven to 350F. Place sample on foil square and bake for 2.0 hours.

11. After the sample is dried (2 hours), weigh dried sample on foil square.

12. Subtract weight of foil and obtain the mass (M) of dried solids (M_{solids}).

    M_{solids} = Weight solids on foil (g) – foil weight (g)

13. Calculate the TSS of the original sample as follows:

    TSS (mg/l) = [M_{solids} (g) * 1000 (mg/g)]/ 0.1 liter {since 100 mL is 0.1 L}

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: Matrix Spike Preparation
Number: IM3-SOP-L08
Revision Date: 9/8/2005

Prepare a Spiking Solution for Reagent Spikes (CCV) and Sample Matrix Spikes (MS)

Hexavalent Chromium

- Add ~50 mls of -- DI water to a 100ml volumetric flask.
- Add 5 mls of a 50 mg/L hexavalent chromium standard using a 1 ml pipette.
- Bring the volume of the flask to 100 mls using DI water.
- Cap, and mix thoroughly.

The resultant concentration of the standard is 2.5 mg/L. This standard solution can be used to prepare a matrix spike and/or a calibration verification standard as outlined in the IM3 Treatment Chemistry Working SOP.

- Take 24 mls of -- DI water (reagent spike-CCV) or sample (sample matrix spike-MS) and place in a sample cell.
- Add 1 ml of the 2.5 mg/L hexavalent chromium standard.
- Mix by inverting the sample cell 4-5 times or by swirling vigorously until completely mixed. The concentration of hexavalent chromium in the cell is 0.1 mg/L.

Total Chromium

- Add ~50 mls of -- DI water to a 100ml volumetric flask.
- Add 5 mls of a 50 mg/L total chromium standard using a 1 ml pipette.
- Bring the volume of the flask to 100 mls using DI water.
- Cap, and mix thoroughly.

The resultant concentration of the standard is 2.5 mg/L. This standard solution can be used to prepare a matrix spike and/or a calibration verification standard as outlined in the IM3 Treatment Chemistry Working SOP.

- Take 24 mls of -- DI water (reagent spike-CCV) or sample (sample matrix spike-MS) and place in a sample cell.
- Add 1 ml of the 2.5 mg/L total chromium standard.
- Mix by inverting the sample cell 4-5 times or by swirling vigorously until completely mixed. The concentration of total chromium in the cell is 0.1 mg/L.

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: pH Measurement
Number: IM3-SOP-L09
Revision Date: 10/11/2005

PROCEDURE

Calibration

The pH meter must be calibrated at the beginning of each shift by the operator and anytime the pH does not make sense.

1. Pour fresh portions (~ 50-mL) of the pH 4, 7 and 10 buffers into the calibration beakers (buffers should be replaced at least 2/week). Rinse each calibration beaker 3 times with small portions of buffer before filling the beaker with the portion to be analyzed.
2. Turn the pH meter on.
3. Make sure the meter is in pH mode.
4. Rinse the electrode with de-ionized (DI) water.
5. Depress the pumping mechanism at the upper end of the probe- once, dispensing 6 uL of Potassium Chloride Electrolyte Reference Gel.
6. Follow the calibration procedures on page 3 in the HACH **Quick Reference Guide** sens**ion156** and sens**ion378** Multi-parameter Meters (54650-23).
7. If the pH probe does not recognize the pH 4 buffer within 2 – 3 minutes, re-rinse the electrode and dry with a chemwipe.
8. With the tip of probe raised to allow viewing, depress the pumping mechanism several times until the Potassium Chloride Electrolyte Reference Gel can be seen emerging from the light colored tube next to the glass bulb.
9. Rinse the electrode with de-ionized (DI) water and re-start the calibration.
10. After calibrating with the pH 4, 7 and 10 buffers, record the Slope value on the calibration sheet and press enter to accept and return to the reading mode.

PRECAUTIONS AND TROUBLESHOOTING

Make sure the electrode is rinsed well between samples.

Store the pH electrode in the pH=4 or 7 buffer solution when it's not in use. Replace the storage solution every week.

Make sure the buffer solutions are not expired. Replace the working buffer solution at least twice a week or if re-calibrating the meter is required.

Be careful not to hit the electrode end against the sides of the beaker.

If the meter does not stabilize during a pH measurement a new calibration may be needed.

QUALITY CONTROL

Make sure the buffers and samples are a constant temperature before beginning analysis.

WDR sample collection SOP

IM3 Sampling Procedure

1. Look at the Sampling Calendar and the list (1 or 2 & 3) associated with the Date.
2. Collect all associated paperwork. COC, Labels, Sampling Log Sheet, list of bottles needed.
3. Gather sample containers needed and put labels on them.
4. Record a time and Date for the sample to be collected (first collect SC-700B-WDR-) on the sample labels, the COC, and the Sampling Log Sheet.
5. Take: All the containers for the sampling location, gloves, and a waste bucket to the first sampling location.
6. Put gloves on.
7. Open the sampling port, and allow enough water to flow to flush the 'off main pipe' piping. Allow the flow to continue uninterrupted/undisturbed during the sample collection.
8. Remove the cap of the Cr(VI) container, rinse the container with sample and collect the sample. Continue one container at a time, start with the Cr(VI) container, then the Cr(T) then 'General chemistry' containers.
9. After all the containers for that sampling location are filled, return to lab, Add 2mLs of HNO_3 to the Total Metals containers, put samples in an Ice chest.
10. Fill in the rest of the information (color, odor, solids, and notes) on the Sampling Log Sheet for the sample just collected.
11. Gather the next sampling site's containers and repeat #4 - #9 for each sample site.
12. Add 2 bags of Ice
13. Sign and Date COC
14. **Make two copies** (one for the courier, one for IM3 records)**, and Fax a copy to Shawn Duffy @ 1-530-339-3303**
15. Place signed COC in a Ziploc bag, place in the ice chest with the samples, sign custody seals and place on ice chest in at least two places (to prevent unauthorized opening of the cooler from going unnoticed).

List 3

Location	# of containers	Container	Preservative	Analytes
SC-Sludge	2	100 mL Soil Jar	4°C	F
	2	100 mL Soil Jar	4°C	Title 22 Metals, Cr(VI)
	2	100 mL Soil Jar	4°C	Bioassay

List 1

Location	# of containers	Container *	Preservative	Analytes
SC-700B	1	1 Liter poly	4°C	TDS
	1	1 Liter poly	4°C	COND, pH, Turb
	1	250 mL poly	4°C	Cr(VI)
	1	250 mL poly	HNO3, 4°C	Cr(T)

* Each line item of the container list is a separate container

List 2

Location	# of containers	Container *	Preservative	Analytes
SC-700B	1	1 Liter poly	4°C	TDS
	1	1 Liter poly	4°C	COND, pH, Turb, Anions
	1	500 mL poly	4°C	Cr(VI)
	1	500 mL poly	4°C	Ammonia (NH3)
	1	500 mL poly	HNO3, 4°C	Cr, Al, Ba, B, Cu, Pb, Mn, Mo, Ni, Fe, Zn- (Totals)
SC-100B	1	1 Liter poly	4°C	TDS
	1	1 Liter poly	4°C	COND, pH, Turb, Anions
	1	500 mL poly	4°C	Cr(VI)
	1	500 mL poly	4°C	Ammonia (NH3)
	1	500 mL poly	HNO3, 4°C	Cr, Al, Ba, B, Cu, Pb, Mn, Mo, Ni, Fe, Zn- (Totals)
SC-701	1	1 Liter poly	4°C	TDS
	1	1 Liter poly	4°C	COND, pH, Anions
	1	500 mL poly	4°C	Cr(VI)
	1	500 mL poly	4°C	Ammonia (NH3)
	1	500 mL poly	HNO3, 4°C	Title 22 Metals (Totals)

* Each line item of the container list is a separate container

COC and Sampling Log – Check Sheet

COC

1. Are the **Sample IDs** complete? Are IDs unique? Has there been a sample with the same ID before? Use event number, date, and/or time as the prefix on the end of the sample ID. (WDR Sludge sample should match the event number of the WDR event sampled that day/week – i.e. SC-Sludge-WDR-033 or SC-MFCIP-02-12-1635)
2. Have you filled in the **Date and Time** information? **This is very important!!** COCs are legal documents.
3. If you know the **analysis required**, are they listed on the COC? Have you indicated which samples get specific analysis?
4. Is the **event** clearly defined on the COC? Located at the top center of COC. (i.e. Sludge Sample-005 or IM3Plant-WDR-032 or IM3Plant-015)
5. Is the turnaround time (**TAT**) listed in the upper right hand corner? Is it correct? If your not sure ask someone (Shawn Duffy, Kevin Mullin, or Dennis Fink)
6. Have you **<u>Signed</u>** the relinquished line at the bottom of the COC? **This is very important!!** COCs are legal documents.

Sampling Log

1. Have you filled in the event name (i.e. IM3Plant-WDR-032), Date (i.e. 02-08-06 or 2/8/2006….), and Weather Conditions (i.e. Hot, light wind from the south)?
2. Have you filled in the **Sampler Name**, **Time** of sampling, and sample notes (i.e. clear, smells like bubble gum, trace amount of fine particles)?
3. Make sure you record the flow-rate from the pumps for the correct wells (i.e. TW-3D - 97.7 gal/min, Depth to water is 45 ft. PE-01 - 39.2 gal/min, Depth to water is 22 ft.

Note:

Sampling logs should be completed for <u>all sample</u>s from SC-100B, SC-700B, SC-701, PE-01, and TW-3D

After you have signed the COC Fax a copy of both sheets to Shawn Duffy @ 530-339-3303

Oct 25 05 03:40p CH2MHILL 7603263329 p.2

TRUESDAIL LABORATORIES, INC.
14201 Franklin Avenue, Tustin, CA 92780-7008
(714)730-6239 FAX: (714) 730-6462
www.truesdail.com

CHAIN OF CUSTODY RECORD

[IM3Plant-WDR-018]

COC Number

TURNAROUND TIME 5 Days

DATE 10-25-05 PAGE 1 OF 1

COMPANY: CH2M HILL

PROJECT NAME: PG&E Topock

PHONE: (510) 251-2888 FAX: (510) 622-7086

ADDRESS: 155 Grand Ave Ste 1000, Oakland, CA 94612

P.O. NUMBER: 334168.IM.04.00

SAMPLERS (SIGNATURE: Joseph Ledbetter

SAMPLE I.D.	DATE	TIME	DESCRIPTION	CR6 (7199) Lab Filtered	Total Met (6010B) Total Chromium	Specific Conductance (120.1)	pH (150.1)	TDS (160.1)	Turbidity (180.1)								NUMBER OF CONTAINERS	COMMENTS
SC-100B-WDR-018	10-25-05	1305	Groundwater	x	x	x	x	x	x								3	
SC-700B-WDR-018	10-25-05	1320	Groundwater	x	x	x	x	x	x								3	
SC-701-WDR-018	10-25-05	1315	Groundwater	x	x	x	x	x									3	
																	9	TOTAL NUMBER OF CONTAINERS

Example

CHAIN OF CUSTODY SIGNATURE RECORD

Signature	Printed Name	Company/Agency	Date/Time
Signature (Relinquished) Joseph Ledbetter	Printed Name Joseph Ledbetter	Company/Agency OMI Inc	Date/Time 10-25-05 1530
Signature (Received) Sparrow 8779	Printed Name SPARROW 8779	Company/Agency EXECUTIVE COURIER	Date/Time 10-23-05 1530
Signature (Relinquished)	Printed Name	Company/Agency	Date/Time
Signature (Received)	Printed Name	Company/Agency	Date/Time
Signature (Relinquished)	Printed Name	Company/Agency	Date/Time
Signature (Received)	Printed Name	Company/Agency	Date/Time

SAMPLE CONDITIONS

RECEIVED COOL ☐ WARM ☐ ____ °F

CUSTODY SEALED YES ☐ NO ☐

SPECIAL REQUIREMENTS:

Sampling Log Sheet

Project Name: PG&E Topock IM3Plant-WDR
Job Number: 334168.IM.04.00
Weather Conditions: 82° F Clear

Sampling Event: IM3Plant-WDR- 018
Date: 10-25-05

Sampling Location SC-100B

Sampler Name	Joseph Ledbetter	Notes:
Sampling Time	1305	
Color	Yellow	
Odor	None	
Solids	None	

SC-700B

Sampler Name	Joseph Ledbetter	Notes:
Sampling Time	1320	
Color	Clear	
Odor	None	
Solids	None	

SC-701

Sampler Name	Joseph Ledbetter	Notes:
Sampling Time	1315	
Color	Clear	
Odor	None	
Solids	None	

	Flow from Wells	Depth to Water
TW-2D	97.48	
TW-2S	0	
Other	0	
Total Flow	97.48	

Color: clear, gray, yellow, brown, black, green

Odor: none, sulphur, organic, other

Solids: fine particles, silt, flacks, sand
Amount of solids (trace, small quantities, 1/4 of the volume, etc.)

Example

Severn Trent Laboratories
1721 Grand Ave, Santa Ana, CA 92705
(714)258-8610

CHAIN OF CUSTODY RECORD
[Sludge Sample-7]

COC Number
TURNAROUND TIME 5 Days
DATE 10/25/05 PAGE 1 OF 1

COMPANY: CH2M HILL
PROJECT NAME: PG&E Topock GWM
PHONE: (510) 251-2888 FAX: (510) 622-7086
ADDRESS: 155 Grand Ave Ste 1000
Oakland, CA 94612
P.O. NUMBER: 334168.IM.04.00 TEAM: 1
SAMPLERS (SIGNATURE:

SAMPLE I.D.	DATE	TIME	DESCRIPTION	CR6 (7199) Lab Filtered	Total Met (6010B) Title 22	Metals (7470A)											NUMBER OF CONTAINERS	COMMENTS
SC-Sludge-WDR-018	10-25-05	1330	Soil	X	X	X											2	
																	2	TOTAL NUMBER OF CONTAINERS

Example

CHAIN OF CUSTODY SIGNATURE RECORD

Signature (Relinquished) Shawn P. Duffy	Printed Name Shawn Duffy	Company/ Agency CH2M Hill	Date/ Time 10-25-05 1530
Signature (Received)	Printed Name	Company/ Agency	Date/ Time
Signature (Relinquished)	Printed Name	Company/ Agency	Date/ Time
Signature (Received)	Printed Name	Company/ Agency	Date/ Time
Signature (Relinquished)	Printed Name	Company/ Agency	Date/ Time
Signature (Received)	Printed Name	Company/ Agency	Date/ Time

SAMPLE CONDITIONS

RECEIVED COOL ☐ WARM ☐ °F

CUSTODY SEALED YES ☐ NO ☐

SPECIAL REQUIREMENTS:

Project Name PG&E Topock IM3Plant-WDR
Job Number 334168.IM.04.00
Weather Conditions ______

Sampling Event IM3Plant-WDR- ______
Date ______

Sampling Location **SC-100B**

Sampler Name	______	Notes: ______
Sampling Time	______	______
Color	______	______
Odor	______	______
Solids	______	______

SC-700B

Sampler Name	______	Notes: ______
Sampling Time	______	______
Color	______	______
Odor	______	______
Solids	______	______

SC-701

Sampler Name	______	Notes: ______
Sampling Time	______	______
Color	______	______
Odor	______	______
Solids	______	______

	Flow from Wells	Depth to Water
TW-3D		
PE-1		
Other		
Total Flow		

Color: clear, gray, yellow, brown, black, green

Odor: none, sulphur, organic, other

Solids: fine particles, silt, flacks, sand
Amount of solids (trace, small quantities, 1/4 of the volume, etc.)

Interim Measures No. 3 Treatment and Extraction

Standard Operating Procedures

Topock Compressor Station Needles, California

Prepared for

Pacific Gas and Electric Company

October 2005

CH2MHILL

Contents

The following Standard Operating Procedures (SOPs) are contained herein:

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: System "Hot" Startup
Number: IM3-SOP-001
Revision Date: 10/27/2005

Scope

The objective of this SOP is to describe the procedure for starting up the groundwater extraction and treatment system after a power outage or short term shut down.

Precautions/Hazards

Operators should have system training and operating experience before attempting a system startup. Operators will not attempt to start up the system without making the field checks specified in the procedure.

One operator will remain at the HMI (see underlined instructions) and communicate by radio to an operator in the plant (see instructions in normal type).

Equipment List

Not applicable.

Procedure

The plant startup sequence will be as follows:

1. After loss of power place all MCC H-O-A switches in "OFF" and place all MCC breakers in "OFF", except "Power Distribution Panel #1"and "Extraction Well PE-2". Leave both of them in the "ON" position. Shut Off 120 Volt Panel at PP1 inside MCC Room.
2. Once power has been restored, press the black reset buttons on all the MCC panels that have one. Energize all MCC breakers except the ones labeled "Spare", and place the H-O-A switches in "AUTO". Turn on 120 Volt Panel at PP1 inside MCC Room. Extraction well PE-2 remains in the "HAND" position.
3. Go to the air compressor and cycle the on-off switch located on the right side of the white compressor enclosure. This will start the air compressor and start building air pressure.
4. Turn the Air Dryer on at the air compressor.
5. Cycle Polymer Skid P-804 switch off then on at the outside panel.
6. Go to the P-601 (A & B) control panel and place the 601 (A or B) H-O-A switch in "ON".
7. Go to the R.O. control panel and turn the H-O-A switch to "ON". Press the "System Reset" button. Then turn the H-O-A switch to "AUTO".

8. Go back to the P-601 (A & B) control panel and turn the 601 (A or B) H-O-A back to "AUTO".
9. Open the blower bypass valve (V-BA-101-01) to allow the blower to start without surging.
10. On the blower control panel place the H-O-A switch in "OFF", press the blue "R" button, and the alarm reset button. Place the H-O-A switch in "AUTO".
11. <u>If T-100 level is less than 9.0 feet, go to Step 12. If T-100 level is greater than 9.0 feet, go to step 15.</u>
12. Ensure that the air compressor has reached a system pressure of at least 90 PSI.
13. <u>Give FV-100 the permissive to open on the HMI Raw Water Tank Screen.</u>
14. <u>Start extraction well TW-2D (and TW-2S if plant flow is supposed to be >90 gpm).</u>
15. <u>On the HMI Iron Oxidation Reactor Screen, give the blower B-300 the permissive to start. Verify that the blower has started. Slowly shut the blower bypass valve, taking care not to surge the blower.</u>
16. <u>Start tank mixers M-300 and M-301C on the HMI. (Mixers M-301A and 301B are currently locked out).</u>
17. <u>Start Clarifier Mixers M-400A, M-400B, and M-400C.</u>
18. Verify that the seal water pump shows 50-60 psi.
19. Open AIT-400 bypass line to prevent floc from getting into the meter during startup.
20. <u>Open FV-201 on the HMI Chromium Reduction Reactor Screen.</u>
21. <u>Set FCV-200 in manual at 50% open on the HMI Raw Water Tank Screen.</u>
22. <u>Start P-400 on the HMI.</u> The VFD may need to be re-set (There is a brown reset button in the lower left hand corner of the Softronics VFD control panel).
23. <u>Start P-201.</u>
24. <u>Start P-200.</u>
25. Cycle the chemical pump ON-OFF switches on P-800 (ferrous pump) and P-802A/B (first two caustic pumps). Push prime button on each pump to start the prime process (after one minute reset the pump back to the ON position).
26. <u>Turn P-800 off and then back "ON" using the HMI (so that the pump symbol shows green). Turn P-802A off and then back "ON" using the HMI (so that the pump symbol shows green). Leave P-802B in "Off" position.</u>
27. <u>Start P-404 (Sludge Recycle Pump).</u>
28. <u>Start P-401 (Sludge Waste Pump) if sludge blanket in Clarifier is above Tap #2.</u>
29. <u>After 5 minutes, put FCV-200 back in auto.</u>

30. Start P-500.
31. Enable M-500 (the Microfilter unit).
32. Touch the MF control panel, acknowledge and reset any alarms.
    - Touch the "Main" button and select "Auto Filter" then press "Confirm".
    - Press "AP Skid", select "Rack Control", select "Auto", press "Auto Filter" then "Confirm".
    - Press the "AP Skid" button.
33. Start P-620 on the HMI Reverse Osmosis Screen #1.
34. Enable M-600 (the Reverse Osmosis unit).
35. Enable P-701 on the HMI Reverse Osmosis Screen #2.
36. Verify that P-605 (A or B) is operating.
37. Collect samples from SC-201, SC--501 and SC-702B. Perform a chrome 6 test on all three and a total chrome test on SC--501 and SC-702B.
38. Once the chrome 6 and total chrome tests have been completed and they show that the water is within permit limits, verify that FV-1202 is in auto and enabled. Enter Results into Lab Book (Restart Testing Results).
39. Shut the butterfly valve that is just upstream of FIT-702.
40. Start P-700 on the HMI Treated Water Tank Screen.
41. Gradually open the butterfly valve that is just upstream of FIT-702. This will help prevent water hammer in the injection well piping. Most of the flow control occurs in the first 25% of the valve being open.
42. Re-set AIT-400 back to normal operations by closing drain valve and opening supply valve to the meter.
43. Verify that the demister wash water solenoid valve (SV-302) is enabled on the HMI Iron Oxidation Reactor Screen.
44. At the HMI, re-check each screen for alarms and check tank levels and flow rates.

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: System "Cold" Startup
Number: IM3-SOP-002
Revision Date: 10/27/2005

Scope

The objective of this SOP is to describe the procedure for starting up the groundwater extraction and treatment system from a full shutdown condition (i.e., shut down for greater than one day for preventative maintenance).

Precautions/Hazards

Operators should have system training and operating experience before attempting a system startup. Operators must not attempt to start up the system without making the field checks specified in the procedure.

One operator will remain at the HMI (see underlined instructions) and communicate by radio to an operator in the plant (see instructions in normal type).

Equipment List

Not applicable.

Procedure

The plant startup sequence shall be as follows:

1. After loss of power place all MCC H-O-A switches in "OFF" and place all MCC breakers in "OFF", except "Power Distribution Panel #1"and "Extraction Well PE-2". Leave both of them in the "ON" position. Shut Off 120 Volt Panel at PP1 inside MCC Room.
2. Once power has been restored, press the black reset buttons on all the MCC panels that have one. Energize all MCC breakers except the ones labeled "Spare", and place the H-O-A switches in "AUTO". Turn on 120 Volt Panel at PP1 inside MCC Room. Extraction well PE-2 remains in the "HAND" position.
3. The system shall be started up in recycle mode. Manually close valve V-TW-103-03 and V-TW-101-01, and manually open valve V-TW-104-01 to recycle water from the Reverse Osmosis Feed Tank (T-600) to the Raw Water Storage Tank (T-100).
4. Go to the air compressor and cycle the on-off switch located on the right side of the white compressor enclosure. This will start the air compressor and start building air pressure.
5. Turn the Air Dryer on at the air compressor.
6. Cycle Polymer Skid P-804 switch off then on at the outside panel.
7. Go to the P-601 (A & B) control panel and place the 601 (A or B) H-O-A switch in "ON".

8. Go to the R.O. control panel and turn the H-O-A switch to “ON”. Press the “System Reset” button. Then turn the H-O-A switch to “AUTO”.
9. Go back to the P-601 (A & B) control panel and turn the 601 (A or B) H-O-A back to “AUTO”.
10. Open the blower bypass valve (V-BA-101-01) to allow the blower to start without surging. Confirm air flow at FIT-300A, FIT-300B, and FIT-300C.
11. On the blower control panel place the H-O-A switch in “ON”, press the blue “R” button, and the alarm reset button. Place the H-O-A switch in “AUTO”.
12. Ensure that the air compressor has reached a system pressure of at least 90 PSI.
13. Give FV-100 the permissive to open on the HMI Raw Water Tank Screen.
14. Start extraction well TW-2D (and TW-2S if plant flow is supposed to be >90 gpm).
15. On the HMI Iron Oxidation Reactor Screen, give the blower B-300 the permissive to start. Verify that the blower has started. Slowly shut the blower bypass valve, taking care not to surge the blower.
16. Confirm water levels in T-300, T-301A/B/C, and Clarifier are at operating values (sufficient for mixer operation).
17. Confirm that the Raw Water Storage Tank level is sufficient for startup (minimum 2.5 feet).
18. Start tank mixers M-300 and M-301C on the HMI. (Mixers M-301A and 301B are currently locked out).
19. Start Clarifier Mixers M-400A, M-400B, and M-400C.
20. Verify that the seal water pump shows 50-60 psi.
21. Open AIT-400 bypass line to prevent floc from getting into the meter during startup.
22. Open FV-201 on the HMI Chromium Reduction Reactor Screen.
23. Set FCV-200 in manual at 50% open on the HMI Raw Water Tank Screen.
24. Start P-400 on the HMI. The VFD may need to be re-set (There is a brown reset button in the lower left hand corner of the Softronics VFD control panel).
25. Start P-201.
26. Start P-200.
27. Cycle the chemical pump ON-OFF switches on P-800 (ferrous pump) and P-802A/B (first two caustic pumps). Push prime button on each pump to start the prime process (after one minute reset the pump back to the ON position).
28. Turn P-800 off and then back “ON” using the HMI (so that the pump symbol shows green). Turn P-802A off and then back “ON” using the HMI (so that the pump symbol shows green). Leave P-802B in “Off” position.

29. After 5 minutes, put FCV-200 in AUTO and enter flow setpoint.

30. Verify that Low Deviation (pH) between AIT-201 and AIT-202 clears before proceeding.

31. Energize pH control loops in Pipe Reactor, Chromium Reduction Reactor, and Iron Oxidation Reactors and review pH probe pair readouts for consistency (AIT-202-1/2, AIT-300-1/2, AIT-301A-1/2, AIT-301B-1/2, and AIT-301C-1/2) by verifying the Deviation symbol is not lit by each of these readings on HMI.

32. Start P-404 (Sludge Recycle Pump).

33. Start P-401 (Sludge Waste Pump) if sludge blanket in Clarifier is above Tap #2.

34. Verify V-RW-125-01 and V-RW-126-01 are closed and V-RW-123-01 and V-RW-124-02 are open so that P-500 pumps to the microfilter skid.

35. Start P-500.

36. Enable M-500 (the Microfilter unit).

37. Touch the MF control panel, acknowledge and reset any alarms.

    - Touch the "Main" button and select "Auto Filter" then press "Confirm".
    - Press "AP Skid", select "Rack Control", select "Auto", press "Auto Filter" then "Confirm".
    - Press the "AP Skid" button.

38. Start P-620 on the HMI Reverse Osmosis Screen #1.

39. Verify that the seal water pump is ON and observe that seal water is reaching Pumps P-200, P-201, P-400, P-500, and P-620. Bleed air out of seal water line by opening up rotometer valves all the way until air is gone.

40. Operate the system in recycle configuration for 2.5 hours (three Tank T-600 residence times) or until 3 samples from the sample tap on the Pump P-620 recycle line taken at 30 minute intervals indicate a hexavalent chromium value of less than 25 parts per billion. Also test at SC-300 (between pipe reactor and T-300) to verify a ferrous iron concentration in target range (7-12 mg/L). Confirm that microfilter influent turbidity is <100 NTU and effluent is <1 NTU.

41. Manually close valve V-TW-104-01 and open valve V-TW-103-03.

42. Enable M-600 (the Reverse Osmosis unit).

43. Locally energize the Antiscalant Feed Pump (P-607).

44. Enable P-701 on the HMI Reverse Osmosis Screen #2.

45. Verify that P-605 (A or B) is operating.

46. Collect samples from SC-201, SC--501 and SC-702B. Perform a chrome 6 test on all three and a total chrome test on SC--501 and SC-702B.

47. Once the chrome 6 and total chrome tests have been completed and they show that the water is within permit limits, verify that FV-1202 is in auto and enabled. Enter Results into Lab Book (Restart Testing Results).

48. Confirm pH value for AIT-606 is between pH 6.0 to 9.0.

49. Confirm treated water conductivity value (AIT-702) is within 15% of the target (currently 7,300 uS/cm which corresponds to 4,200 mg/L TDS).

50. Shut the butterfly valve that is just upstream of FIT-702.

51. Start P-700 on the HMI Treated Water Tank Screen.

52. Gradually open the butterfly valve that is just upstream of FIT-702. This will help prevent water hammer in the injection well piping. Most of the flow control occurs in the first 25% of the valve being open.

53. Re-set AIT-400 back to normal operations by closing drain valve and opening supply valve to the meter.

54. Verify that the demister wash water solenoid valve (SV-302) is enabled on the HMI Iron Oxidation Reactor Screen.

55. At the HMI, re-check each screen for alarms and check tank levels and flow rates.

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: Emergency Generator Startup
Number: IM3-SOP-003
Revision Date: 10/27/2005

Scope

The objective of this SOP is to describe the procedure for starting up the emergency generator after a power outage or when it appears that lightning strikes may impact electricity supply to the plant.

Precautions/Hazards

Operators should have generator and motor control center (MCC) training and operating experience before attempting to start up the generator. Operators will not attempt to start up the generator without making the field checks specified in the procedure.

Equipment List

Not applicable.

Procedure

NOTE: Implement this procedure when main power from the city of Needles has shutdown.

1. Turn off main power disconnect on outside of building.
2. Emergency generator start-up
   a. Open generator control panel and lock panel doors in 'OPEN' position
   b. Turn circuit breaker #3 to the 'OFF' position
   c. Turn battery switch #1 to the 'ON' position
   d. Turn switch #2 to the 'manual' position. The generator should automatically start.
   e. Allow generator to warm up for 5 minutes
3. Motor Control Center (MCC) #1 shutdown procedure
   a. Turn all hand switches and circuit breakers to the 'OFF' position except for the following:
      - DO NOT turn off Pump P-102 (PE-2)
      - DO NOT turn off Power Distribution Panel #1 (Transformer)
4. Restore Emergency Power to IM-3 facility
   a. Emergency generator: Turn circuit breaker #3 to the 'ON' position after warming up for 5 minutes as noted in Step 2e above.
   b. Open transfer switch panel box. Ratchet the transfer switch inside the box from the green (normal) position to red (emergency) position.

c. Close panel box and generator doors.

5. MCC #1 re-start procedure

Turn all hand switches to the 'AUTO' position and circuit breakers to the 'ON' position except for the following:

- DO NOT turn on any 'spare' circuit breaker.
- DO NOT turn on any circuit breaker that is tagged and locked-out.

6. Begin IM-3 Plant Hot Start Standard Operating Procedure (SOP).

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: Emergency Generator Shutdown and Return to Mains Power
Number: IM3-SOP-004
Revision Date: 10/27/2005

Scope

The objective of this SOP is to describe the procedure for shutting down the emergency generator after mains power has been restored.

Precautions/Hazards

Operators should have generator and motor control center (MCC) training and operating experience before attempting to shut down the generator and restore mains power. Operators will not attempt to start up the generator without making the field checks specified in the procedure.

Equipment List

Not applicable.

Procedure

1. Confirm that mains power is available at the transformer.
2. Motor Control Center (MCC) #1 shutdown procedure

   Turn all hand switches and circuit breakers to the 'OFF' position except for the following:

   - DO NOT turn off Pump P-102 (PE-2)
   - DO NOT turn off Power Distribution Panel #1 (Transformer)

3. Emergency generator shut-down
   a. Open generator control panel and lock panel doors in 'OPEN' position
   b. Turn circuit breaker #3 to the 'OFF' position
   c. Allow generator to wind down for 5 minutes
   d. Turn switch #2 to the 'AUTO/OFF' position. The generator should automatically shutdown.
   e. Wait for complete shutdown and than turn battery switch #1 to the 'OFF' position
   f. Close generator doors.

3. Restore Emergency Power to IM-3 facility
   a. Open transfer switch panel box. Ratchet the transfer switch inside the box from the red (emergency) position to green (normal) position and close panel box.
   b. Close panel box. Turn off main power disconnect on outside of building.

c. Turn on main power disconnect on outside of building.

4. MCC #1 re-start procedure

Turn all hand switches to the 'auto' position and circuit breakers to the 'on' position except for the following:

- DO NOT turn on any 'spare' circuit breaker.
- DO NOT turn on any circuit breaker that is tagged and locked-out.

5. Begin IM-3 Plant Hot Start Standard Operating Procedure (SOP).

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: <u>Bypassing T-301A or T-301B</u>
Number: IM3-SOP-005
Revision Date: 10/27/2005

Scope

The objective of this SOP is to describe the procedure for bypassing one of the first two iron oxidation tanks.

Precautions/Hazards

Operators should verify that Raw Water Tank is low level (<4 ft) before beginning as chance of P-200 shutdown is high. Follow site H&S Plan.

Equipment List

Not applicable.

Procedure

1) Verify that Raw Water Tank is low level (<4 ft) before beginning as chance of P-200 shutdown is high.

2) To isolate T-301A: Open V-RW-119-01 and V-RW-119-02. Close V-RW-116-02 and V-RW-117-01 and V-RW-119-03.

   To isolate T-301B: Open V-RW-119-02 and V-RW-119-03. Close V-RW-117-02 and V-RW-118-01.

3) In order to avoid high level alarm in 301A or 301B, lower the target level in 301C to 10.5 feet at the HMI (need to be logged in as Administrator).

4) If isolating Tank A: Close the manual sludge recirculation valve (V-WS-103-03) to Tank 301A that is Normally Open. Open the manual sludge recirculation valve (V-WS-103-04) to Tank 301B. These valves are accessed from top of tanks.

5) Click the button on the HMI labeled Mode Active to Bypass Mode. This will disable alarms associated with this tank (low air, caustic off).

6) Turn off associated caustic feed pump P-802A for T-301A or P-802B for T-301B. Turn off at HMI and close and tagout the discharge valve at the pump.

7) Close the manual valve on the Demister rinse line for the tank to be bypassed. A ladder will be required to access these valves. The valves are located immediately above the valves on the air lines into the 301 tanks.

8) If needed for work to be done, stop flow into the 301 tank by closing the manual valve on the air line from the blower. Note: this will necessitate adjusting valves on air lines to other two tanks so should only be done if necessary.

9) Retract pH probes and check that it is full of water:

   a) Slowly retract pH probe until clear of isolation valve, but do not remove completely

   b) Close valve, work slowly to ensure probe has cleared

   c) Collect 0.5 to 1 gallon of water from a 301 tank sample tap.

   d) Remove plug on bottom (with wrench) and drain

   e) Remove plug on top (with wrench) and flush out sleeve with water from the 301 tank.

   f) Close bottom plug

   g) Fill sleeve with water

   h) Close top plug

10) To take tank out of bypass:

   a) Reverse the actions above

   b) Flush the bypass line using flush connection points

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: <u>Ferrous Dosage Calculations</u>
Number: IM3-SOP-006
Revision Date: 10/27/2005

Background

The injection of ferrous chloride (ferrous iron [Fe^{2+}]) is the most critical operation at IM3 in order to achieve the reduction and removal of hexavalent chromium (Cr^{6+}). Ferrous iron reacts with hexavalent chromium as shown in the chemical equation below. Hexavalent chromium is converted to trivalent chromium (Cr^{3+}):

$NaCrO_4 + 3FeCl_2 + 8H2O$ -------> $2NaCl + Cr(OH)_3 + 3Fe(OH)_3 + 4HCl$

However, ferrous iron also reacts with oxygen present in the water. Ferrous iron reacts with oxygen as shown in the chemical equation below:

$4FeCl_2 + O2 + 10H_2O$ -------> $4Fe(OH)_3 + 8HCl$

Thus, the presence of both hexavalent chromium and oxygen will exert a "demand" on the ferrous iron and the calculation of the ferrous iron dosage must account for both hexavalent chromium and oxygen. In addition, it is necessary to add a slight excess to be assured that there is adequate ferrous iron to convert all of the hexavalent chromium to trivalent chromium. A slight excess provides a driving force to react "all" of the hexavalent chromium leaving only a slight trace of hexavalent chromium.

NOTE: Depending on the stream temperature and pH, the oxygen may not completely react. Thus, it may not be necessary to account for all of the oxygen in the incoming water. After IM3 develops a sound operating history, the performance records can be used to determine if all of the oxygen is exerting demand on the ferrous iron (i.e., Does all of the O2 react?) and the level of excess ferrous iron needed to achieve the desired hexavalent chromium residual (i.e., less than 2 ppb).

The attached provides further description of the calculation details to estimate the ferrous chloride dosage (ppm) and ferrous chloride solution drawdown (ml/min).

Procedure

The following procedure can be used to calculate and check the ferrous chloride dosage and drawdown.

1. Obtain a clean, dry sample bottle and draw a sample from the Raw Water Tank (T-100).
2. Analyze the sample in the laboratory for hexavalent chromium.
3. If the lab has an oxygen probe, also analyze for oxygen. If oxygen analysis is performed, special sampling procedures are needed:
    a. Crack sample tap such that the discharge rate is not turbulent.
    b. Drain sample into the sample bottle in such a manner as to minimize splashing (i.e., avoid aeration of the sample). For example, it is typical to pour the sample in holding the bottle at a slight angle so that the water gently glances the side without splashing.
    c. Fill the sample bottle completely to the top and cap.
4. Using the chromium and oxygen (if available) concentration values determined by the lab, insert the concentration values and the current pump stroke into the HMI ferrous iron pump algorithm calculator. The calculator will automatically calculate and set the needed pump speed.
5. Hand calculation of the ferrous iron (Fe^{2+}) dosage is also necessary. Using the same chromium and oxygen (if available) concentration values, hand calculate the ferrous iron (Fe^{2+}) dosage. The calculation details and an example calculation are described herein. It is necessary to also apply an "excess factor." A typical range for the "excess factor" is about 1.2 to 2.0. A factor of 1.5 is typical. Use the following formula to calculate the iron dosage:

$$[Fe^{2+}\ (mg/l)]_{\text{Total Stoich. Dose with Excess}} = \text{Excess Factor} * (3.2 * [Cr^{6+}(mg/l)]_{\text{Inlet}} + 7.0 * [O_2\ (mg/l)]_{\text{Inlet}})$$

6. After the ferrous iron (Fe^{2+}) dosage is calculated, the ferrous chloride solution drawdown must be estimated. The calculation details and an example calculation are also described in the attached.

$$FeCl_2 \text{ Drawdown (ml/min)} = 0.020 * [\text{Plant Flow (gpm)}] * [Fe^{2+} \text{ Dose (ppm)}]$$

7. Using the calculated ferrous chloride ($FeCl_2$) drawdown value, check the actual ferrous iron pump (P-800) drawdown. If the drawdown value varies significantly, from the estimated value, check with the operating supervisor. Until otherwise directed, the hand calculated value shall take precedence. Adjust the values as needed in the HMI ferrous iron pump algorithm calculator to match the actual drawdown to the calculated drawdown value.
8. After implementing the new ferrous iron dosage, wait one hour and check the concentration of residual ferrous iron at the exit (effluent) of the chromium reduction

reactor (Tank T-300A). At the time of this writing, it is desired to maintain a ferrous iron (Fe^{2+}) residual at the effluent of T-300A between 7.0 to 12.0 mg/l.

9. If the residual ferrous iron is below the target range, increase the ferrous chloride injection rate. If the residual ferrous iron is above the target range, decrease the ferrous chloride injection rate.

Stoichimetric Dosage to Reduce Cr^{6+}

$NaCrO_4 + 3FeCl_2 + 8H2O$ -------> $2NaCl + Cr(OH)_3 + 3Fe(OH)_3 + 4HCl$

$[Fe^{2+}\,(mg/l)]_{\text{Dose for Cr Reduct}} = ((3 \times [Fe^{2+} \text{mol wt.}]) / [Cr^{6+} \text{mol wt}]) * [Cr^{6+}(mg/l)]_{\text{Inlet}}$

$[Fe^{2+}\,(mg/l)]_{\text{Dose for Cr Reduct}} = ((3 \times [55.8\ g/mol]) / [52\ g/mol]) * [Cr^{6+}(mg/l)]_{\text{Inlet}}$

$[Fe^{2+}\,(mg/l)]_{\text{Dose for Cr Reduct}} = 3.2 * [Cr^{6+}(mg/l)]_{\text{Inlet}}$

Stoichimetric Dosage to Reduce Oxygen (O_2)

$4FeCl_2 + O2 + 10H_2O$ -------> $4Fe(OH)_3 + 8HCl$

$[Fe^{2+}\,(mg/l)]_{\text{Dose for O2 Reduct}} = ((4 \times [Fe^{2+} \text{mol wt.}]) / [O_2 \text{mol wt}]) * [O_2(mg/l)]_{\text{Inlet}}$

$[Fe^{2+}\,(mg/l)]_{\text{Dose for O2 Reduct}} = ((4 \times [55.8\ g/mol]) / [32\ g/mol]) * [O_2(mg/l)]_{\text{Inlet}}$

$[Fe^{2+}\,(mg/l)]_{\text{Dose for O2 Reduct}} = 7.0 * [O_2\,(mg/l)]_{\text{Inlet}}$

Total Stoichimetric Iron Dosage to Reduce Cr^{6+} and Oxygen

$[Fe^{2+}\,(mg/l)]_{\text{Total Stoich. Dose}} = 3.2 * [Cr^{6+}(mg/l)]_{\text{Inlet}} + 7.0 * [O_2\,(mg/l)]_{\text{Inlet}}$

Total Stoichimetric Iron Dosage to Reduce Cr^{6+} and Oxygen with Excess

Add "Excess Factor" Typical range (1.2 to 2.0)

$[Fe^{2+}\,(mg/l)]_{\text{Total Stoich. Dose with Excess}} = \text{Excess Factor} * (3.2 * [Cr^{6+}(mg/l)]_{\text{Inlet}} + 7.0 * [O_2\,(mg/l)]_{\text{Inlet}})$

Example calculation of Ferrous Dosage

$[Cr^{6+}(mg/l)]_{Inlet}$ = 4.6 mg/l

$[O_2\ (mg/l)]_{Inlet}$ = 2.0 mg/l

Excess Factor = 1.5

$[Fe^{2+}\ (mg/l)]_{\text{Total Stoich. Dose with Excess}}$ = 1.5 * (3.2 * [4.6 mg/l] + 7.0 * [2.0 mg/l])

$[Fe^{2+}\ (mg/l)]_{\text{Total Stoich. Dose with Excess}}$ = 43 mg/l of Fe^{2+} (same as 43 ppm of Fe^{2+})

Note: At typical water concentration and densities, the dosage expressed in mg/l is numerically the same as parts per million (ppm). Thus, 43 mg/l of Fe^{2+} equals 43 ppm of Fe^{2+}.

Calculation of Ferrous Chloride Solution Drawdown

Note: At the time of this writing, the ferrous chloride solution is delivered as 12 percent ferrous iron by weight.

$$FeCl_2 \text{ Drawdown (ml/min)} = \frac{[\text{Plant Flow (gpm)}] * [8.34\ (\text{lbs } H_2O/\text{gal } H_2O)] * [Fe^{2+} \text{ Dose (ppm)} * 1{,}000{,}000\ (\text{lbs } Fe^{2+}/\text{lbs } H_2O)] * [3785\ (\text{ml/gal})]}{[0.12\ (\text{lbs } Fe^{2+}/\text{lbs } FeCl_2 \text{ Soln})] * [1.35 * 8.34\ (\text{lbs } FeCl_2 \text{ Soln/gal})]}$$

This equation reduces to:

$FeCl_2$ Drawdown (ml/min) = 0.020 * [Plant Flow (gpm)] * [Fe^{2+} Dose (ppm)]

Example calculation of Ferrous Chloride Drawdown

Plant Flow = 70 gpm

Fe^{2+} Dose = 43 ppm

$FeCl_2$ Drawdown (ml/min) = 0.020 * [70 gpm] * [43 ppm]

$FeCl_2$ Drawdown (ml/min) = 60 ml/min

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: Polymer Solution Make-up and Feed
Number: IM3-SOP-007
Revision Date: 10/27/2005

NOTE: As of March 2006, the polymer skid is fully functional in AUTO mode. This procedure will only be necessary if the polymer skid cannot operate in AUTO mode.

Scope

The objective of this SOP is to describe the procedure for making a batch of polymer.

Precautions/Hazards

Operators should have training and operating experience before attempting to operate the polymer mixing skid. Operators will not attempt to make up a batch of polymer without taking the steps specified in the procedure.

Equipment List

- Dry Polymer – This material should be stored within an overpack inside the Conex to ensure it stays dry.

Procedure

1. The polymer system is to be operated in automatic mode.
2. Set system to make-up 100 gal batches of 0.1 percent strength polymer. The weight of 100 gallons of water is 834 pounds. Previous tests have found that the hopper auger must operate for 14 seconds to deliver 0.834 pounds of polymer.
3. Fill hopper with Nalco Optimer 9901 powdered polymer.
4. Run system in automatic mode (see Chem-Feed manual). The system should automatically make 100 gallons batches and automatically transfer batches to the day tank, when the level probes indicate that space is available.
5. Perform a drawdown test on the polymer dose pump and record the polymer dose rate.
6. Observe the floc formation in the clarifier. The floc should look like a "sand slurry", with little to no water separation between the floc particles. You should see folding and layering of the floc. If the floc particles look too big, reduce the polymer dose rate using the VFD ratio control on the HMI Polymer Skid Screen. If there is little or no floc, increase the VFD ratio control. If the VFD ratio is adjusted, perform another drawdown test and record the new polymer dose rate.
7. The polymer feed rate needed for the clarifier rapid mix inlet can also be estimated by running lab-scale jar tests, according to the procedure below (not required if floc looks good):
   a. Mix 0.1 percent strength polymer (1 gram per 1,000 ml of water).

b. Run jar tests using 1 liter samples of the Tank T-301C effluent.

c. Each 0.1 ml of 0.1 % polymer solution equals 0.1 ppm dosage.

d. Select a dosage that provides a small tight floc. Typical dosages are likely to be 0.05 to 0.3 ppm.

8. Estimate the polymer drawdown rate as follows:

Polymer Drawdown (ml/min) = Dosage (ppm) * Plant Flow (gpm) * 3.79

Example Calculation:

Polymer Dosage = 0.1 ppm

Plant Flow = 80 gpm

Polymer Drawdown (ml/min) = 0.1 ppm * 80 gpm * 3.79 = 30 ml/min

9. If you have not done this in step 6, set the polymer dose rate via HMI system percent control.

10. Check the drawdown of polymer in the plant. Adjust as necessary.

11. After 30 minutes at new polymer feed setting, check floc formation in slow mix section of clarifier and check effluent clarity.

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: Clarifier Solids Balancing and Wasting
Number: IM3-SOP-009
Revision Date: 10/27/2005

Scope

SOP describes approach to wasting sludge from Clarifier to Sludge Holding Tank (T-402), and from Sludge Holding Tank (T-402) to Phase Separators (405A [South] and 405B [North]).

Sludge Wasting from Clarifier

1. The target sludge level in the clarifier is to have a definite sludge blanket / clean water break between Taps 2 and 3.
2. Estimate the sludge blanket level as follows:
   a. Open sampling valve at Clarifier underflow pipe. Allow sample tap to flow for 3 to 5 seconds to flush out line. Drain sample tap hose into a 5-gallon pail. Capture about 1000 ml of underflow sludge into 1,000 ml graduated cylinder.
   b. Similarly obtain samples from Clarifier Taps 1, 2, 3, and 4.
   c. Place all full graduated cylinders in sequence: underflow, Tap 1, Tap 2, Tap 3, and Tap 4.
   d. Allow material in graduated cylinders to settle for 1 hour.
   e. Visually judge where the breakpoint in the sludge volume after settling is between cylinders. It is likely to be easily notable.
3. If the sludge breakpoint is between Tap 1 and Tap 2 or lower, reduce the sludge wasting rate (i.e., reduce the discharge to the sludge holding tank [T-402]). Reduce the sludge wasting rate by reducing the sludge pump "on" time (P-401) at the HMI system.
4. If the sludge breakpoint is between Tap 2 and Tap 3, the sludge level is ideal. No process change is necessary.
5. If the sludge breakpoint is above Tap 3, increase the sludge wasting rate (i.e., increase the discharge to the sludge holding tank [T-402].). Increase the sludge wasting rate by increasing the sludge pump "on" time (P-401) at the HMI system.

Sludge Thickening Process in Sludge Holding Tank (T-402)

1. The target sludge level in the sludge holding tank (T-402) before transfer to the phase separators is at sludge holding tank Tap 3.
2. Operate the sludge holding tank (T-402) as follows:
    a. After the sludge holding tank (T-402) has been emptied, open the tap that is second from the bottom.
    b. As the sludge holding tank (T-402) is filled, clear water will overflow (decant) from the second tap.
    c. When the sludge blanket reaches the second tap, sludge will overflow and be noted by the deep red, brown color.
    d. When the sludge blanket reaches the second tap, close the second tap and open the third tap.
    e. As the sludge holding tank (Tank T-402) is filled, clear water will overflow (decant) from the third tap.
    f. When the sludge blanket reaches the third tap, sludge will overflow and be noted by the deep red, brown color.
    g. When the sludge blanket reaches the third tap, closed the valve for the third tap and prepare to transfer the sludge load to one of the phase separators.

Sludge Wasting to Phase Separators

1. The target sludge level in the sludge holding tank (T-402) before transfer to the phase separators is at sludge holding tank Tap 3.
2. Open the manual valves on the intake (V-TW-105-01) and discharge (V-TW-106-01) of the sludge transfer pump (P-403), the influent valve next to phase separator 405B (North) (V-WS-106-02), the polymer feed valves, and the air line to the sludge transfer pump. The valve on the air line can be used to throttle the air rate to the sludge transfer pump to limit the sludge transfer rate. Limiting the sludge transfer rate may be necessary depending on the needed dewatering polymer dosage and the maximum flow capacity of the polymer feed pump (Pump 2 on Polymer Skid).
3. Initiate the sludge transfer to the phase separator using the HMI system.
4. The polymer pump will automatically initiate operation.
5. Select a polymer feed rate that further dewaters the sludge being transferred to the phase separator. Perform jar tests prior to the transfer to "rough-in" the dosage required for dewatering. Previous tests have suggested that the necessary polymer dosage was about 10 gallons of 0.2 percent polymer solution per 100 gallons of sludge.
6. Polymer feed rate can be selected by turning the dial for Pump 2 below the Hand-Off-Auto switch on the polymer control panel. It may be necessary to set the polymer solution flow rate and set the sludge feed rate by throttling air supply valve for the sludge pump.

7. If there is adequate polymer supply and phase separator space, transfer the entire volume of sludge from sludge holding tank (T-402) to the selected phase separator. The phase separator high-high alarm should actuate if the phase separator is filled. It is believed that the phase separator may "blinded off" if small batches of sludge are discharged to the separator and allowed to dry or partially dry. Thus, it is preferred to transfer a single large batch. Secondly, the transfer of large batches minimizes the time and effort of set-up for the sludge transfer.

8. Close the valves on the intake (V-TW-105-01) and discharge (V-TW-106-01) of the sludge transfer pump (P-403) and the influent valve next to phase separator 405B (North) (V-WS-106-02).

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: <u>Reverse Osmosis Anti-Scalant Blending</u>
Number: IM3-SOP-010
Revision Date: 10/27/2005

When the anti-scalant day tank drops below roughly 15 gallons, initiate the preparation of a new batch of anti-scalant.

1. Make-up a 10 percent solution (by weight) of dilute anti-scalant as follows. Add 20.75 gal of low TDS water. Use potable water or RO permeate. Do not use plant effluent or RO concentrate. Immediately proceed to Step 3.

2. Add 2.0 gal of neat (pure) anti-scalant to day tank.

   Note: The anti-scalant is more dense than water, thus, 2.0 gal of anti-scalant mixed with 20.75 gallons for water is a 10 percent solution by weight.

3. Mix for 5 minutes.

4. Check anti-scalant process feed rate. The target feed dosage is 2.0 ppm. The estimated feed rate for the 10 weight percent anti-scalant is 12 ml/min when the RO system influent rate is 135 gpm. (Note = RO system influent flow should always be 135 gpm due to our recirculation loops, it is independent of flow from the extraction wells.)

Note: See also Ecolochem memo attached for more detail.

Ecolochem®, Inc.

September 13, 2004

Customer: CH2M Hill Engineering Company for PG&E
Topock Plant
Topock, CA

Subject: RO 154 Antiscalant Dilution, Dosing & Calibration Procedure

Background:
Mistakes in chemical dilution and dosing are common, but they are preventable. They typically occur from dilution or dosage calculation errors, or when chemical feed pumps are not calibrated correctly and regularly. And as a reminder, with all procedures involving the handling of chemicals, every applicable and appropriate safety procedure should be followed along with the wearing of personal protection equipment.

Discussion:
Since ionic concentration levels in the feedwater are currently high enough to precipitate out and scale the membranes when concentrated in the RO, Avista **Vitec 3000** antiscalant is to be used for controlling the formation of scale. Antiscalants are surface-active materials that interfere with precipitation reactions in three primary ways:

1. *Threshold Inhibition*: the ability of an antiscalant to keep supersaturated solutions of sparingly soluble salts in solution. The negative groups located on the antiscalant molecule attack the positive charges on scale nuclei interrupting the electronic balance that is necessary to propagate crystal growth.

2. *Crystal Modification*: a property of an antiscalant to distort crystal shapes, resulting in soft, non-adherant scale. When treated with crystal modifiers, scale crystals appear distorted, generally more oval in shape and less compact.

3. *Dispersion*: the ability of some antiscalants to adsorb on crystals or colloidal particles and impart a high anionic charge. The high charge tends to keep crystals separated.

Dilution
Though the antiscalant can be injected neat (undiluted), this application requires that the antiscalant be diluted to a 10% (by weight) solution so that the chemical delivery pump will operate within their optimal performance zone. To dilute to a 10% solution:

1. Fill the dilution tank with 20.75 gallons of **DI or RO Permeate** water.
2. Turn on the mixer, then add 2 gallons of antiscalant.
3. Mix well and then turn off the mixer.
4. A hydrometer may be used to verify the density of 8.5 pounds per gallon.

To calculate the number of gallons of antiscalant needed per gallon of water to prepare a 10% (by weight) solution:

Antiscalant density is 9.6 pounds per gallon. Water density is 8.34 pounds per gallon.

Weight percent chemical = 100 x weight of chemical / (weight of water+weight of chemical)

10 = (100 * Y * 9.6) / (1 gallon water * 8.34 + Y * 9.6)

where Y = the gallons of antiscalant needed per gallon of water

Y = 8.34 / 86.4 = 0.0965 gallons of antiscalant per gallon of water

20.75 gallons of water * 0.0965 gallons antiscalant/gallon water = 2 gallons antiscalant

A double batch would add 4 gallons of antiscalant to 41.5 gallons of water.

A half batch would add 1 gallon of antiscalant to 10.375 gallons of water.

Dosing

At the **current ionic concentration levels** of the feedwater, the dosage of antiscalant is 2.00 ppm when the RO is run at 75% recovery. The injection rate of a 10% solution to deliver this dosage is 9.96 mL/min. or 3.79 gpd. Since antiscalant is being injected, feeding acid is optional. However, even if acid is injected, this dosage will remain the same. To calculate the injection rate in mL/min. and gpd with the system feed flowrate of 134 gpm and knowing that the density of the 10% antiscalant solution is 8.5 pounds per gallon, the mass balance equation used to calculate chemical injection rate is:

*System Feed Flowrate * Chemical Dosage = Injection Rate * Chemical Feed Concentration*

134 gpm * 8.34 * 2.00 ppm = X gpm * 8.5 * 100,000 ppm (% concentration * 10,000)

where X = the Injection Rate in gallons per minute

X = 2,218 / 850,000 = 0.00263 gpm

converting to mL/min.: 0.00263 gpm * 3.785 Liters/gal * 1000 mL/L = 9.96 mL/min.

or multiplying 0.00263 gpm by 1440 min./day = 3.79 gpd

The **rough** settings for the 13.3 gpd ProMinent pump are determined this way:

*Injection Rate (gpd) = % Speed * % Stroke * Pump Capacity (gpd)*

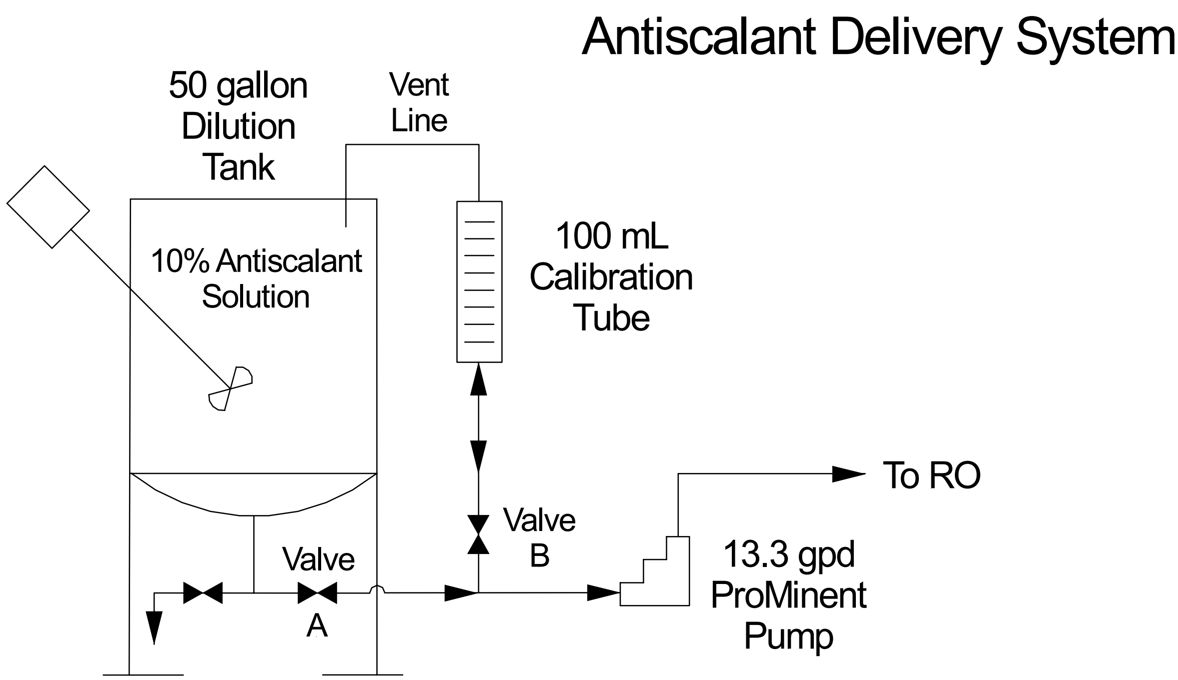
3.79 gpd = %speed * %stroke * 13.3 gpd

%speed * %stroke = 3.79 gpd / 13.3 gpd = 0.285

Now, keeping the % speed more than the % stroke, if the speed is set at 60%,
(speed is actually set as strokes/min. = 180 (full scale) * 0.6 = 108 strokes/min.)
the stroke will be 0.285 / 0.6 = 0.475 = 47.5% ~ 48%.

Calibration

These rough ProMinent pump settings are just a starting point, because as the pump discharge backpressure changes, if the pump settings are not adjusted, the amount of chemical delivered changes. So, to get the correct chemical dosage, the pump must be calibrated **weekly** and adjusted as necessary. Proper chemical dosing is important because both underdosing *and* overdosing is detrimental to RO performance and membrane life (although even slight underdosing is much more detrimental than moderate overdosing). To calibrate the pump, follow the steps below, referring to the "Antiscalant Delivery System" process flow diagram:



1. With Valve A open and the ProMinent pump operating, open Valve B slowly until antiscalant level reaches the "0" mark in the Calibration Tube.

2. Close Valve A and start timing with a stopwatch or wristwatch second hand.

3. At the 1 minute mark, check the level of the antiscalant. Though this should be 9.96 mL/min., since it is impractical to get this value exactly, round up to **10** mL/min.

4. Adjust the pump if necessary, keeping the % speed higher than the % stroke and **recheck** the calibration.

5. Let the Calibration Tube drain, close Valve B and open Valve A.

Reporting
Report the following data on a *weekly* basis:

1. Calibration values in mL/min.

2. Pump needing adjustment.

3. Pump's speed and stroke settings.

4. Daily antiscalant level in the Dilution Tank (attach a plastic yard stick to the side of each tank and record the level as inches or fractions thereof).

Sampling
A raw RO feedwater sample should be taken *quarterly*, and sent to the Ecolochem lab in the Norfolk Service Center. In addition to a standard analysis, the sample label must be marked to also include a Barium test. Quarterly tests are needed to determine if an adjustment in the dosage of antiscalant is required.

Reordering
When needing to order more Avista Vitec 3000 antiscalant, contact Dennis Holley at the Fontana Service Center at 1-800-252-8004. Allow **3** working days for deliveries. Expect to use a total of about 2.75 gallons of neat antiscalant each week when continuously running the RO.

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: I&C Equipment Preventative Maintenance
Number: IM3-SOP-011
Revision Date: 10/27/2005

Scope

The objective of this SOP is to describe when PM may be needed for field I&C instruments. The SOP does not specify regular PM schedules (which are included in MP-2), but rather the non-routine conditions that would trigger maintenance.

Objectives of Preventative Maintenance Testing

Evaluate effectiveness of some of the key instruments. These can be performed while conducting a visual walk down of the plant. It is best to run these tests first thing in the morning and just before the shift ends.

Approach

Where two analyzers are on the same line, or same tank, take comparison readings for both channels: pH or conductivity, and temperature. Operator needs to be aware of the process parameters, as both pH & temperature increase slightly as the fluid passes through the tanks. Both may appear to drift due to ambient temperature changes.

Once a confidence in instruments is established, and process conditions are stable, calibration frequency can be determined. It is suggested readings be noted twice a shift. The following general guidance is provided, see MP-2 for actual PM schedule.

1. pH loops may require calibration as often as one a month, but at least once every three months. See MP-2 for actual PM schedule

2. Conductivity loops may require calibration as often as one a month, but at least once every three months. See MP-2 for actual PM schedule

3. Level Transmitters should be checked annually. Calibration only requires a measured distance from the probe head face, less 6", to a target within the range of the transmitter. Accuracy has been shown to be within ¼". See MP-2 for actual PM schedule

4. Pressure Gauges & Transmitters should be pulled and "bench" calibrated annually. See MP-2 for actual PM schedule

5. High Level switches in the Rx tanks should be pulled and “bench” calibrated annually. See MP-2 for actual PM schedule

6. Flow Transmitters should be checked annually. They are calibrated at the factory, and normally only require re-ranging in the field. They need to be checked using the method described in section 6. See MP-2 for actual PM schedule

Procedures

1. pH/Temperature Probes (Where there are two probes in the same line or tank)
   - Difference between pH should be less than 1.0.
     - If greater than 1.0, conduct an inspection of both probes.
     - Clean, using soft brush tooth brush. Return to service.
     - If still greater than 1.0, conduct a calibration of both probes.
   - Difference between temperature readings should be less than 2.0°F.
     - If greater than 2.0°F, conduct a calibration of both probes.

2. Conductivity Probes (There is only one conductivity probe per line)
   - If readings exceed the ranges of the conductivity analyzer, then ...
     - Clean, using soft brush tooth brush.
     - Readings should be 0.0 in air.
     - Return to service
     - If still greater than unit range, conduct a calibration of the probe.

3. Turbidity meter (**AIT-400** on the Clarifiers and **AIT-501** on the MF system)
   - Compare the readings in the control room.
   - If the suspended solids exceed 100 NTU, then
     - Inspect the chamber of the analyzer in question.
     - If the chamber appears coated, conduct a cleaning.
   - Note the color of the water going to the drain at the top of the clarifer (should be nearly clear).
     - If the fluid appears reddish there could be a process problem.

4. High Level probes in the Iron Oxidation Reactor tanks.
   - Check that the inlet valve to the next tank is open.
   - Check that Pump P-400 is running.
   - To remove the probe
     - The tank needs to be bypassed.
     - The level needs to be lowered below the process tap of the probe.
   - Remove the probe and inspect for a build up of materials across the probe tongs.
     - When clean, and in open air, the HMI alarm should be clear.
     - Dip in water to check that the probe works correctly.
   - Re-install, the tongs in a vertical position.

5. Low Flow Switch: **(FSL-201)**.
   - If a no flow condition occurs, use a DVM to take readings on terminals 1 & 2 when Pump 201 has been started.

- Readings should be between 0.75 & 1.25 Vdc
- With P-201 off, no flow voltage is 2.26 Vdc
- Set point is for low flow alarm is 1.60 Vdc

6. Flow Transmitters:
   - **FIT-700** and **FIT-701**: Flow meters can be checked by filling the Baker tanks, noting starting level & ending level for a predetermined time, and converting cubic feet to gallons.

   - Injection well Flow meters (**FIT-702, -1202** and **-1203**) can be checked using a drawdown method in the Treated Water Storage Tank (T-700) noting starting level & ending level on the HMI for a predetermined time, and converting cubic feet to gallons.

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: I&C Equipment - Process pH Probe Cleaning and Recalibration
Number: IM3-SOP-012
Revision Date: 10/27/2005

Scope

The objective of this SOP is to describe cleaning the pH probes. Please also refer to the manufacturer's O&M manual prior to conducting this operation.

Precautions/Hazards

Operators should wear proper PPE when conducting this operation. In case of accidental exposure, immediately wash affected area and notify the plant supervisor.

Use caution when removing pH probes from a pressurized line (once the first holding collar has been loosened, a probe under pressure will "shoot out" very quickly). Use caution when removing pH probes from the iron oxidation reactors to prevent spills.

Procedure

The currently recommended method to clean and recalibrate the process system's pH probes is outlined below:

1. At the pH transmitter, place the pH process output on "hold." The commands are approximately MENU ==> OUTPUT ==> HOLD ==> YES
2. Extract the pH probe from process stream as follows:
   a. Completely loosen the first holding collar.
   b. Pull back pH probe assembly until the probe tip "clears" the isolation ball valve.
   c. Close the isolation ball valve.
   d. Remove the lower drain tap and loosen the top drain tap. Drain off excess process fluid into a catch basin.
   e. Completely loosen the second holding collar.
   f. Remove the pH probe assembly and both holding collars.
3. Per manufactures cleaning recommendations, place enough Whink® Rust Stain Remover in a 250 m/L beaker to completely cover the probe tip. Soak probe tip in the Whink® for 5 to 10 minutes. Carefully wipe probe tip with a non-abrasive cloth. Repeat as needed to remove all build-up.
4. Scrub the pipe portion of pH probe assembly with abrasive side (Scotchbrite side) of the kitchen-type sponge. Carefully wipe the pH probe glass "eye" with the soft portion of the sponge.
5. Rinse entire assembly with a plant hose. Flush the water into all areas of the assembly to remove the traces of Whink®.

6. Below are the basic steps to recalibrate the pH probe. Please also refer to the pH probe transmitter manual for more details. Recalibrate the probe as follows:

   a. Please pH transmitter in recalibration mode. The commands are approximately MENU ==> RECALIBRATE? ==> YES ==> pH RECALIBRATE? ==> YES ==> 1 Pt? ==> NO ==> 2 Pt? ==> YES

   b. With the pH probe still soaking in the treated plant water, use a lab thermometer and measure the temperature in degrees Celsius. Enter current temperature of probe into controller.

   c. The controller will ask for the first of two pH standards. It will ask first for the low pH standard and defaults to a standard of 4.0. Press ENTER.

   d. Place probe in 4.0 pH standard and move the probe about to mix. The pH transmitter will ask "pH STABILIZED ?" When the pH reading stabilizes. Respond "YES."

   e. The controller will ask for the second of two pH standards. It will ask for the high pH standard. In this case, there are two different standards that are used, either the 7.0 standard or the 10.0 standard. Most of the process probes use the 10.0 standard for the second pH point. The pH probes on the ferrous feed reactor loop, ask for the 7.0 standard. If you accept the requested standard, press ENTER.

   f. Place probe in the high pH standard (7.0 or 10.0 standard) and move the probe about to mix. The pH transmitter will ask "pH STABILIZED ?" When the pH reading stabilizes. Respond "YES.".

   g. If the calibration is accepted by the transmitter, it will display the pH probe calibration curve "slope factor." Press "YES." Then it displays the "offset value", press "YES."

   h. Then it will ask you if you want to "RELEASEHOLD?" Do not press "YES." First, we want to reinstall the process probe.

7. Reinstall the process probe as the reverse of the extraction procedure.

8. After the probe is reinstalled, watch the measured temperature and pH readings. If they look correct, then you may release the "process hold" by pressing "YES." The pH probe should be back online.

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: I&C Equipment – Conductivity and Turbidity Probe Calibration Procedures
Number: IM3-SOP-013
Revision Date: 10/27/2005

Scope

The objective of this SOP is to describe calibration. The manufacturer's Calibration procedures should also be referenced.

Precautions/Hazards

Use caution when removing conductivity probes from a pressurized line (once the first holding collar has been loosened, a probe under pressure may forcibly pop out). Do not stand in front of the probe when removing. Use caution when removing probes to prevent spills.

Procedure – Conductivity Probe Calibration (AIT-600, 604, 605, 606, 701, 702)

1. Notify Operations which system will be Out of Service for calibration.

2. Verify required range solution for Calibration:
   2.1. Solution of 1,000.0, +/- 10
   2.2. Solution of 10,000.0, +/- 10
   2.3. Solution of 1000.0, +/- 10
   2.4. Empty bucket for fluid collection.
   2.5. Rubber Gloves and Face shield are required.
   2.6. Bottle of distilled water to rinse probe.

3. Using "Menu" button, select Output mode. Place analyzer in "HOLD" mode. Retains last output to PLC.

4. Using "Menu" button, select Calibration mode for 2 point calibration.

5. Removal of Conductivity sensor
   5.1. **CAUTION: Probe may forcibly pop out**
   5.2. Carefully loosen compression nut, **Do NOT stand in front of it.**
   5.3. Retract the probe.
   5.4. Close the Isolation Valve
   5.5. Drain the probe chamber into the bucket.
   5.6. Slide back the compression not and loosen the retaining nut.

5.7. Extract the Conductivity probe.

6. Calibration:
   6.1. Place thermometer in Solution, note temperature in C, & record
   6.2. Push DOWN arrow button to select Calibration Method
   6.3. Push DOWN arrow button to select 2 point calibration.
   6.4. Rinse the probe with distilled water, and dry off, removing excess.
   6.5. Zero is done in air. Wait 2 minutes to stabilize.
   6.6. Check value of lower limit on Analyzer.
      6.6.1. When stable, press enter.
      6.6.2. If value differs from zero, use buttons to change value.
      6.6.3. Press Enter
   6.7. Place conductivity probe in Solution, note temperature in C, & record
      6.7.1. Wait 2 minutes to stabilize. Note reading on analyzer.
      6.7.2. When stable, press enter.
      6.7.3. If value differs from solution, use buttons to change value.
      6.7.4. Pressure Enter
   6.8. To check calibration:
      6.8.1. Remove probe from solution: noted reading (0 NTU).
      6.8.2. Rinse the probe with distilled water, and dry off, removing excess.
      6.8.3. Return to calibration solution
      6.8.4. Verify reading when stable.

Procedure – Turbidity Probe Calibration (AIT-400)

1.0 Select method for Calibration:
   1.1 Solution of 20.0, +/- 0.10 or of 40.0, +/- 0.10 NTU
   1.2 Calibration Cube: 21.4 NTU
   1.3 Distilled Water for zero check 0.0 NTU (0.250 NTU Max.)

2.0 Empty bucket for fluid collection.
   2.1 Rubber Gloves and Face shield are required
   2.2 Bottle of Distilled water to rinse out chamber
   2.3 Clean paper towels to wipe down inside chamber.
   2.4 3 bottles of clean water for flushing & Zero Calibration

3.0 Using “Menu” button, select Output mode. Place analyzer in “HOLD” mode. Retains last reading to PLC.

4.0 Flush & Clean sample system
   4.1 Block in Sample Valve from Clarifier
   4.2 Open Drain Valve. Observe level in Flow Chamber, as it falls.
   4.3 Open Sample Cabinet, Flip 3 way-valve to point at Calibration hose.
   4.4 Add 1 bottle of potable water through funnel to flush out flow chamber.
   4.5 Note Readings on Turbidity Transmitter, should fall into range
   4.6 Flip 3 way-valve to point at sample in.. Observe level in Flow Chamber as it empties.

4.7 Cleaning of Chamber

- 4.7.1 Place bucket under Flow chamber.
- 4.7.2 Remove cover on Flow Chamber, (turning CCW)
- 4.7.3 Remove internal baffle assembly & flush with distilled water.
- 4.7.4 Spray distilled water in side chamber, flushing out contaminants.
- 4.7.5 Wipe Detectors (4), inside of chamber, with a clean clothe.
- 4.7.6 Go to calibration method of choice.

5.0 Calibration Methods

5.1 Calibration Method using Cal-Cube

- 5.1.1 Install Cal-Cube into Flow Assembly
- 5.1.2 Re-install cover to Flow Chamber
- 5.1.3 Go to Menu on Turbidity Analyzer, selecting Cal-cube method
  - 5.1.3.1 Select “Calibrate” with arrow button, than enter button
  - 5.1.3.2 Select “Sensor” with arrow button, than enter button
  - 5.1.3.3 Select “Cube Cal” with arrow button, than enter button
  - 5.1.3.4 Let unit stabilize on reading (2 to 3 minutes)
- 5.1.4 Confirm EPA NTU value on Cube agrees with Analyzer: 21.4 NTU
  - 5.1.4.1 Press Enter
  - 5.1.4.2 Go to Step 7.3 or 8.0 to complete Calibration

5.2 Calibration Method using Calibration Solution

- 5.2.1 Re-assemble Flow chamber
  - 5.2.1.1 Re-insert baffle assembly, aligning with internal pen
  - 5.2.1.2 Re-install cover to Flow Chamber.
  - 5.2.1.3 Flip 3 way-valve to point at Calibration hose
  - 5.2.1.4 Pore Solution into funnel, to Flow Chamber.
  - 5.2.1.5 When chamber is full, note readings
- 5.2.2 Go to Menu on Turbidity Analyzer, selecting Primary Cal method
  - 5.2.2.1 Select “Calibrate” with arrow button, than enter button
  - 5.2.2.2 Select “Sensor” with arrow button, than enter button
  - 5.2.2.3 Select “Primary Cal” with arrow button, than enter button
  - 5.2.2.4 Let unit stabilize on reading (3 to 5 minutes)
- 5.2.3 Confirm EPA NTU value for Solution agrees with Analyzer.
  - 5.2.3.1 If not, Enter cal value using arrow keys
  - 5.2.3.2 Press “Enter”.
  - 5.2.3.3 Goto step 7.3 or 8.0 to complete calibration.

5.3 Zero Check with Distilled water

- 5.3.1 If chamber is full, open drain valve. Close drain valve when empty.
- 5.3.2 Confirm 3 way-valve to point at Calibration hose.
- 5.3.3 Add 2 bottles of potable water through funnel to flush out flow chamber. Let unit stabilize on reading (3 to 5 minutes)
- 5.3.4 Note Readings on Turbidity Transmitter, should fall to 0.0 range
- 5.3.5 Add distilled water for zero check 0.0 NTU (0.250 NTU Max.)

6.0 Placing Turbidity Analyzer into Service.

- 6.1 Open in Sample Valve from Clarifier
- 6.2 Flush sample line for 1 minute.. Open Drain Valve
- 6.3 Close Drain Valve
- 6.4 Flip 3-way valve to process side.
- 6.5 Note when chamber is full.
  - 6.5.1 Allow system to stabilize (3 to 5 minutes)
  - 6.5.2 Reading should fall between 30 & 50 NTU.
- 6.6 Release “hold” on output. Confirm reading in Control Room.

IM3 Treatment Process Rules (10/27/2005)

SOP-014

1. **Extraction Well shutdowns.** Must be communicated to Matt Johns (720-289-4166) and Chris Smith (928-645-8294).
2. No intentional **discharges to floor drains**. Process fluids should be discharged to white lab sink adjacent to Sludge Holding Tank.
3. No discharge of **non-compliant effluent to Injection Wells**. Total Chromium at SC-700 must be sampled every 3 hours and analyzed within 1 hour. If samples detected above action levels, stop flow to Injection Wells and initiate plant recirc (O&M Manual Section 5.5.5):
   - Samples downstream of microfilter to be <0.025 mg/L (<25 ppb) Total Cr.
   - Samples downstream of Tank 301C to be <0.012 mg/L (<12 ppb) Hexavalent Cr.[1]
4. Log all setpoint changes and power outages in **Operator's Log**.
5. **Flow to IM2 Bench.** 48-hour notice is required to increase trucking, so alert Denbeste to any increase in flow rate to IM2 Bench (can be caused by increasing flow at FCV-201 or manually pumping P700 or P701 to MW20 bench). Especially on weekends when trucking is not scheduled to occur.
6. **Checking tank levels at IM2 Bench.** OMI operator to visually check the 3 Baker Tanks at the IM2 Bench once every 2 hours to verify levels and check for leaks, spills, etc.

/SOP 014_IM3 RULES.DOC

[1] Trigger point for Hexavalent Chromium is problematic because the on-site Hach meter's detection level is not low enough to monitor if water is below the Monthly Average Limit of 8 ppb. Daily Max Limit is 16 ppb. Have chosen 12 ppb as it is above what is typically read on the Hach meter on-site. This will be refined once a Detection Limit study of the on-site Hach meter is done.

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: IM-3 Truck Loading Station
Number: IM3-SOP-015
Revision Date: 03/17/2006

Purpose:

To provide an Instruction Manual to enable an operator to be able to locate and operate tank valves and flow control valves, the pump, flow meter and all adapters and hoses needed to load tankers.

To provide step by step instructions to guide the operator from post truck inspection to clearing the truck out of the site after being loaded.

I. Loading Site Preparation

A. Check containment pad area

1. Adjust containment pad so when trailer tandems are at the front lip of the pad the loading hose will lay within the rear area of the containment pad .

2. Confirm that all the adapters are present and that the loading hose is properly stored and not in the path of the trucks as they enter the loading area.

3. Confirm that the safety cones are in place at the south end of the containment pad and that you have a 5 gallon bucket to place under the trailers drip tray valves.

B. Check storage tank valves #702 - 703 - 704

1. Always confirm that you are drawing water from one tank at a time and that the others are in the closed position.

C. Check flow control valves #702b & 704b

1. These valves should be in the same position as the tank valves they are in line with. If 702a is open then 702b should be open and the other valves 703a and 704a and 704b should be closed. If 703a is open then 702a&b and 704a&b should be closed etc.

2. Prior to the daily loading these valves will be in the closed position and the proper valves will need to be opened to select the tank you will be loading from.

II. Staging a Truck on the Containment Pad

As the truck moves from the inspection area to the loading area the truck loader will control the placement of the truck on the containment pad.

1. The truck loader, using hand signals, should stop the truck when the front trailer axle is at the north end of the containment pad. This assures enough room in the containment pad behind the trailer to catch any minor spills.

2. This also provides enough room for the hose to be in the containment pad in case it is dropped during connecting or disconnecting to the trailer.

III. Connecting the Hose to the Trailer

A. Confirm with truck driver that the trailer vent and or the dome lid is open.

B. Place a 5 gallon bucket under drip tray valve and then open drip tray valve.

C. Slowly unlock one of the trailer valve caps cam-lok levers to check for pressure or water behind the cap. The trailer valve’s may have a cap or a plug, which ever it is, Use caution.

D. Remove trailer valve plug or cap and hang it on the hook or place it out of the way.

E. Install any adapter that is needed to provide a 3” male fitting at the trailer valve.

F. Take the hose from its storage hook and attach it to the trailer valve fitting making sure that the cam-lok fittings levers are fully locked.

G. Reconfirm with the driver that the trailer vent and or dome lid is open.

H. Open the trailer valve.

IV. Selecting Tank and Activating Pump

Visually inspect tanks and select the one you are going to draw from.

A. If you select tank 703

1. Confirm that valves 702a & 702b and 704a & 704b are closed.

2. Open Valve 703a

3. Confirm the flow meter is zeroed out by pushing and holding the set button until it shows zero.

4. Reconfirm with the driver that trailer valve and vent and or dome lid is open.

5. Open the load control valve first then push the Green button on pump switch #________

6. During the pumping operation the truck loader must stay in the load control area and the driver must stay by the trailer valve.

7. There are numerous ways the drivers use to load their trucks to the legal limits. This means that the truck loader and the driver need to work together to assure that the truck goes out properly loaded.

8. When the truck is loaded, push the red button on pump switch #______ first, then closes the load control valve, and then closes the trailer valve.

C. If you select tank 702.

1. Confirm that valves 703a and 704a & 704b are closed.

2. Open valves 702a &702b

3. Follow IV, B, 3 through 8 as before.

D. If you select tank 704.

1. Confirm that valves 702a & 702b and 703a are closed.

2. Open valves 704a & 704b.

3. Follow IV, B, 3 through 8 as before.

V. Disconnecting Hose from Trailer Valve.

A. Confirm that load control valve and trailer valve are closed

B. Confirm that 5 gallon bucket is under drip tray valve and drip tray valve is open

C. Slowly open one of the cam-lok levers on the hose fitting and allow the water to drain into drip tray.

D. When water flow slows open both cam-lok levers and remove hose from valve directing hose into drip tray or into 5 gallon bucket.

E. Hang the hose on the storage hook, remove any adapters used and replace trailer valve cap or plug.

F. Close drip tray valve and remove 5 gallon bucket from under drip tray and replace it in storage area.

VI Filling out Manifest and Recording the Load

A. Check the flow meter for the number of gallons pumped to the trailer and enter it on the manifest.

B. Confirm that you and the driver have filled out and signed all the forms listed below and that the manifest has properly filled in and the manifest number has been recorded.

C. Confirm that you and the driver have signed the manifest and give the driver his copies.

VII Site Shutdown after Loading is completed.

A. Confirm that valves 703a, 702a & b, 704a & b are closed.

B. Confirm that the loading hose has its 3” plug installed and that the hose is pulled over the tank containment wall and is hanging on it’s storage hook.

C. Adjust placement of containment pad in the loading area as it tends to slip northward during the loading operation.

D. Empty the 5 gallon buckets into the top of tank 703 as needed.

E. Take all paperwork back to the IM-3 office and put on the DenBeste dispatch desk in the control room.

VII Contacts and or Questions may be directed to the following.

A. IM-2 Project Manager: Steve Hancock 707-975-1444

B. Dispatcher: Curt Watson 707-974-0923

C. Author: Doug Boostrom 707-974-5119

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

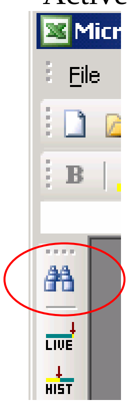
Title: Data Historian Use
Number: IM3-SOP-016
Revision Date: 10/27/2005

Scope

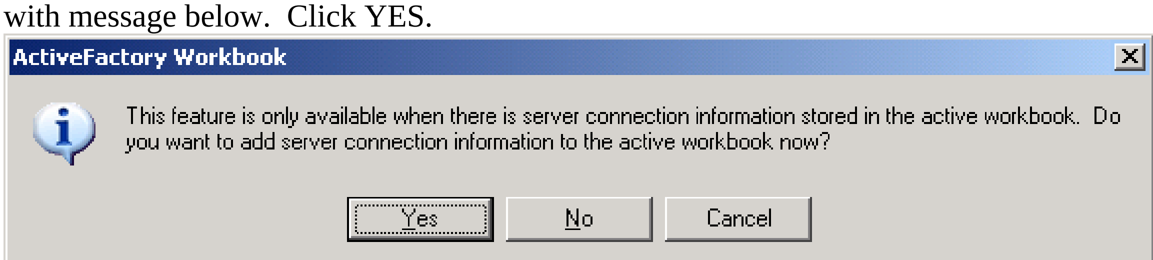
The Data Historian is a SQL database system operating through an Excel link. The purpose of this SOP is to download data from the HMI data using the Data Historian.

Procedures

1) Log into Data Historian computer.
2) Open Excel, the "Active Factory" toolbar will be on the left of the screen and the "Active Factory" will appear at the top of the screen.
3) Open a new workbook, and then click on the binocular icon (Tag Search) on the "Active Factory" toolbar.

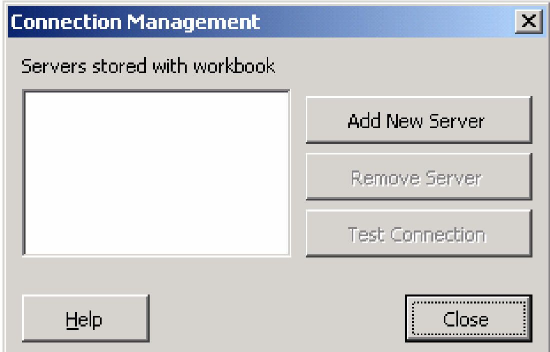


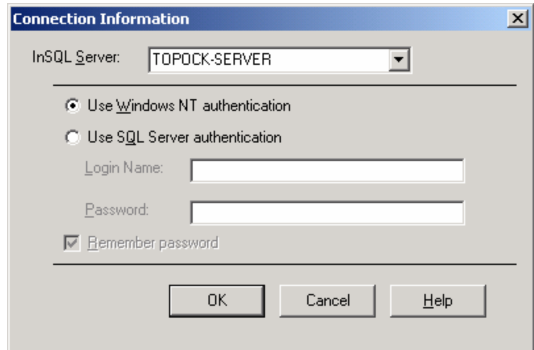
4) If you are not logged into the serve you may be prompted to add a server connection with message below. Click YES.



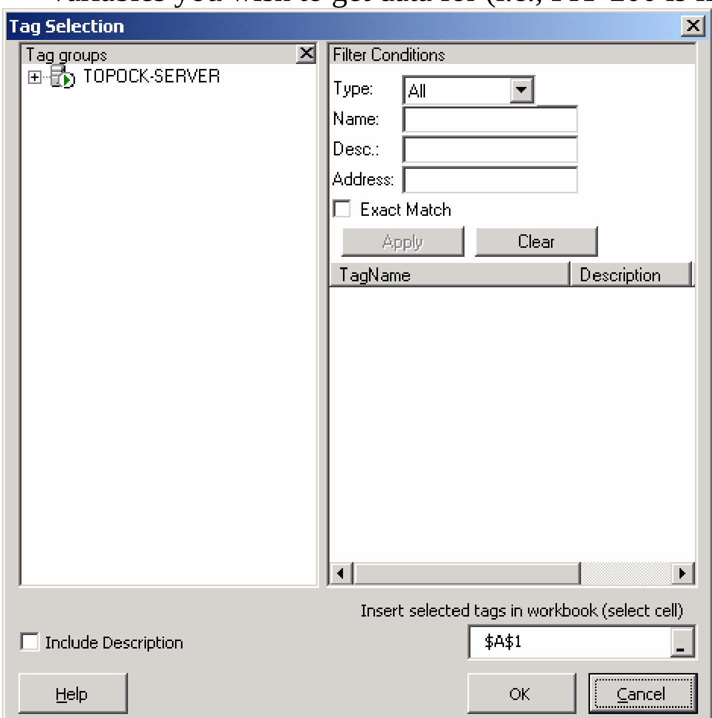
5) Popup window "Connection Management" below appears. Click Add New Server, which will bring up a window "Connection Information" now select at the InSQL Server window: TOPOCK SERVER and click OK which should return you to Connection Management window, now with TOPOCK SERVER in "Servers Stored

with workbook" frame. Then click CLOSE in the Connection Management window.



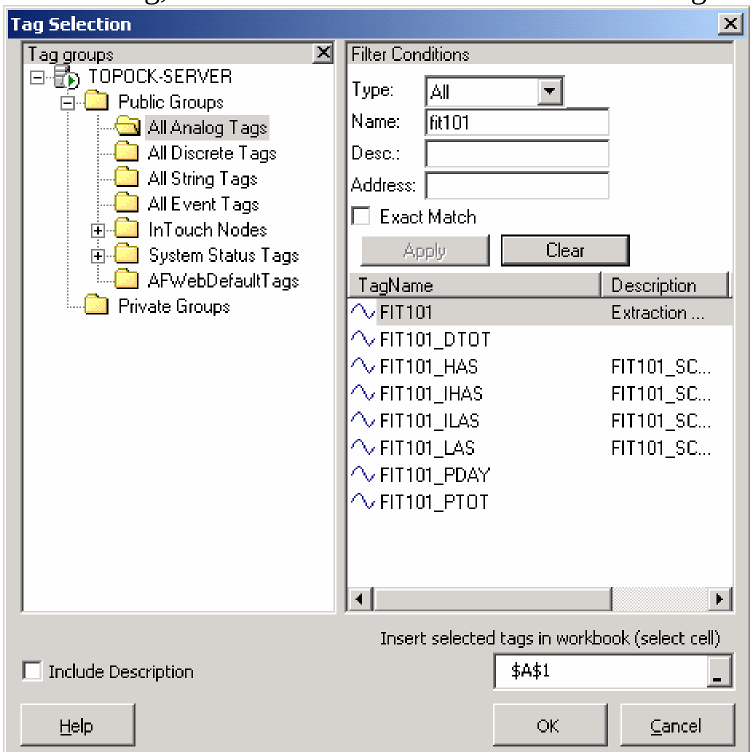


6) Tag Selection window pictured below should now appear, you can now select the variables you wish to get data for (i.e., FIT-200 is flow from Raw Water Pump).

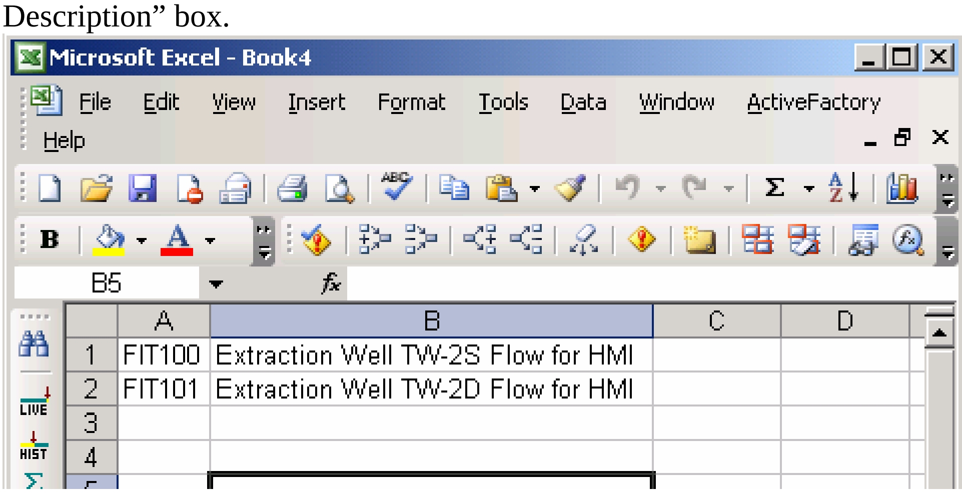


a) Select by expanding the Tag Groups using the + symbol by TOPOCK-SERVER in left frame of window and then + by Public Groups folder. Highlight either the All Analog Tags (i.e., for flows, levels, pH) folder or All Digital Tags (i.e., for switches) folder.
b) Then enter the Tag Name in the Name slot in the Filter Conditions (upper right) frame of the window, and click Apply. Those tags with the desired variable ID should appear in the lower right frame of the window. You can use a part of a name (i.e., enter "FIT" to get all flow meter readings. Note that many tags are shown for every variable (i.e., entering FIT100 actually brings up FIT100, FIT_DTOT, FIT100_HAS, FIT100_LAS, FIT100_PDAY, FIT100_PTOT. In this case, you will want the FIT100 for flow data).

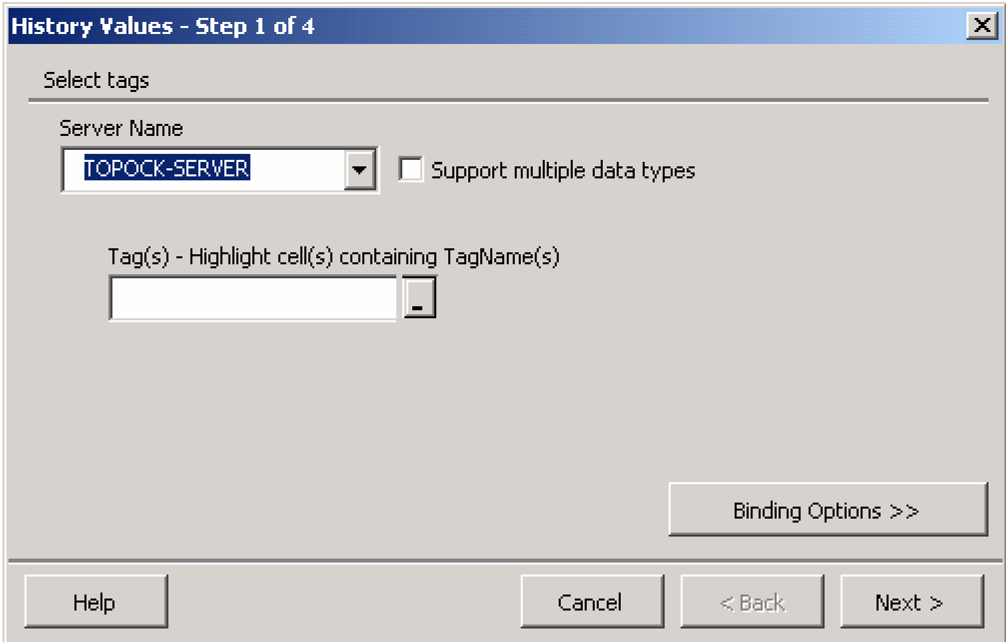
c) Finally, highlight the TagName to be captured and click OK. If you want more than one tag, hold down Control button when selecting.



7) This will put the Insert Selected tags in workbook (select cell) frame reads A1 as shown below. To get the description included along with the tag, check the "Include Description" box.



8) Click on the "Hist" icon on the Active Factory toolbar on left of screen. The HISTORY VALUES STEP 1 OF 4 window will appear to start a 4-step process to build and format the data download that will be generated from the database query.



a) Step 1 – Select Tags: Click in the "Tag(s) – Highlight cells(s) containing TagName(s)" frame and then highlight in the worksheet those tag names desired. You should see flashing dashed box around the cell(s). Click the Next button
b) Step 2 – Select Output Options: Choose the Output Location. Select the output location cell that you want to be the upper left corner of what will be a multi-column array (date/time is first column, values of each tag are each in column). Verify that the "Enter the results as an array-formula" box is checked. Click Next.
c) Step 3 – Select Query Options: is 4 tabs:
   i) Format: Should keep the "Allows 'value' based criteria and the ability to include 'quality' field" radio button selected.
   ii) Display Options. All boxes unchecked.
   iii) Criteria. Check the "Value is not null" box and the "Quality is" Good box. Others unchecked.
   iv) Resolution. Select radio buttons "Return values evenly spaced" and "Values spaced every". Then select the value spacing, note that this is in ms (milliseconds or thousandths of a second). A typical value would be a data point every 5 minutes, or 300,000 ms. Values at every hour is 3,600,000 ms.
d) Click Next.
e) Step 4 – Select time period: Can select Relative Time (a selected period of time from a selected date/time) or Absolute Time (between two selected dates/times). Typically select Absolute Time and two date/times.
f) Click Finish.

9) This should dump data along with Date Time labels in the first column.

10) Note that the values are at this time actually formulas linking back to the database so can not be sent to another computer. Need to either:

a) Select and copy the entire array of data and then Paste Special / Formulas Only over the data array, or
b) Save As a CSV file; Close file; Reopen file; and Save As .XLS file.

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: Flow Rate Changes
Number: IM3-SOP-017
Revision Date: 10/27/2005

Scope

The objective of this SOP is to describe how to adjust the extraction, treatment, and extraction system during changes to overall flow (defined as changes to extraction rate). Note that this does not cover changes within the treatment and/or injection system for tank level management.

Approach:
Changes to the extraction rate will be rare. They should be made at the direction of PG&E and/or Engineering. They are predicted to occur only a few times a year. It is noted that if extraction rate is set low (especially below 50 gpm), the extraction pumps are designed to cycle on and off based on level in Raw Water Tank, this is acceptable and appropriate.

Procedure:
Extraction System:

Summary: Flow from extraction well TW-2D is controlled by throttling manual valve in Valve Vault #1 at MW-20 Bench (V-RW-102-02). TW-2D should not be operated below 45 gpm. If more than 95 gpm is required, turn ON TW-2S and set total extraction flow by modulating valve throttling TW-2S flow (V-RW-108-02). TW-2S should not be operated below 25 gpm.

More information is provided in the *Extraction System O&M Manual*.

Treatment System:

Flow changes within the treatment plant are made by setting FCV-200 at the HMI. Flow should be set slightly higher than extraction flow to compensate for return of water to the Raw Water Tank via the Process Drain Tank (T-900) such as Microfilter backwash and turbidity meter drains; and events such as rainfall or sludge dewatering. Significant changes to plant function due to changes in flow through include:

- Chromium reduction / Iron oxidation / clarifier:
  - Nearly all processes should adjust automatically.
    - Ferrous and polymer feed are flow-paced.
    - Caustic feed is pH and flow paced.
    - Pumps react to tank level and flow control setting.

- The effectiveness of the chemical flow-pacing should be checked by visually observing that floc formation in clarifier is still producing a 'coarse sand' slurry.
- The effectiveness of the chemical flow-pacing should be checked by also by scrutinizing on-site lab results to ensure that hex chromium is still being removed by T-300 point, and ferrous residual maintained after T-301C.
- MANUAL CHANGES NEEDED:
  - Sludge recirculation and sludge wasting rates will both need to be modified to keep Key Parameters within target. Sludge recirculation rate (P-404 cycles/min) should be set to maintain the T-301C TSS (sample tap SC-301C) in the range of 2,000 to 4,000 mg/L. Sludge wasting rate (P-401 cycles/hour) should be set to maintain the clarifier underflow percent solids (sample tap SC-400E) in the range of 2 to 5 percent.

- Microfilter: Flow through Microfilter is controlled based on tank level so will adjust to flow change automatically.
- RO: Flow through RO is fixed at roughly 135 gpm feed. The ability of the control valves around the RO to operate in automated mode (i.e., fully control the RO bypass, brine, and permeate flows) depends on the conductivity of the influent groundwater, the target conductivity at AIT-702 (effluent conductivity), and the permeate/brine balance on the RO. Some manual adjustments may be needed to ensure that the control valves around the RO operate in automated mode and steady-state conditions are achieved. It has been confirmed that automated mode works well at 70 gpm without any manual adjustments to the bypass lines around the control valves. However, manual adjustments will be necessary as system processing rates are decreased below approximately 50 gpm or increased above approximately 90 gpm. Details on the control valves and manual adjustment are as follows:
  - Level in RO Feed Tank T-600 (8 feet). Controlled by LCV-603 on the permeate recirculation line to T-600. LCV-603 can be "assisted" in controlling level by adjusting the "clamp" on LCV-603. Figure 1 shows the effect of the clamp settings on LCV-603. The two "clamp" settings correspond to the LCV-603 setting at a T-600 level of 25% (upper control level) and 75% (lower control level). As the T-600 level drops below the target level (8 feet , or 50%), the valve will open based on the slope of the line over the valve control range. Alternatively, if the T-600 level rises above the target level, the valve will close according to the slope of the line over the valve control range. When the T-600 level falls below 25% full or rises above 75% full, the clamps no longer control the valve setting. Under steady-state operations, the span on the clamp range should be about 20%. MANUAL ADJUSTMENTS: At system processing rates below 70 gpm, LCV-603 may not be able to maintain the level in T-600. CTV-603 (bypass line around LCV-603) should be opened sufficiently to allow

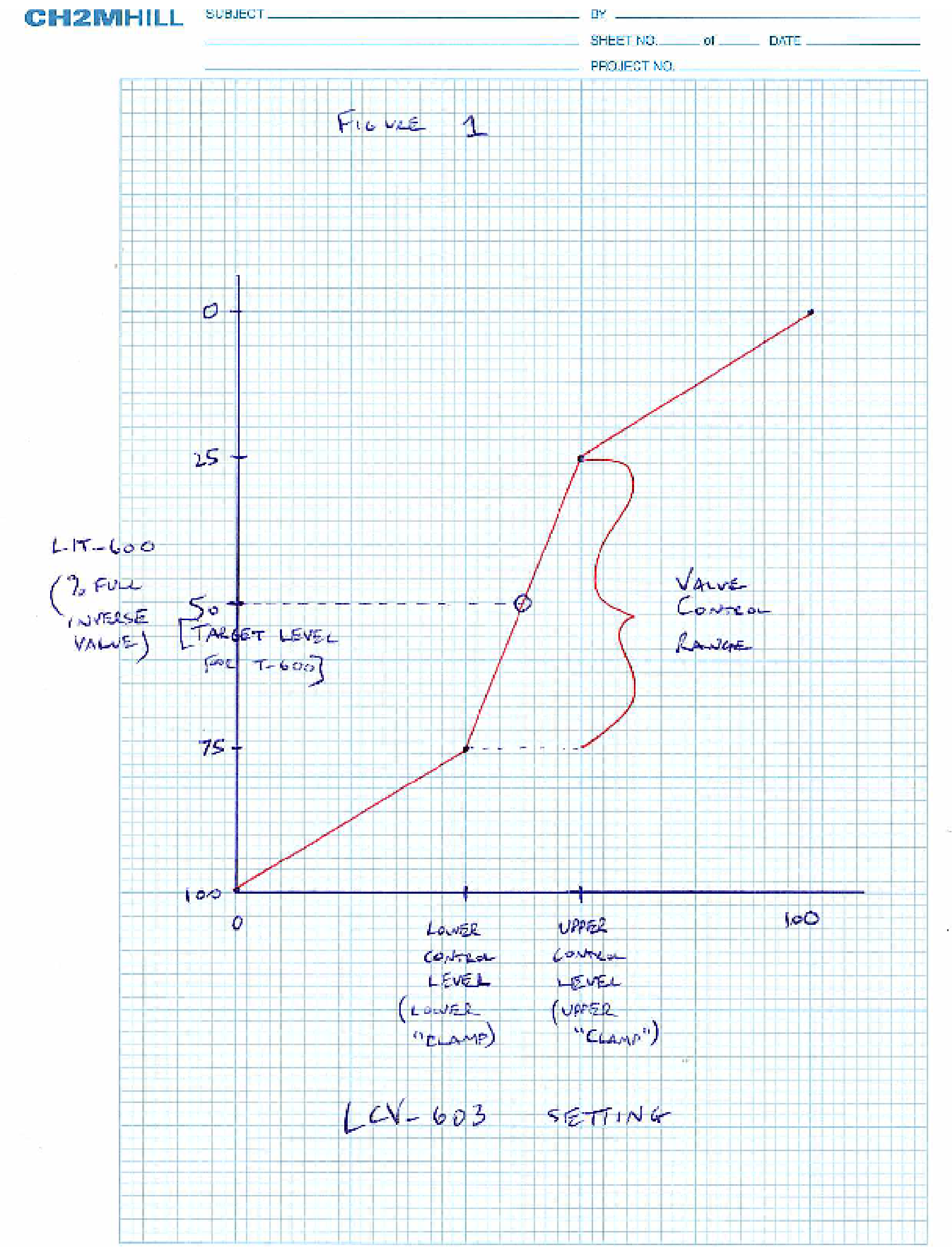
LCV-603 to operate in automated mode. Adjustments to CTV-603 will likely require similar adjustments to CTV-602 (see next item).

  - Conductivity of Permeate/Brine recycle to T-600 (match AIT-600, conductivity of new water entering T-600 from the microfilter). Controlled by FCV-602 on the brine recirculation line to T-600. MANUAL ADJUSTMENTS: At system processing rates below 70 gpm, FCV-602 can be "assisted" in controlling conductivity in two ways. The main way is opening CTV-602 (bypass line around FCV-602) to allow FCV-602 to operate in automated mode. In addition, valve V-TW-109-01 on the brine routing to T-701 can be throttled to reduce the brine wasting rate from the system.

  - Level in Forced Draft Aerator T-603 (6 to 9 inches). Controlled by LCV-604 on the permeate line to T-700. MANUAL ADJUSTMENT: At very low system processing rates (below about 40 gpm), LCV-604 can be "assisted" in controlling level by throttling manual valve immediately on discharge of the active pump (P-605A or B).

  - Conductivity of RO Bypass blend to T-700 (setpoint AIC702 on the HMI). Controlled by FCV-615. MANUAL ADJUSTMENT: At high system processing rates (in excess of 70 gpm), high conductivity setpoints (above 7600 µS/cm), or low groundwater conductivities (below about 10,000 µS/cm), FCV-615 can be "assisted" by opening valve CTV-615 (bypass line around FCV-615) to allow FCV-615 to operate in automated mode. In addition, the manual valve on the return pipe from P-620 to T-600 can be opened to further assist FCV-615.

- Treated water effluent (flow to T-700): The flow rate of treated water effluent results from the flow controlled by LCV-604 and the RO Bypass blend controlled by FCV-615 (and potentially CTV-615).



Injection System:

Flow to the injection wells can be operated either as on/off mode using level in T-700 to turn P-700 on/off. HOWEVER, it is preferred to keep P-700 on so that other services around plant (hose bibs, polymer makeup) are charged. Therefore, it is preferred to modulate the flow to the injection wells to match the flow into T-700 (which should be roughly 85% of the flow from the extraction wells). Change flow to injection wells using the ½" CRL fitting on SV-1202 or SV-1203. After the change to these valves by Cla-Valve on September 8, 2005, these valves are adjusted through the procedure below:

1. Verify the target injection flow, typically 85% of extraction flow rate

2. Will need wrench and confined space equipment such as air monitoring and two operators as this is confined space
3. Flow is changed by adjusting the bolt on the ½" CRL fitting
4. Loosen locknut (the inner of the two nuts on the bolt)
5. Adjust the nut on the outer end of the bolt, read the local flow meter until flow is at desired rate
6. Verify flow holds at the target rate. This may take 2-3 minutes when increasing flow, but up to 20-30 minutes when decreasing the flow. If the bypass cartridge filter is open it exacerbates this problem.
7. Tighten the locking nut
8. Close up the injection well vault
9. Log the change in the Operator Log

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: <u>Cleaning RO in Place</u>
Number: IM3-SOP-018
Revision Date: 12/9/2005

Scope

The objective of this SOP is to instruct operators on when and how to perform a chemical clean in place of the RO system. This SOP is written to augment and clarify the manufacturer's instructions for RO clean in place (CIP).

Precautions/Hazards

Operators should verify that regulators have been notified of planned plant down time as this operation will likely take longer than the buffer provided by the volume of the Raw Water Tank. Follow site H&S Plan.

References

Additional information is also available in RO O&M Manual, Section 4: "RO 154 General Cleaning Procedure", Ecolochem 9/13/2004 and "RO Cleaning Procedure", Ecolochem 7/6/2001.

Equipment / Preparation

Performing a RO clean in place will require:

- Manage the tank levels in T600, T500, T100, and T700 to minimize extraction well downtime.
- Drawings with valves identified (see figure below)
- Clean in place tank (T- 601) be empty prior to starting
- Citric acid: five (5) 50-pound bags
- 1,500 gallons of RO permeate in a temporary tank or water in T-700 that has been managed so as to minimize conductivity (the lower salinity, the more effective the cleaning. Soft target is 1,500 uS/cm)

- RoClean L211 (an AVISTA Technologies product): two (2) 5-gallon buckets (this is a caustic chemical that is buffered to hold a pH of 10-11, it also has some additives to help with cleaning)
- Sodium hydroxide to raise pH of cleaning solution to 11-12. This will likely require a small amount (5-10 gallon). This should be taken from the sodium hydroxide totes using the valve and tap on the caustic

header, fit with a section of flexible hose (see photo).

- Waste disposal truck with vac fitting to remove waste. Coordinate with T&D Contractor (Denbeste). Will likely generate 1500 to 2000 gallons. Will need to have this trucked to off-site disposal facility.
- Hoses for temporary connection from CIP Tank to RO Skid. Requires three hoses, two hoses each with 2″ female Cam Lok fittings on each end and one with 3″ female Cam Lok fittings on each end. A fourth hose is required to carry water from CIP Tank (VALVE-K) 3″ cam-loc fitting to a tank truck.
- Hand-held or lab pH meter
- ½″ deep-socket wrench for cartridge filter
- 5/8″ open-end wrench for automatic valve on RO
- Rubber mallet
- 14 cartridge filters
- Several 5-gallon buckets or drain pans for drips
- Squeegee and Wet Floor signs or cones
- PPE: See H&S Plan

Procedure

1) The need for an RO CIP will be indicated by either:

   a) Pressure drop across Stage 1 concentrate channel of >20 psi, or 10 to 15 percent of clean baseline, or
      Pressure drop across Stage 2 concentrate channel of >20 psi, or 10 to 15 percent of clean baseline, or
      Pressure drop across Stage 3 concentrate channel of >20 psi, or 10 to 15 percent of clean baseline

   b) RO system feed pressure increase of ~ 10 to 15 percent above clean baseline conditions at constant permeate flow rate, constant temperature and constant feed conductivity.

   c) Normalized flux decline of 10 to 15 percent from clean conditions.

2) Prepare for CIP:

   a) Verify chemicals to be used with Engineering and Vendor. Chemicals are chosen based on foulant present. Initial procedure will be per Ecolochem September 13, 2004 memo: **citric acid, RoClean L211, citric acid**, rinse.

   b) Arrange for 1,500 gallons of RO permeate in a temporary tank or water in T-700 that has been managed so as to minimize conductivity (the lower salinity, the more effective the cleaning. Soft target is 1,500 uS/cm)

   c) To begin CIP, shutdown the RO system at the HMI and then by turning HAND-OFF-AUTO on RO panel to HAND. Exception is if permission has been granted to discharge RO Bypass by Engineering. Shutting down RO will cause cascading shutdown of processes upstream (i.e., T600 High level shuts down microfilter, then T500 High level shuts down P-400, then T301C High level shuts down P200, and then T200 High level shuts down extraction well pump(s)). This will help minimize the downtime of the extraction well pumps.

   d) Verify RO cartridge filters are in place as in normal operation to avoid damaging membranes during cleaning.

   e) Temporarily reset pH alarm points to avoid alarms during cleaning using touch pad on RO control panel.

      i) Click MENU, then right arrow:

      ii) Select SETPOINT #1 Low pH Alarm, select TYPE = OFF.

      iii) Select SETPOINT #2 High pH Alarm, select TYPE = OFF.

      iv) Select EXIT

   f) Connect CIP Tank to RO Skid. This is illustrated in photo below.

      i) 3”: CIP Skid discharge (VALVE-G) connects to the RO Skid Feed (VALVE-E)

      ii) 2”: CIP Skid Concentrate Return (VALVE-I) connects to RO Skid Concentrate drain (VALVE-F)

iii) 2″: CIP skid Permeate Return (VALVE-H) connects to RO skid Permeate drain (VALVE-D).

g) To increase the axial velocity (turbulence) of the cleaning solution and maximize the amount of feed that will clean the Concentrate path (where scale would form), open the concentrate bypass valve 100%. This is the chrome-plated needle valve located on the front of the RO skid, near the north end. It is used to increase or decrease the concentrate flow.

h) Isolate RO system:

i) Close valve V-TW-101-01, the valve that isolates T-600 from the 601 pumps.

ii) Close valves on discharge side of P-601A and P-601B to prevent backflow of solution.

iii) Close valves that carry brine to T-701 and permeate to Forced Draft Aerator.

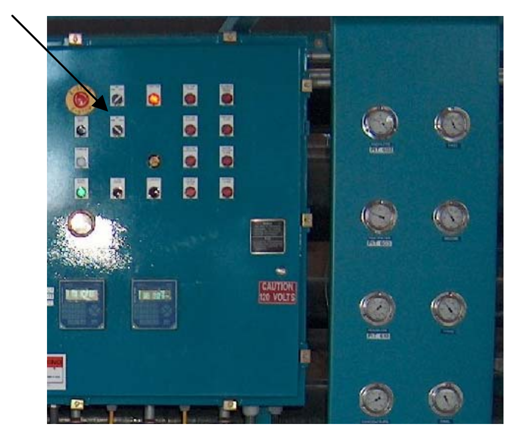
3) Flush system with RO permeate by:

a) Fill CIP tank with roughly 350 gallons of RO permeate.

b) Open valves so that the three connection hoses are open at each end.

c) Verify RO panel HAND-OFF-AUTO switch to HAND.

d) Set Run1-OFF-FILL1[a] switch to FILL1 on the RO control panel. Verify that the Electrically Actuated Valve opens, if not cycle the FILL1 switch. (Note: Fill1 opens the automatic



[a] RUN1 mode opens automatic valve and then turns on the high-pressure pump P-602
FILL1 mode opens automatic valve

valve upstream of the P-602. This valve will close after approximately 20 minutes in FILL mode, so if an extended flush is to be done, will need a wrench to open the valve. Display on top of valve slides up to access stem to turn with wrench.)

e) Flush. Turn ON-OFF-AUTO switch on Clean in Place Skid control panel to ON. Slowly close RO Recycle (VALVE-J) to force the water through the RO system until Pre-Filter pressure reads 65 psi. for 5-10 minutes or until temperature (permeate or feed) reaches 105F.

4) Prepare First Citric Acid Solution

a) Use the 350 gallons from the Flush for the first stage of the cleaning to save on disposal and water.

b) Add Citric Acid to water in CIP Tank through the manway on top of tank. Slowly add 150 pounds of Citric Acid directly into CIP Tank. Follow H&S Plan for handling citric acid.

c) Mix citric acid solution by routing flow of CIP Pump directly back into the CIP tank (not the RO skid) by ensuring valves closed on the three connection hoses and opening CIP Recycle valve (VALVE-J) and Recycle Loop valve (VALVE-O). Then open the Cleaning-in-Place Skid Recycle Loop Valve (VALVE-J) 50%. Turn the CIP Skid Pump (P-603) ON. Recirculate the solution for approximately 5 minutes to mix.

d) Turn OFF the CIP pump P-603 to stop solution mixing.

e) Check the pH of the cleaning solution. Target is pH 3.0, with acceptable range of 2.5 to 3.2. If pH is >3.2, add more acid and repeat mixing and pH testing until within range.

5) Citric Acid Wash

a) Open hose flow pathways from CIP Tank to RO Skid by opening valves:

i) RO CIP Permeate (VALVE-D)

ii) RO CIP Feed (VALVE-E)

iii) RO CIP Concentrate (VALVE-F)

iv) CIP Discharge (VALVE-G)

v) CIP Permeate (VALVE-H)

vi) CIP Concentrate (VALVE-I)

b) Start RO pumping; ***Generic Pump Start Method:***

i) Open RO Recycle valve (VALVE-J) 100%

ii) Turn CIP Pump P-603 ON at CIP Skid Control Panel

iii) Slowly close RO Recycle valve (VALVE-J) until Pre-Filter pressure gauge on RO Control Panel is 65 psi

iv) Set RUN1-OFF-FILL1 switch to RUN1 to turn on RO High-Pressure pump P-602

c) Wash for up to 1 hour or until temperature (Feed or Permeate) reaches 105 F. (Note: Watch the Stage pressures, you should see a slight ~30psi decline.) During wash, monitor the pH, foulant dissolving off the membrane may affect pH, typically decreasing it. Stop procedure to add more Citric Acid if pH rises above target range of 2.0 to 4.0. If pH drops below 2.0, end Wash.

d) To end Wash

(1) Open RO Recycle valve (VALVE-J)

(2) Turn RUN1-OFF-FILL1 to FILL1 to turn OFF P-602

(3) Turn OFF the CIP Pump P-603 at the CIP skid panel

(4) To prevent draining the RO during the upcoming Soak, close the valves on the RO Skid end of the 3 connecting hoses.

6) Citric Acid Soak

a) Let solution sit in RO for 1 to 24 hours, as time permits. Note: Manufacturer's representative's suggestion is to try a 1-hour soak until cleanings found to be ineffective. One hour soaks should be adequate for iron oxide which should be our main foulant, longer soaks are needed if foulants such as gypsum are present.

7) Citric Acid Post-Soak Flush

a) Turn ON P-603 and then P-602 using Generic Pump Start method above.

b) Run flush for 15 minutes or until Feed or Permeate reaches 105F.

8) Remove Citric Acid Solution to Waste

a) To end the Soak, reverse earlier isolation of the skid by opening the valves on the RO Skid at the 3 connecting hoses.

b) Flush out any solids remaining that may have come loose during soak by turning on P-602 using the Generic Pump Start method above. Run for 15 minutes or until Feed or Permeate reaches 105F.

c) Empty out the CIP Tank:

i) Connect a hose with 3" female cam-loc to CIP Waste connection (VALVE-K). Turn P-603 ON to pump CIP tank to the vac-truck (or use a vac hose to pull water from the tank). Be sure to safely secure hose. There will be 6 to 8" residual left in the tank.

ii) Transfer some RO Feed water into CIP Tank to dilute this remaining acid solution by Open valves on P-601 discharge and then pumping from T-600 with P-601A or B. Bring CIP Tank to roughly 400 gallons.

iii) Close valve on discharge of P-601 to again isolate the RO skid.

iv) Turn P-603 ON to pump CIP tank to the vac-truck (or use a vac hose to pull water from the tank). Be sure to safely secure hose. There will be 6 to 8" residual left in the tank again, but this is OK.

9) RoClean L211 Solution Phase. This is similar to Acid Phase above, with the following notes:

   a) RoClean L211 Solution Preparation:

      i) Once CIP tank has been drained of acid rinse water, begin RoClean L211 process. Fill CIP tank to 350 gallons with RO permeate.

      ii) Add 10 gallons of RoClean L211.

      iii) Mix solution within CIP Tank using P-603.

      iv) Check pH and add sodium hydroxide to the cleaning solution to raise the pH to between 11-12

      v) Mix solution within CIP Tank using P-603. Repeat until pH is 11 to 12.

   b) RoClean L211 Wash. Start P-603 and then P-602 using Generic Pump Start method until water (permeate or feed) is 105F, or 20 minutes. Readjust the pH with caustic to 11-12 if pH is depressed below 11 during recirculation. End wash and isolate RO Skid for soaking.

   c) RoClean L211 Soak. Routinely soak for 4 hours. If flow performance is not restored to ~95 to 98 percent of clean conditions, either repeat the cleaning cycle or increase soaking time during next cleaning cycle.

   d) RoClean L211 Flush. Start P-603 and then P-602 using Generic Pump Start method until water (permeate or feed) is 105F, or 15 minutes.

   e) Remove RoClean L211 to Waste as in the Acid phase above. Note that this is adding dilute high-pH solution to dilute acidic solution. It appears from the first CIP and chemistry that this should not generate significant heat or reaction, however, care should be taken.

   f) Rinse. Rinse with permeate or water from T-700 until pH decreases to ~8.5 to 9.0 or below.

10) Second Citric Acid Phase, once CIP tank has been drained of rinse water, begin final citric acid cleaning process.

   a) Acid Solution Preparation:

      i) Once CIP tank has been drained of caustic water, begin second citric acid process. Fill CIP tank to 350 gallons with RO permeate.

      ii) Add 100 pounds of citric acid.

      iii) Mix solution within CIP Tank using P-603.

iv) Check pH and add more acid, if needed, to get to pH 3 to 4.

v) Mix solution within CIP Tank using P-603.

b) Citric Acid Wash. Start P-603 and then P-602 using Generic Pump Start method until water (permeate or feed) is 105F, or 20 minutes. Readjust the pH with acid to if pH is above 4 during recirculation. This step does not need great accuracy, so the pH reading on the RO control panel can be used rather than sampling CIP Tank. End wash.

c) Citric Acid Soak is NOT done.

d) Remove Citric Acid to Waste as in the Acid phase above.

11) Final Flush.

a) Need to drain pipes and dilute the solution within the RO skid, can use water from T-600. Close the RO Feed and Return Valves so that T-600 water flows as normal into the RO Skid. Turn ON P-601A or B for 2 minutes. Water will flow out of the RO permeate hose and Concentrate hose to the CIP Tank.

b) Because no permeate is created with just P603, now need to turn on P602 using Generic Start Method above. Run until the pH of feed water goes up to 4.

c) To reduce waste produced, can now route the permeate to the Forced Draft Aerator by opening isolation valve in permeate line. Then turn ON pumps P-603 and P-602 using Generic Start method until Feed pH returns to above 6.5. Caution: P-605A or B will not turn on to empty the FDA since the RO skid is still in HAND rather than AUTO, so the FDA can overflow. Therefore, will need to watch level in FDA (sight glass) and turn P-605A or B to HAND when level rises to roughly 6". The LCV-604 should then throttle P-605 to maintain the level in FDA, but this should be visually verified.

12) Change cartridge filters:

a) Open the yellow drain valves at base and top of cartridge filter canisters

b) Fully drain, attempt to catch as much as possible in bucket

c) Close the bottom drain valves

d) Remove the clamp using ½" wrench

e) Remove top of canisters

f) Remove the 7 filters from each canister

g) Insert 7 new filters in each canister, ensuring that they fit into the holes in the bottom plate. The filters have a short stretch without fiber material, this end goes up.

h) Reattach top plate and wing nut. Tighten to only loose hand tight, plastic mesh of filter should just begin to distort.

i) Inspect O-rings in canister

j) Replace top of canisters. Tap with rubber mallet. Reattach ring.

13) Reset system for normal operation:

a) Reset pH alarm points to reset alarms using touch pad on RO control panel. Click MENU, then right arrow:

i) select SETPOINT #1 Low pH Alarm, select TYPE = ON. Reset to value from pre-test conditions.

ii) select SETPOINT #2 High pH Alarm, select TYPE = ON. Reset to value from pre-test conditions.

iii) Select EXIT

b) Reset all valves to original positions

c) Reset the concentrate bypass valve to the normal position. This can be observed when permeate / concentrate split returns to baseline (100 gpm permeate, 33-35 gpm concentrate).

d) Disconnect hoses from CIP, drain hoses to T-900, rinse hoses using RO permeate and directly into T-900 , and return hoses to storage.

e) Return P-605A or B and P-601A or B to AUTO.

14) Ensure waste is transported off-site by T&D contractor

15) Note any deviations from this procedure, the chemicals used, and pressures before and after procedure in table below and transcribe to operations log.

	Prior to CIP	**After CIP**
Date and Time		
Operator(s) Name doing CIP		
Pressure Pre-Filter (psi)		
Pressure Post-Filter (psi)		
Pressure - First stage (psi)		
Pressure - Second stage (psi)		
Pressure - Third stage (psi)		
Pressure – Final (psi)		
Feed conductivity (uS/cm)		
Permeate conductivity (uS/cm)		
Permeate flow (gpm)		
Concentrate flow (gpm)		
Chemicals used (type and amount)		
Deviations from SOP		

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: Microfilter Clean-in-Place
Number: IM3-SOP-19
Revision Date: 10/5/2005

Scope

The objective of this SOP is to instruct operators on when and how to perform a chemical clean in place (CIP) of the microfiltration (MF) system. This SOP is written to augment and clarify the manufacturer's instructions for MF CIP and to provide site-specific details.

Precautions/Hazards

Operators should verify that regulators have been notified of planned plant down time as this operation could take longer than buffer provided by volume of Raw Water Tank. Follow site H&S Plan.

References

Pall AP-3 O&M Manual (pages 81-84; Appendix C, Pages C2 (CIP Message Screen) and C11-13 (Chemical Usage Tables).

Equipment List

Performing a MF clean in place will require:

- Citric acid: liquid (8 gallons of 50% solution per acid wash step to be executed) or solid (40 pounds per acid wash step to be executed)
- Sodium hydroxide (caustic): (4 gallons of 25% solution per caustic wash step to be executed)
- Sodium hypochlorite: (approximately 1 gallon of 12.5% solution per caustic/bleach wash step to be executed)
- Sufficient tank storage for containment of CIP waste
- Skid-mounted air diaphragm pump
- Hoses for connecting fluid intake on air diaphragm pump to MF skid and fluid discharge to waste storage tank
- Hoses for filling T-1 (feed tank) on AP-3 skid with RO permeate or T-600 water
- Tubing for compressed air [official name of the quick connect tubing??]
- Ladder (to open and access the top of T-1, the MF feed tank)
- Personal protective equipment for use of caustic, bleach, and dry or liquid citric acid

General Information

1) The need for a MF CIP will be indicated by either:

   a) Transmembrane pressure on the MF exceeds 30 psi

   b) MF has been in operation for 3 months since last CIP

2) Per guidance in the Pall O&M manual, citric acid wash will precede caustic wash because metal hydroxides are the dominant source for membrane fouling.

3) Pall does not prescribe exact chemical strengths for the CIP. Appendix C provides typical concentrations, but operations personnel may develop more appropriate site-specific formulations.

4) Chemical and rinse water circulation times are subject to site-specific modification.

Procedures

1) Obtain appropriate quantities of chemicals (acid and caustic) based on the details in Appendix C of the Pall O&M Manual (pages C11-13).

2) Place any temporary waste storage tank(s) for CIP waste water near the microfilter.

3) Unscrew the hexnut bolts on the lid on MF feed tank T-1. Store the bolts in a safe place.

4) Connect water hosing to allow water transfer from the RO permeate tank or gravity feed from T-600 to the MF feed tank (T-1) on the AP-3 skid. The inlet connection on the AP-3 skid is labeled ____________ (west side of the AP-3 skid).

5) Place and secure the air diaphragm drain pump near the southwest corner of the AP-3 skid (adjacent to HV-25, the off-skid ball valve for CIP waste flow). NOTE: The pump will vibrate significantly during operation, so it needs to be properly secured before being brought online.

6) Connect inlet and discharge fluid hoses on the air diaphragm drain pump. The inlet hose should be connected to [name the piping break at HV-24] and the discharge hose should be connected to the appropriate waste storage tank.

7) Shut down the MF at the HMI panel on the MF skid. NOTE: This step may be performed earlier if the MF downtime is not an issue (e.g., the entire IM3 system will be shutdown for maintenance).

8) Plug in the yellow electrical cord on the air diaphragm drain pump to the three-prong plug on the south side of the MF skid.

9) Connect compressed air line to the solenoid valve on the air diaphragm drain pump with the [official name of the quick connect tubing]. Open the valve on the compressed air line.

10) Open valve HV-25 on the fluid inlet line to the air diaphragm drain pump. Close valve HV-24 on the 4" drain line to the Process Drains Tank (T-900).

11) Perform the CIP per pages 81-84 in the Pall O&M Manual.

    - The Pall Aria™ Valve Truth Table on page C2 of Appendix C provides additional detail on the positions of all hand valves (HVs) on the MF skid. Valves LCV1 and V2 through V7 are automatically controlled by the MF PLC.
    - The air diaphragm drain pump will be controlled by the MF PLC.

12) Complete the CIP procedure with a clean water rinse cycle in order to leave neutral water in the hoses and pipes around the air diaphragm drain pump. Following completion of all chemical and rinse cycles per the CIP procedure, leave the MF in pause or shut down (if system is going to be down for additional maintenance. For longer term shutdowns, refer to the Pall O&M Manual for guidance on layup procedures.

13) Confirm that all hand valves are restored to "Auto Filter" settings per the Pall Aria™ Valve Truth Table. NOTE: This step is also noted on the HMI and within the CIP procedure during step 11).

14) Restart AP-3 skid. The MF should enter into a reverse filtration cycle following the CIP procedure.

15) Disconnect electrical cord on the air diaphragm drain pump.

16) Close valve on compressed air line. Release air pressure at the solenoid valve and disconnect air line from the air diaphragm drain pump.

17) Close the valves on the fluid inlet and discharge lines on the air diaphragm drain pump. Allow hoses to drain into the floor drain located south of the MF skid.

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: Ferrous Chloride Detection (Interim Procedures)
Number: IM3-SOP-020
Revision Date: 03/17/2006

Scope

The objective of this SOP is to describe activities to be done by IM3 operators until the automated safeguards assuring ferrous chloride flows are maintained. This SOP is written in response to lessons learned during the September 18, 2005 stress testing of the ferrous chloride system. The addition of ferrous chloride is essential to the IM3 plant treating the chromium contamination in the water.

Approach

Procedures already in place to check ferrous chloride flow will be continued. Additional checks will be added.

Procedures

Continue to perform the following checks:

- Visual inspection of ferrous pump and tote 1/shift.
- Confirmation that pump stroke length dial is set at pump to same value as is on HMI 1/shift.
- Drawdown test of ferrous pump 1/shift
- Confirm that ferrous pump is on during visual inspection 1/ shift.
- Confirm that all manual valves are open along run of ferrous chloride from tote to pump to injection point.

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: Motor Control Center Operation
Number: IM3-SOP-021
Revision Date: 10/28/2005

Scope

The objective of this SOP is to describe how the daily observations of the motor control center should be performed.

Approach:

There are no procedures that need to be performed on the motor control center. The motors are operated in most part through control that is part of the PLC control system. No manual adjustments are required during normal operations.

More information is provided in the *Cutler-Hammer Instruction Booklet 8926-1A*

Procedure:

IQ 7000 Power Meter: (Incoming Metering)

Summary: The power meter has the ability to monitor and display a variety of electrical parameters applicable to the operating conditions of the plant electrical system. Values such as phase current and phase voltage should be checked and recorded on a daily basis. The phase voltage is of particular concern at this facility because of the weak power system that feeds the plant. The voltage should read between 450 volts and 504 volts (480 $\pm$ 5%). It is also important to note the percent variation between phase A, phase B, and phase C voltage readings. This can be computed as:

(Largest reading minus smallest reading) ÷ (Average of all three readings) * 100%

The percent difference should be 3% or less. Any variations of more than 3% should be reported to Needles Power Company. Larger voltage variations can cause premature motor failure due to excess heating.

More information is provided in the *Cutler-Hammer Instruction Booklet IB02601001E*.

Power Factor Correction Capacitors:

Power factor correction capacitors are provided in the motor control center to help protect against low voltage conditions at the plant, and improve the plant running power factor. Power factor is the ratio between the KW (kilowatts) and the KVA (kilo volt-amps) drawn by an electrical load where the KW is the actual load power and the KVA is the apparent load power. It is a measure of how effectively the current is being converted into useful work output and more particularly is a good indicator of the effect of the load current on the efficiency of the supply system.

All current flow causes losses in the supply and distribution system. A load with a power factor of 1.0 results in the most efficient loading of the supply and a load with a power factor of 0.5 will result in much higher losses in the supply system.
A poor power factor is usually the result of a significant phase difference between the voltage and current at the load terminals. Poor load current phase angle is generally the result of an inductive load such as an induction motor, power transformer, lighting ballasts, welder or induction furnace.

There are three 30 KVAR (kilo volt-amps reactance) banks of capacitors installed. The breakers that feed the capacitors should be left in the ON position at all times. There are three red indicators on the front door of the capacitor compartment. During normal operation these indicators are OFF. When a fuse that protects the capacitors has blown, the indicator will light. The capacitor bank breaker should be left ON, but an electrician should be called to replace the faulty fuse. The faulty capacitor bank will not measurably affect the running of the plant. There are also power factor correction capacitors installed on the load side of the well pump motor starters. The red indicator lights, when lit, perform the same function as the capacitors that are attached to the MCC bus, with one exception. The pump starter capacitors are only in service when the pumps are running. Consequently, if there is a blown fuse, the red light will only illuminate when the pump in running. A blown capacitor fuse will not prevent the pump motor from operating.

<u>Transient Voltage Surge Suppressor:</u>

There is a Transient Voltage Surge Suppressor (TVSS) installed in the motor control center. Its purpose is to protect the plant from lightning and switching-induced surges in the overhead lines that feed the plant. The unit sends high energy induced lightning surges, as well as other forms of transient disturbances, to ground before they travel through the distribution system wires to sensitive loads. There is a circuit breaker that feeds the TVSS and it should be in the ON position at all times. There are three LED indicators located on the front of the Clipper Power System (TVSS) panel. Under normal operating conditions all three should be GREEN. Under abnormal conditions one or more of the LED's turns RED. If this happens, call Eaton Electrical technical support at 800 809-2772, option 1, sub-option 3. They will help determine the cause of the problem and offer assistance in the warranty process, if applicable. An alarm will also be registered in the PLC control system and a message will appear on the HMI alarm banner. The TVSS should be repaired or replaced as soon as possible.

More information is provided in the *Cutler-Hammer Instruction Manual IM01001002E.*

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: Manually Checking the Extraction Well Pipeline Leak Detection System
Number: IM3-SOP-022
Revision Date: 3/1/2006

Scope

The objective of this SOP is to describe the procedure for manually checking the double contained extraction piping.

Precautions/Hazards

Operators should have Confined Space entry training and operating experience before attempting to manually check for leaks. Operators will not attempt this task until they have been properly trained.

Equipment List

Confined space gas sniffer, step ladder, 2 large adjustable wrenches, vault key, Confined space entry permit, leather gloves, water level tape.

Procedure

1. Open Leak Detection Vault #1, lock lid in the upright position and test atmosphere. If the atmosphere is acceptable proceed, if not, contact your supervisor for assistance.
2. Enter vault using step ladder.
3. Look for signs of moisture around flange blinds. If there is no sign of moisture, slowly remove both flange blinds. While removing blinds be alert for signs of moisture. If there is moisture, contact your supervisor, before removing blinds, for assistance.
4. Lower water level tape into stand pipes. No moisture should be present. If moisture is present, contact your supervisor for assistance.
5. After vivifying that no moisture is present in either stand pipe, replace the blinds, remove yourself and your tools, lower and bolt the vault lid closed.
6. Repeat the above steps at Leak Detection Vault #7.

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: Trucking Water from T-500
Number: IM3-SOP-022
Revision Date: 3/1/2006

Scope

The objective of this SOP is to describe the procedure for moving clarified water from T-500 to the off-spec water tank at the 20 bench.

Precautions/Hazards

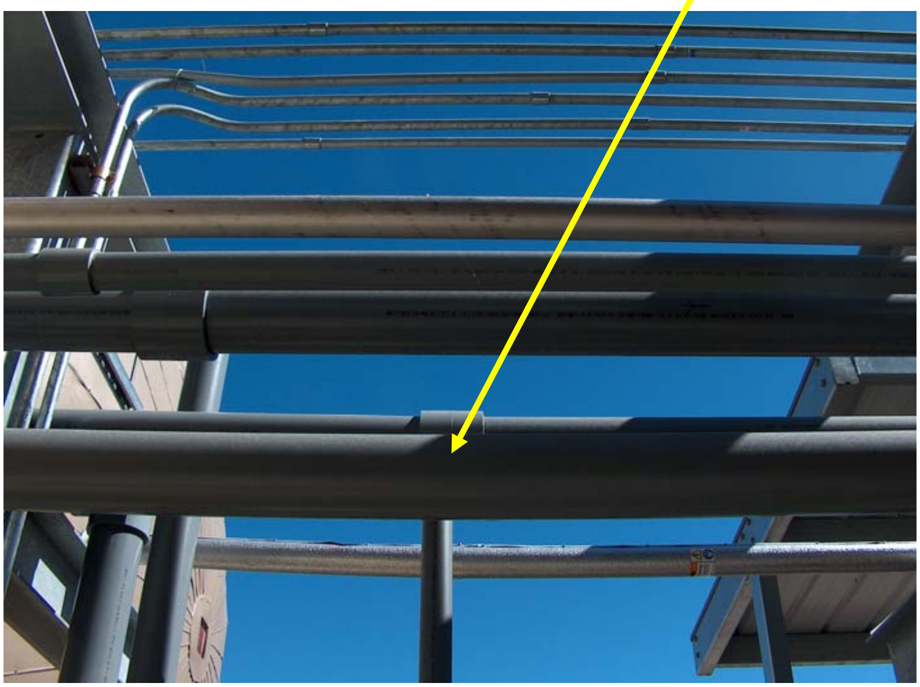
Operators should have Lockout/Tagout training and operating experience before attempting . Operators will not attempt this task until they have been properly trained.

Equipment List

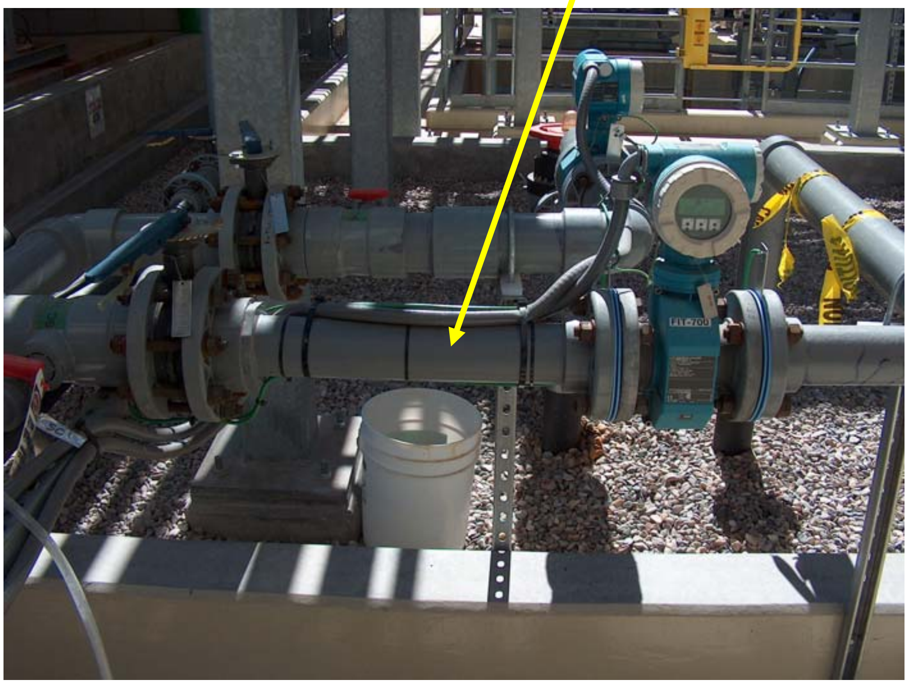
Confined space gas sniffer, step ladder, 2 large adjustable wrenches, vault key, Confined space entry permit, leather gloves, water level tape.

Procedure

1. Cut P-500 recirculation pipe and install a 4″ valve with a 4x4x3 tee upstream of the valve. Install a 3″ valve on the 3″ leg of the tee. Install a 3″ male cam lock coupler on the downstream side of the valve. (Install tee here).



2. Remove pipe spool upstream of FIT-700. Install a 4″ blind flange on the manual butterfly valve upstream of FIT-700. Build a new 3″ spool that has a 3″ female cam lock coupler on one end and a 3″ flange on the other end that will bolt to FIT-700. (Remove existing spool and install new spool here).



3. Use a 3″ hose that is properly anchored and supported to attach the P-500 recirculation line to FIT-700.

Appendix F
List of Equipment O&M Manuals

APPENDIX F

List of Equipment O&M Manuals

Equipment O&M Manuals are presented as supplemental volumes to this report:

- Volume 2: Reverse Osmosis System
- Volume 3: Microfilter System
- Volume 4: Clarifier
- Volume 5: Chemical Feed Systems
- Volume 6: Mechanical Equipment
- Volume 7: Instrumentation and Control / Motor Control Center
- Addendum: General Process Equipment Information

Appendix G
Alarms and Troubleshooting Summary

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
20	TP-PR-10-10-03	LSH100	TOPOCK1	LCP-001	DI	I:12/0	LSH100	20132	LSH100	Field Set	A	Well Vault No. 2 High Water Level	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2S	Leaking connection in well vault.		Accumulated rain water.					
27	TP-PR-10-10-03	LT100	TOPOCK1	LCP-001	AI	I:1.0		20165	LT100_HA	110% normal	A	Extraction Well TW-2S Level High	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2S	Possible pump malfunction. May also see low flow alarm and/or low pressure alarm.	Check pump.	Flow may be obstructed or valve closed. May also have low flow alarm or high pressure alarm.	Check valve settings.				
28	TP-PR-10-10-03	LT100	TOPOCK1	LCP-001	AI	I:1.0		20164	LT100_LA	85% normal	A	Extraction Well TW-2S Level Low	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2S	Throttling valve has been opened. May also have high flow alarm.	Check flow rate and throttle valve position.	Possible leak in primary containment before throttle valve . May have leak detection alarm and/or low flow alarm.	Check Valve Vault No. 1.				
44	TP-PR-10-10-03	PIT100	TOPOCK1	LCP-001	AI	I:1.1		20167	PIT100_HA	155 psig	A	Extraction Well TW-2S Line Pressure High	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2S	Flow may be obstructed or valve closed. May also have low flow alarm or high pressure alarm.	Check valve settings.						
43	TP-PR-10-10-03	PIT100	TOPOCK1	LCP-001	AI	I:1.1		20166	PIT100_LA	50 psig	A	Extraction Well TW-2S Line Pressure Low	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2S	Possible leak in primary containment before throttle valve . May have leak detection alarm and/or low flow alarm.	Check Valve Vault No. 1.						
11	TP-PR-10-10-03	FIT100	TOPOCK1	LCP-001	AI	I:1.2		20169	FIT100_HA	45 gpm	A	Extraction Well TW-2S Flow High	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2S	Throttling valve has been opened or back pressure valve setting has changed.	Check valve settings.	Possible leak in primary containment after the flow meter. May have high level alarm in Valve Vault 1 if leak is there or leak detection system alarm if leak is in double-contained discharge line.	Check Valve Vault No. 1 and leak detection panel.				
10	TP-PR-10-10-03	FIT100	TOPOCK1	LCP-001	AI	I:1.2		20168	FIT100_LA	15 gpm	A	Extraction Well TW-2S Flow Low	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2S	One or more valves between pump and Raw Water Tank have been closed.	Check valve settings.	Pump malfunction.	Check pump.				
36	TP-PR-10-10-03	P100 ON	TOPOCK1	LCP-001	DI	I:12/1		20100	P100FTST	10 sec	A	Extraction Well TW-2S Pump Fail to Start	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2S								
35	TP-PR-10-10-03	P100 ON	TOPOCK1	LCP-001	DI	I:12/1		20111	P100FTSP	10 sec	A	Extraction Well TW-2S Pump Fail to Stop	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2S								
21	TP-PR-10-10-03	LSH101	TOPOCK1	LCP-001	DI	I:12/3	LSH101	20131	LSH101	Field Set	A	Well Vault No. 1 High Water Level	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2D	Leaking connection in well vault.		Accumulated rain water.					
29	TP-PR-10-10-03	LT101	TOPOCK1	LCP-001	AI	I:1.3		20171	LT101_HA	110% normal	A	Extraction Well TW-2D Level High	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2D	Possible pump malfunction. May also see low flow alarm and/or low pressure alarm.	Check pump.	Flow may be obstructed or valve closed. May also have low flow alarm or high pressure alarm.	Check valve settings.				
30	TP-PR-10-10-03	LT101	TOPOCK1	LCP-001	AI	I:1.3		20170	LT101_LA	85% normal	A	Extraction Well TW-2D Level Low	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2D	Throttling valve has been opened. May also have high flow alarm.	Check flow rate and throttle valve position.	Possible leak in primary containment before throttle valve . May have leak detection alarm and/or low flow alarm.	Check Valve Vault No. 1.				
45	TP-PR-10-10-03	PIT101	TOPOCK1	LCP-001	AI	I:1.4		20173	PIT101_HA	155 psig	A	Extraction Well TW-2D Line Pressure High	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2D	Flow may be obstructed or valve closed. May also have low flow alarm or high pressure alarm.	Check valve settings.						
46	TP-PR-10-10-03	PIT101	TOPOCK1	LCP-001	AI	I:1.4		20172	PIT101_LA	50 psig	A	Extraction Well TW-2D Line Pressure Low	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2D	Possible leak in primary containment before throttle valve . May have leak detection alarm and/or low flow alarm.	Check Valve Vault No. 1.						
12	TP-PR-10-10-03	FIT101	TOPOCK1	LCP-001	AI	I:1.5		20175	FIT101_HA	95 gpm	A	Extraction Well TW-2D Flow High	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2D	Throttling valve has been opened or back pressure valve setting has changed.	Check valve settings.	Possible leak in primary containment after the flow meter. May have high level alarm in Valve Vault 1 if leak is there or leak detection system alarm if leak is in double-contained discharge line.	Check Valve Vault No. 1 and leak detection panel.				
13	TP-PR-10-10-03	FIT101	TOPOCK1	LCP-001	AI	I:1.5		30101	FIT101_LA	45 gpm	A	Extraction Well TW-2D Flow Low	HMI Alarm	Shutdown Pump P-101 after one minute time delay		Silence Alarm	Investigate Cause at Extraction Well TW-2D	One or more valves between pump and Raw Water Tank have been closed.	Check valve settings.	Pump malfunction.	Check pump.				
38	TP-PR-10-10-03	P101 ON	TOPOCK1	LCP-001	DI	I:12/4		20101	P101FTST	10 sec	A	Extraction Well TW-2D Pump Fail to Start	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2D	Another alarm condition exists that has shut down the system.	Check other alarm conditions.	Pump malfunction or loss of power..					
37	TP-PR-10-10-03	P101 ON	TOPOCK1	LCP-001	DI	I:12/4		20110	P101FTSP	10 sec	A	Extraction Well TW-2D Pump Fail to Stop	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-2D	Pump malfunction.							
22	TP-PR-10-10-03	LSH102	TOPOCK1	LCP-001	DI	I:12/6	LSH102	20134	LSH102	Field Set	A	Well Vault No. 4 High Water Level	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-3D								
31	TP-PR-10-10-03	LT102	TOPOCK1	LCP-001	AI	I:1.6		20177	LT102_HA	9999	A	Extraction Well PE-2 Level High	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-3D		Check pump.						
32	TP-PR-10-10-03	LT102	TOPOCK1	LCP-001	AI	I:1.6		20176	LT102_LA	10 ft	A	Extraction Well PE-2 Level Low	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-3D		Check flow rate and throttle valve position.						

APPENDIX G: ALARMS AND TROUBLESHOOTING SUMMARY
PG&E Topock Compressore Station, Interim Measures No. 3 Facility

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
47	TP-PR-10-10-03	PIT102	TOPOCK1	LCP-001	AI	I:1.7		20179	PIT102_HA	130 psig	A	Extraction Well PE-2 Line Pressure High	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-3D		Check valve settings.						
48	TP-PR-10-10-03	PIT102	TOPOCK1	LCP-001	AI	I:1.7		20178	PIT102_LA	30 psig	A	Extraction Well PE-2 Line Pressure Low	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-3D		Check Valve Vault No. 1.						
15	TP-PR-10-10-03	FIT102	TOPOCK1	LCP-001	AI	I:1.8		20181	FIT102_HA	140 gpm	A	Extraction Well PE-2 Flow High	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-3D		Check valve settings.						
14	TP-PR-10-10-03	FIT102	TOPOCK1	LCP-001	AI	I:1.8		20180	FIT102_LA	5 gpm	A	Extraction Well PE-2 Flow Low	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-3D		Check valve settings.						
39	TP-PR-10-10-03	P102 ON	TOPOCK1	LCP-001	DI	I:12/7		20102	P102FTST	10 sec	A	Extraction Well PE-2 Pump Fail to Start	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-3D		Check other alarm conditions.						
40	TP-PR-10-10-03	P102 ON	TOPOCK1	LCP-001	DI	I:12/7		20186	P102FTSP	10 sec	A	Extraction Well PE-2 Pump Fail to Stop	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well TW-3D								
23	TP-PR-10-10-03	LSH103	TOPOCK1	LCP-001	DI	I:12/9	LSH103	20133	LSH103	Field Set	A	Well Vault No. 3 High Water Level	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well PE-1								
33	TP-PR-10-10-03	LT103	TOPOCK1	LCP-001	AI	I:1.9		20182	LT103_LA	1 ft	A	Extraction Well PE-1 Level High	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well PE-1		Check pump.						
34	TP-PR-10-10-03	LT103	TOPOCK1	LCP-001	AI	I:1.9		20183	LT103_HA	9999	A	Extraction Well PE-1 Level Low	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well PE-1		Check flow rate and throttle valve position.						
49	TP-PR-10-10-03	PIT103	TOPOCK1	LCP-001	AI	I:1.10		20185	PIT103_HA	95 psig	A	Extraction Well PE-1 Line Pressure	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well PE-1		Check valve settings.						
50	TP-PR-10-10-03	PIT103	TOPOCK1	LCP-001	AI	I:1.10		20184	PIT103_LA	30 psig	A	Extraction Well PE-1 Line Pressure	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well PE-1		Check Valve Vault No. 1.						
16	TP-PR-10-10-03	FIT103	TOPOCK1	LCP-001	AI	I:1.11		20187	FIT103_HA	65 gpm	A	Extraction Well PE-1 Flow	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well PE-1		Check valve settings.						
17	TP-PR-10-10-03	FIT103	TOPOCK1	LCP-001	AI	I:1.11		20186	FIT103_LA	5 gpm	A	Extraction Well PE-1 Flow	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well PE-1		Check valve settings.						
41	TP-PR-10-10-03	P103 ON	TOPOCK1	LCP-001	DI	I:12/10		20103	P103FTST	10 sec	A	Extraction Well PE-1 Pump Fail to Start	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well PE-1		Check other alarm conditions.						
42	TP-PR-10-10-03	P103 ON	TOPOCK1	LCP-001	DI	I:12/10		20113	P103FTSP	10 sec	A	Extraction Well PE-1 Pump Fail to Stop	HMI Alarm			Silence Alarm	Investigate Cause at Extraction Well PE-1								
18	TP-PR-10-10-03	LSH001	TOPOCK1	LCP-001	DI	I:12/12	LSH001	20121	LSH001	Field Set	A	Valve Vault No. 1 High Water Level	HMI Alarm			Silence Alarm	Investigate Cause at Valve Vault No. 1	Leaking connection in valve vault.		Accumulated rain water.					
25	TP-PR-10-10-03	LSHH001	TOPOCK1	LCP-001	DI	I:12/13	LSHH001	30112	LSHH001	Field Set	B	Valve Vault No. 1 High High Water Level	HMI Alarm	Shutdown Extraction Well Pumps	Operator Manual Restart	Silence Alarm	Investigate Cause at Valve Vault No. 1	Leaking connection in valve vault.		Accumulated rain water.					
19	TP-PR-10-10-03	LSH002	TOPOCK1	LCP-001	DI	I:12/14	LSH002	20122	LSH002	Field Set	A	Valve Vault No. 2 High Water Level	HMI Alarm			Silence Alarm	Investigate Cause at Valve Vault No. 2								
26	TP-PR-10-10-03	LSHH002	TOPOCK1	LCP-001	DI	I:12/15	LSHH002	30113	LSHH002	Field Set	B	Valve Vault No. 2 High High Water Level	HMI Alarm	Shutdown Extraction Well Pumps	Operator Manual Restart	Silence Alarm	Investigate Cause at Valve Vault No. 2								
76	TP-PR-10-10-04	ZSO100	TOPOCK1	LCP-001	DI	I:13/0		30121	FV100_VSW	10 sec	A	Raw Water Storage Tank Block Valve Fail to Open	HMI Alarm			Silence Alarm	Check Limit Switches on Raw Water Tank Influent Valve	Valve malfunction							
75	TP-PR-10-10-04	ZSC100	TOPOCK1	LCP-001	DI	I:13/1		30122	FV100_VSW	10 sec	A	Raw Water Storage Tank Block Valve Fail to Close	HMI Alarm			Silence Alarm	Check Limit Switches on Raw Water Tank Influent Valve	Valve malfunction							
56	TP-PR-10-10-04		TOPOCK1	LCP-001	Bit			30123	FV100_VSW	Immediate	A	Raw Water Storage Tank Block Valve Double Limits	HMI Alarm			Silence Alarm	Check Limit Switches on Raw Water Tank Influent Valve	Valve malfunction							
52	TP-PR-10-10-04		TOPOCK1	LCP-001	DI			30124	FV100_VSW	10 sec	A	Raw Water Storage Tank Block Valve No Limits	HMI Alarm			Silence Alarm	Check Limit Switches on Raw Water Tank Influent Valve	Valve malfunction							
62	TP-PR-10-10-04	LIT200	TOPOCK1	LCP-001	AI	I:2.12		30203	LIT200_HHA	11 ft	B	Raw Water Storage Tank Level High High	HMI Alarm	Shut down Extraction Well Pumps and Drain Pump P-900	1 foot differential auto reset	Silence Alarm	Visually Check Level on Raw Water Storage Tank	Tank level control setpoints incorrect.	Check tank level control setpoints.	Process Drain Pump discharging to tank.	Check process drain tank.				
63	TP-PR-10-10-04	LIT200	TOPOCK1	LCP-001	AI	I:2.12		20205	LIT200_HA	10 ft	A	Raw Water Storage Tank Level High	HMI Alarm			Silence Alarm	Visually Check Level on Raw Water Storage Tank	Tank level control setpoints incorrect.	Check tank level control setpoints.	Process Drain Pump discharging to tank.	Check process drain tank.				
64	TP-PR-10-10-04	LIT200	TOPOCK1	LCP-001	AI	I:2.12		20206	LIT200_LA	2 ft	A	Raw Water Storage Tank Level Low	HMI Alarm			Silence Alarm	Visually Check Level on Raw Water Storage Tank	Raw Water Feed Pump discharge set higher than well pumps.	Check well pumps and balance flows.	Control valve FCV-200 stuck open.	Check control valve.				
65	TP-PR-10-10-04	LIT200	TOPOCK1	LCP-001	AI	I:2.12		30204	LIT200_LLA	1 ft	B	Raw Water Storage Tank Level Low Low	HMI Alarm	Shut down P-200 Raw Water Feed Pump	1 foot differential auto reset	Silence Alarm	Visually Check Level on Raw Water Storage Tank	Raw Water Feed Pump discharge set higher than well pumps.	Check well pumps and balance flows.	Control valve FCV-200 stuck open.	Check control valve.				
70	TP-PR-10-10-04	P200 ON	TOPOCK1	LCP-001	DI	I:13/3		20200	P200FTST	10 sec	A	Raw Water Feed Pump Fail to Start	HMI Alarm			Silence Alarm	Check Raw Water Feed Pump Motor Starter	Pump malfunction.							
71	TP-PR-10-10-04	P200 ON	TOPOCK1	LCP-001	DI	I:13/3		20208	P200FTSP	10 sec	A	Raw Water Feed Pump Fail to Stop	HMI Alarm			Silence Alarm	Check Raw Water Feed Pump Motor Starter	Pump malfunction.							
59	TP-PR-10-10-04	FIT 200	TOPOCK1	LCP-001	AI	I:5.0		20229	FIT200_HA	150 gpm	A	Plant Influent Flow	HMI Alarm			Silence Alarm	Check Control Valve FCV200 and Setpoint	Control valve malfunction.							
58	TP-PR-10-10-04	FIT 200	TOPOCK1	LCP-001	AI	I:5.0		20230	FIT200_LA	15 gpm	A	Plant Influent Flow	HMI Alarm			Silence Alarm	Check Control Valve FCV200 and Setpoint	Control valve malfuntion, other valves closed, line obstruction.	Check valve settings and pump discharge pressure gage.						
67	TP-PR-10-10-04	LIT700	TOPOCK1	LCP-001	AI	I:4.0		30505	LIT700_HHA	11 ft	B	Treated Water Tank Level High High	HMI Alarm	Shutdown P-605A/B RO Permeate Pump	1 foot differential auto reset	Silence Alarm	Visually Check Level on Treated Water Storage Tank	Malfunction of Treated Water Transfer Pump	Check pump, valve settings, and discharge pressure gage.						
66	TP-PR-10-10-04	LIT700	TOPOCK1	LCP-001	AI	I:4.0		20512	LIT700_HA	10 ft	A	Treated Water Tank Level High	HMI Alarm			Silence Alarm	Visually Check Level on Treated Water Storage Tank	Malfunction of Treated Water Transfer Pump	Check pump, valve settings, and discharge pressure gage.						
69	TP-PR-10-10-04	LIT700	TOPOCK1	LCP-001	AI	I:4.0		20511	LIT700_LA	3 ft	A	Treated Water Tank Level Low	HMI Alarm			Silence Alarm	Visually Check Level on Treated Water Storage Tank	Tank level control setpoints incorrect.	Check tank level control setpoints.						
68	TP-PR-10-10-04	LIT700	TOPOCK1	LCP-001	AI	I:4.0		30506	LIT700_LLA	2 ft	B	Treated Water Tank Level Low Low	HMI Alarm	Shut down P-700 Treated Water XFR Pump	1 foot differential auto reset	Silence Alarm	Visually Check Level on Treated Water Storage Tank	Tank level control setpoints incorrect.	Check tank level control setpoints.						
73	TP-PR-10-10-04	P700 ON	TOPOCK1	LCP-001	DI	I:13/5		20700	P700FTST	10 sec	A	Treated Water Transfer Pump Fail to Start	HMI Alarm			Silence Alarm	Check Treated Water Transfer Pump Motor Starter	Pump malfunction.							
72	TP-PR-10-10-04	P700 ON	TOPOCK1	LCP-001	DI	I:13/5		20705	P700FTSP	10 sec	A	Treated Water Transfer Pump Fail to Stop	HMI Alarm			Silence Alarm	Check Treated Water Transfer Pump Motor Starter	Pump malfunction.							
74	TP-PR-10-10-04	PSL 1100	TOPOCK1	LCP-001	DI	I:13/7	PSL 1100	30619	PSL1100	30 psig	A	Seal Water System Low Pressure	HMI Alarm	Shutdown all Pumps which require seal water after 30 second time delay		Silence Alarm	Check Pump Seal Flush Water System for Status	Seal water pump malfunction	Check pump.	Seal water system leaks or open line.	Check seal water system for leaks or open line.				

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
60	TP-PR-10-10-04	FIT 700	TOPOCK1	LCP-001	AI	I:5.2		20736	FIT700_HA	150 gpm	A	Plant Effluent Flow High	HMI Alarm			Silence Alarm	Check Baker Tank Valve line-up	Improper Valve Line-up		Line Break					
61	TP-PR-10-10-04	FIT 700	TOPOCK1	LCP-001	AI	I:5.2		20737	FIT700_LA	15 gpm	A	Plant Effluent Flow Low	HMI Alarm			Silence Alarm	Check Baker Tank Valve line-up	Improper Valve Line-up		Line obstruction or incorrect valve setting.	Check pump pressure gage and discharge valves.				
215	TP-PR-10-10-05	ZSO201	TOPOCK1	LCP-001	DI	I:13/8		30221	FV201_VSW	10 sec	A	Plant Influent Block Valve Fail to Open	HMI Alarm			Silence Alarm	Check Limit Switches on Plant Influent Valve	Valve malfunction							
214	TP-PR-10-10-05	ZSC201	TOPOCK1	LCP-001	DI	I:13/9		30222	FV201_VSW	10 sec	A	Plant Influent Block Valve Fail to Close	HMI Alarm			Silence Alarm	Check Limit Switches on Plant Influent Valve	Valve malfunction							
92	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit			30224	FV201_VSW	Immediate	A	Plant Influent Block Valve Double Limits	HMI Alarm			Silence Alarm	Check Limit Switches on Plant Influent Valve	Valve malfunction							
93	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit			30223	FV201_VSW	10 sec	A	Plant Influent Block Valve No Limits	HMI Alarm			Silence Alarm	Check Limit Switches on Plant Influent Valve	Valve malfunction							
127	TP-PR-10-10-05	AIT201pH	TOPOCK1	LCP-001	AI	I:2.0	Calculated Bit	20212	AIT201_pH_HA	8.0 pH	A	Plant Influent pH High	HMI Alarm			Silence Alarm	Check Plant Influent pH Sensor	pH sensor out of calibration	Recalibrate pH sensor	High pH water being recycled to Raw Water Tank	Check process drain tank pH.				
128	TP-PR-10-10-05	AIT201pH	TOPOCK1	LCP-001	AI	I:2.0		20213	AIT201_pH_LA	7.0 pH	A	Plant Influent pH Low	HMI Alarm			Silence Alarm	Check Plant Influent pH Sensor	pH sensor out of calibration	Recalibrate pH sensor	Low pH water being recycled to Raw Water Tank	Check process drain tank pH.				
130	TP-PR-10-10-05	AIT201TEMP	TOPOCK1	LCP-001	AI	I:2.1		20214	AIT201_TEMP_HA	90 deg F	A	Plant Influent Temperature High	HMI Alarm			Silence Alarm	Check Plant Influent pH Sensor	pH sensor out of calibration	Recalibrate pH sensor						
129	TP-PR-10-10-05	AIT201TEMP	TOPOCK1	LCP-001	AI	I:2.1		20215	AIT201_TEMP_LA	70 deg F	A	Plant Influent Temperature Low	HMI Alarm			Silence Alarm	Check Plant Influent pH Sensor	pH sensor out of calibration	Recalibrate pH sensor						
193	TP-PR-10-10-05	FSL201	TOPOCK1	LCP-001	DI	I:13/11	FSL201	30211	FSL201	120 gpm	B	Chemical Mixing Loop Low Flow	HMI Alarm	Shutdown P-200 and P-201 after 15 second time delay	Manual Reset By Operator	Silence Alarm	Verify Operation of P-201, Check Operation of Flow Switch	Flow switch malfunction, pump malfunction, pump isolation valves closed.	Verify Operation of P-201, confirm pump isolation valves are open, and check operation of flow switch.						
209	TP-PR-10-10-05	P201 ON	TOPOCK1	LCP-001	DI	I:13/12		20201	P201FTST	10 sec	A	Chemical Mixing Pump Fail to Start	HMI Alarm			Silence Alarm	Check Chemical Mixing Pump Motor Starter	Pump malfunction.							
210	TP-PR-10-10-05	P201 ON	TOPOCK1	LCP-001	DI	I:13/12		20237	P201FTSP	10 sec	A	Chemical Mixing Pump Fail to Stop	HMI Alarm			Silence Alarm	Check Chemical Mixing Pump Motor Starter	Pump malfunction.							
133	TP-PR-10-10-05	AIT202-1pH	TOPOCK1	LCP-001	AI	I:2.2		30208	AIT202_1_pH_HHA	7.0 pH	D	Chemical Mixing Loop pH #1 High High	HMI Alarm	Shutdown P-200 & P-201 pumps & Chemical Injection		Silence Alarm	Check Chemical Mixing Loop pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical strength too high.	Confirm chemical strengh.		
134	TP-PR-10-10-05	AIT202-1pH	TOPOCK1	LCP-001	AI	I:2.2		20238	AIT202_1_pH_HA	6.8 pH	A	Chemical Mixing Loop pH #1 High	HMI Alarm			Silence Alarm	Check Chemical Mixing Loop pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical strength too high.	Confirm chemical strengh.		
135	TP-PR-10-10-05	AIT202-1pH	TOPOCK1	LCP-001	AI	I:2.2		20239	AIT202_1_pH_LA	5.0 pH	A	Chemical Mixing Loop pH #1 Low	HMI Alarm			Silence Alarm	Check Chemical Mixing Loop pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too low.	Confirm chemical strengh.
136	TP-PR-10-10-05	AIT202-1TEMP	TOPOCK1	LCP-001	AI	I:2.3		20236	AIT202_1_TEMP_HA	90 deg F	A	Chemical Mixing Loop Temperature #1 High	HMI Alarm			Silence Alarm	Check Chemical Mixing Loop pH Sensor	pH sensor out of calibration							
137	TP-PR-10-10-05	AIT202-1TEMP	TOPOCK1	LCP-001	AI	I:2.3		20235	AIT202_1_TEMP_LA	60 deg F	A	Chemical Mixing Loop Temperature #1 Low	HMI Alarm			Silence Alarm	Check Chemical Mixing Loop pH Sensor	pH sensor out of calibration							
140	TP-PR-10-10-05	AIT202-2pH	TOPOCK1	LCP-001	AI	I:3.2		30209	AIT202_2_pH_HHA	7.0 pH	D	Chemical Mixing Loop pH #2 High High	HMI Alarm	Shutdown P-200 & P-201 pumps & Chemical Injection		Silence Alarm	Check Chemical Mixing Loop pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical strength too high.	Confirm chemical strengh.		
139	TP-PR-10-10-05	AIT202-2pH	TOPOCK1	LCP-001	AI	I:3.2		20233	AIT202_2_pH_HA	6.8 pH	A	Chemical Mixing Loop pH #2 High	HMI Alarm			Silence Alarm	Check Chemical Mixing Loop pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical strength too high.	Confirm chemical strengh.		
138	TP-PR-10-10-05	AIT202-2pH	TOPOCK1	LCP-001	AI	I:3.2		20234	AIT202_2_pH_LA	5.0 pH	A	Chemical Mixing Loop pH #2 Low	HMI Alarm			Silence Alarm	Check Chemical Mixing Loop pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too low.	Confirm chemical strengh.
142	TP-PR-10-10-05	AIT202-2TEMP	TOPOCK1	LCP-001	AI	I:3.3		20240	AIT202_2_TEMP_HA	90 deg F	A	Chemical Mixing Loop Temperature #2 High	HMI Alarm			Silence Alarm	Check Chemical Mixing Loop pH Sensor	pH sensor out of calibration							
141	TP-PR-10-10-05	AIT202-2TEMP	TOPOCK1	LCP-001	AI	I:3.3		20241	AIT202_2_TEMP_LA	70 deg F	A	Chemical Mixing Loop Temperature #2 Low	HMI Alarm			Silence Alarm	Check Chemical Mixing Loop pH Sensor	pH sensor out of calibration							
131	TP-PR-10-10-05	AIT202_pH 1&2	TOPOCK1	LCP-001	Bit	N31:28/00	Calculated Real	20231	AAD202_pH	0.5 pH	A	Chemical Mixing Loop pH Transmitter Deviation	HMI Alarm			Silence Alarm	Check Chemical Mixing Loop pH Sensor	pH sensor out of calibration							
132	TP-PR-10-10-05	AIT202_TEMP 1&2	TOPOCK1	LCP-001	Bit	N31:28/01	Calculated Real	20232	AAD202_TEMP	5 deg	A	Chemical Mixing Loop TEMP Transmitter Deviation	HMI Alarm			Silence Alarm	Check Chemical Mixing Loop pH Sensor	pH sensor out of calibration							
201	TP-PR-10-10-05	M300 ON	TOPOCK1	LCP-001	DI	I:13/14		20300	M300FTST	10 sec	A	Chromium Reduction Reactor Mixer Fail to Start	HMI Alarm			Silence Alarm	Check Chromium Reduction Reactor Mixer Motor Starter	Mixer malfunction							
202	TP-PR-10-10-05	M300 ON	TOPOCK1	LCP-001	DI	I:13/14		20305	M300FTSP	10 sec	A	Chromium Reduction Reactor Mixer Fail to Stop	HMI Alarm			Silence Alarm	Check Chromium Reduction Reactor Mixer Motor Starter	Mixer malfunction							
197	TP-PR-10-10-05	LSH300	TOPOCK1	LCP-001	DI	I:14/1	LSH300	30301	LSH300	Field Set	A	Chromium Reduction Reactor High Level	HMI Alarm	Shut down P-200 Raw Water Feed Pump	1 foot differential auto reset	Silence Alarm	Check Chromium Reduction Reactor Level	Sensor malfunction, line obstruction, or discharge valve closed.							
146	TP-PR-10-10-05	AIT300-1pH	TOPOCK1	LCP-001	AI	I:2.4		30309	AIT300_1_pH_HHA	7.0 pH	D	Chromium Reduction Reactor pH #1 High High	HMI Alarm	Shutdown P-200 & P-201 pumps & Chemical Injection		Silence Alarm	Check Chromium Reduction Reactor pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical strength too high.	Confirm chemical strengh.		
147	TP-PR-10-10-05	AIT300-1pH	TOPOCK1	LCP-001	AI	I:2.4		20341	AIT300_1_pH_HA	6.8 pH	A	Chromium Reduction Reactor pH #1 High	HMI Alarm			Silence Alarm	Check Chromium Reduction Reactor pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical strength too high.	Confirm chemical strengh.		
145	TP-PR-10-10-05	AIT300-1pH	TOPOCK1	LCP-001	AI	I:2.4		20340	AIT300_1_pH_LA	5.0 pH	A	Chromium Reduction Reactor pH #1 Low	HMI Alarm			Silence Alarm	Check Chromium Reduction Reactor pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too low.	Confirm chemical strengh.
148	TP-PR-10-10-05	AIT300-1TEMP	TOPOCK1	LCP-001	AI	I:2.5		20345	AIT300_1_TEMP_HA	90 deg F	A	Chromium Reduction Reactor Temperature #1 High	HMI Alarm			Silence Alarm	Check Chromium Reduction Reactor pH Sensor	pH sensor out of calibration							
149	TP-PR-10-10-05	AIT300-1TEMP	TOPOCK1	LCP-001	AI	I:2.5		20344	AIT300_1_TEMP_LA	60 deg F	A	Chromium Reduction Reactor Temperature #1 Low	HMI Alarm			Silence Alarm	Check Chromium Reduction Reactor pH Sensor	pH sensor out of calibration							
152	TP-PR-10-10-05	AIT300-2pH	TOPOCK1	LCP-001	AI	I:3.4		30310	AIT300_2_pH_HHA	7.0 pH	D	Chromium Reduction Reactor pH #2 High High	HMI Alarm	Shutdown P-200 & P-201 pumps & Chemical Injection		Silence Alarm	Check Chromium Reduction Reactor pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical strength too high.	Confirm chemical strengh.		
151	TP-PR-10-10-05	AIT300-2pH	TOPOCK1	LCP-001	AI	I:3.4		20343	AIT300_2_pH_HA	6.8 pH	A	Chromium Reduction Reactor pH #2 High	HMI Alarm			Silence Alarm	Check Chromium Reduction Reactor pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical strength too high.	Confirm chemical strengh.		

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
150	TP-PR-10-10-05	AIT300-2pH	TOPOCK1	LCP-001	AI	I:3.4		20342	AIT300_2_pH_LA	5.0 pH	A	Chromium Reduction Reactor pH #2 Low	HMI Alarm			Silence Alarm	Check Chromium Reduction Reactor pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too low.	Confirm chemical strengh.
154	TP-PR-10-10-05	AIT300-2TEMP	TOPOCK1	LCP-001	AI	I:3.5		20347	AIT300_2_TEMP_HA	90 deg F	A	Chromium Reduction Reactor Temperature #2 High	HMI Alarm			Silence Alarm	Check Chromium Reduction Reactor pH Sensor	pH sensor out of calibration							
153	TP-PR-10-10-05	AIT300-2TEMP	TOPOCK1	LCP-001	AI	I:3.5		20346	AIT300_2_TEMP_LA	70 deg F	A	Chromium Reduction Reactor Temperature #2 Low	HMI Alarm			Silence Alarm	Check Chromium Reduction Reactor pH Sensor	pH sensor out of calibration							
143	TP-PR-10-10-05	AIT300_pH 1&2	TOPOCK1	LCP-001	Bit	N31:28/02	Calculated Real	20320	AAD300_pH	0.5 pH	A	Chromium Reduction Reactor pH Transmitter Deviation	HMI Alarm			Silence Alarm	Check Chromium Reduction Reactor pH Sensor	pH sensor out of calibration							
144	TP-PR-10-10-05	AIT300_TEMP 1&2	TOPOCK1	LCP-001	Bit	N31:28/03	Calculated Real	20330	AAD300_TEMP	5 deg	A	Chromium Reduction Reactor TEMP Transmitter Deviation	HMI Alarm			Silence Alarm	Check Chromium Reduction Reactor pH Sensor	pH sensor out of calibration							
203	TP-PR-10-10-05	M301A ON	TOPOCK1	LCP-001	DI	I:14/2		20301	M301AFTST	10 sec	A	Iron Oxidation Reactor No. 1 Mixer Fail to Start	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 1 Mixer Motor Starter	Mixer malfunction							
204	TP-PR-10-10-05	M301A ON	TOPOCK1	LCP-001	DI	I:14/2		20306	M301AFTSP	10 sec	A	Iron Oxidation Reactor No. 1 Mixer Fail to Stop	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 1 Mixer Motor Starter	Mixer malfunction							
198	TP-PR-10-10-05	LSH301A	TOPOCK1	LCP-001	DI	I:14/4	LSH301A	30302	LSH301A	Field Set	A	Iron Oxidation Reactor No. 1 High Level	HMI Alarm	Shut down P-200 Raw Water Feed Pump	1 foot differential auto reset	Silence Alarm	Check Iron Oxidation Reactor 1 Level	Sensor malfunction, line obstruction, or discharge valve closed.							
157	TP-PR-10-10-05	AIT301A-1pH	TOPOCK1	LCP-001	AI	I:2.6		20351	AIT301A_1_pH_HA	8.5 pH	A	Iron Oxidation Reactor No. 1 pH #1 High	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 1 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too high.	Confirm chemical strengh.
159	TP-PR-10-10-05	AIT301A-1pH	TOPOCK1	LCP-001	AI	I:2.6		20350	AIT301A_1_pH_LA	7.5 pH	A	Iron Oxidation Reactor No. 1 pH #1 Low	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 1 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too high.	Confirm chemical strengh.
158	TP-PR-10-10-05	AIT301A-1pH	TOPOCK1	LCP-001	AI	I:2.6		30311	AIT301A_1_pH_LLA	7.0 pH	D	Iron Oxidation Reactor No. 1 pH #1 Low Low	HMI Alarm	Shutdown P-200 & P-201 pumps	Manual Reset By Operator	Silence Alarm	Check Iron Oxidation Reactor 1 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical strength too low.	Confirm chemical strengh.		
160	TP-PR-10-10-05	AIT301A-1TEMP	TOPOCK1	LCP-001	AI	I:2.7		20355	AIT301A_1_TEMP_HA	90 deg F	A	Iron Oxidation Reactor No. 1 Temperature #1 Low	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 1 pH Sensor	pH sensor out of calibration							
161	TP-PR-10-10-05	AIT301A-1TEMP	TOPOCK1	LCP-001	AI	I:2.7		20354	AIT301A_1_TEMP_LA	70 deg F	A	Iron Oxidation Reactor No. 1 Temperature #1 Low	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 1 pH Sensor	pH sensor out of calibration							
162	TP-PR-10-10-05	AIT301A-2pH	TOPOCK1	LCP-001	AI	I:3.6		20353	AIT301A_2_pH_HA	8.5 pH	A	Iron Oxidation Reactor No. 1 pH #2 High	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 1 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too high.	Confirm chemical strengh.
163	TP-PR-10-10-05	AIT301A-2pH	TOPOCK1	LCP-001	AI	I:3.6		20352	AIT301A_2_pH_LA	7.5 pH	A	Iron Oxidation Reactor No. 1 pH #2 Low	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 1 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too high.	Confirm chemical strengh.
164	TP-PR-10-10-05	AIT301A-2pH	TOPOCK1	LCP-001	AI	I:3.6		30312	AIT301A_2_pH_LLA	7.0 pH	D	Iron Oxidation Reactor No. 1 pH #2 Low Low	HMI Alarm	Shutdown P-200 & P-201 pumps	Manual Reset By Operator	Silence Alarm	Check Iron Oxidation Reactor 1 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical strength too low.	Confirm chemical strengh.		
165	TP-PR-10-10-05	AIT301A-2TEMP	TOPOCK1	LCP-001	AI	I:3.7		20357	AIT301A_2_TEMP_HA	90 deg F	A	Iron Oxidation Reactor No. 1 Temperature #2 High	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 1 pH Sensor	pH sensor out of calibration							
166	TP-PR-10-10-05	AIT301A-2TEMP	TOPOCK1	LCP-001	AI	I:3.7		20356	AIT301A_2_TEMP_LA	70 deg F	A	Iron Oxidation Reactor No. 1 Temperature #2 Low	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 1 pH Sensor	pH sensor out of calibration							
155	TP-PR-10-10-05	AIT301A_pH 1&2	TOPOCK1	LCP-001	Bit	N31:28/04	Calculated Real	20321	AAD301A_pH	0.5 pH	A	Iron Oxidation Reactor No. 1 pH Transmitter Deviation	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 1 pH Sensor	pH sensor out of calibration							
156	TP-PR-10-10-05	AIT301A_TEMP 1&2	TOPOCK1	LCP-001	Bit	N31:28/05	Calculated Real	20331	AAD301A_TEMP	5 deg	A	Iron Oxidation Reactor No. 1 Temp Transmitter Deviation	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 1 pH Sensor	pH sensor out of calibration							
205	TP-PR-10-10-05	M301B ON	TOPOCK1	LCP-001	DI	I:14/5		20302	M301BFTST	10 sec	A	Iron Oxidation Reactor No. 2 Mixer Fail to Start	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 2 Mixer Motor Starter	Mixer malfunction							
206	TP-PR-10-10-05	M301B ON	TOPOCK1	LCP-001	DI	I:14/5		20307	M301BFTSP	10 sec	A	Iron Oxidation Reactor No. 2 Mixer Fail to Stop	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 2 Mixer Motor Starter	Mixer malfunction							
199	TP-PR-10-10-05	LSH301B	TOPOCK1	LCP-001	DI	I:14/7	LSH301B	30303	LSH301B	Field Set	A1	Iron Oxidation Reactor No. 2 High Level	HMI Alarm	Shut down P-200 Raw Water Feed Pump	1 foot differential auto reset	Silence Alarm	Check Iron Oxidation Reactor 2 Level	Sensor malfunction, line obstruction, or discharge valve closed.							
171	TP-PR-10-10-05	AIT301B-1pH	TOPOCK1	LCP-001	AI	I:2.8		20361	AIT301B_1_pH_HA	8.5 pH	A	Iron Oxidation Reactor No. 2 pH #1 High	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 2 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too high.	Confirm chemical strengh.
170	TP-PR-10-10-05	AIT301B-1pH	TOPOCK1	LCP-001	AI	I:2.8		20360	AIT301B_1_pH_LA	7.5 pH	A	Iron Oxidation Reactor No. 2 pH #1 Low	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 2 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too high.	Confirm chemical strengh.
172	TP-PR-10-10-05	AIT301B-1pH	TOPOCK1	LCP-001	AI	I:2.8		30313	AIT301B_1_pH_LLA	7.0 pH	D	Iron Oxidation Reactor No. 2 pH #1 Low Low	HMI Alarm	Shutdown P-200 & P-201 pumps	Manual Reset By Operator	Silence Alarm	Check Iron Oxidation Reactor 2 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical strength too low.	Confirm chemical strengh.		
174	TP-PR-10-10-05	AIT301B-1TEMP	TOPOCK1	LCP-001	AI	I:2.9		20365	AIT301B_1_TEMP_HA	90 deg F	A	Iron Oxidation Reactor No. 2 Temperature #1 High	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 2 pH Sensor	pH sensor out of calibration							
173	TP-PR-10-10-05	AIT301B-1TEMP	TOPOCK1	LCP-001	AI	I:2.9		20364	AIT301B_1_TEMP_LA	70 deg F	A	Iron Oxidation Reactor No. 2 Temperature #1 Low	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 2 pH Sensor	pH sensor out of calibration							
177	TP-PR-10-10-05	AIT301B-2pH	TOPOCK1	LCP-001	AI	I:3.8		20363	AIT301B_2_pH_HA	8.5 pH	A	Iron Oxidation Reactor No. 2 pH #2 High	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 2 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too high.	Confirm chemical strengh.
175	TP-PR-10-10-05	AIT301B-2pH	TOPOCK1	LCP-001	AI	I:3.8		20362	AIT301B_2_pH_LA	7.5 pH	A	Iron Oxidation Reactor No. 2 pH #2 Low	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 2 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too high.	Confirm chemical strengh.
176	TP-PR-10-10-05	AIT301B-2pH	TOPOCK1	LCP-001	AI	I:3.8		30314	AIT301B_2_pH_LLA	7.0 pH	D	Iron Oxidation Reactor No. 2 pH #2 Low Low	HMI Alarm	Shutdown P-200 & P-201 pumps	Manual Reset By Operator	Silence Alarm	Check Iron Oxidation Reactor 2 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical strength too low.	Confirm chemical strengh.		
178	TP-PR-10-10-05	AIT301B-2TEMP	TOPOCK1	LCP-001	AI	I:3.9		20367	AIT301B_2_TEMP_HA	90 deg F	A	Iron Oxidation Reactor No. 2 Temperature #2 High	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 2 pH Sensor	pH sensor out of calibration							
179	TP-PR-10-10-05	AIT301B-2TEMP	TOPOCK1	LCP-001	AI	I:3.9		20366	AIT301B_2_TEMP_LA	70 deg F	A	Iron Oxidation Reactor No. 2 Temperature #2 Low	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 2 pH Sensor	pH sensor out of calibration							
168	TP-PR-10-10-05	AIT301B_pH 1&2	TOPOCK1	LCP-001	Bit	N31:28/06	Calculated Real	20322	AAD301B_pH	0.5 pH	A	Iron Oxidation Reactor No. 2 pH Transmitter Deviation	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 2 pH Sensor	pH sensor out of calibration							

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
169	TP-PR-10-10-05	AIT301B_TEMP 1&2	TOPOCK1	LCP-001	Bit	N31:28/07	Calculated Real	20332	AAD301B_TEMP	5 deg	A	Iron Oxidation Reactor No. 2 Temp Transmitter Deviation	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 2 pH Sensor	pH sensor out of calibration							
208	TP-PR-10-10-05	M301C ON	TOPOCK1	LCP-001	DI	I:14/8		20303	M301CFTST	10 sec	A	Iron Oxidation Reactor No. 3 Mixer Fail to Start	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 3 Mixer Motor Starter	Mixer malfunction							
207	TP-PR-10-10-05	M301C ON	TOPOCK1	LCP-001	DI	I:14/8		20308	M301CFTSP	10 sec	A	Iron Oxidation Reactor No. 3 Mixer Fail to Stop	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 3 Mixer Motor Starter	Mixer malfunction							
194	TP-PR-10-10-05	LIT301C	TOPOCK1	LCP-001	AI	I:2.13		20381	LIT301C_HA	14 ft	A	Iron Oxidation Reactor No. 3 Level High	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 3 Level	Sensor malfunction, line obstruction, or discharge valve closed.							
196	TP-PR-10-10-05	LIT301C	TOPOCK1	LCP-001	AI	I:2.13		20380	LIT301C_LA	10 ft	A	Iron Oxidation Reactor No. 3 Level Low	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor								
195	TP-PR-10-10-05	LIT301C	TOPOCK1	LCP-001	AI	I:2.13		30320	LIT301C_LLA	2 ft	A1	Iron Oxidation Reactor No. 3 Level Low Low	HMI Alarm	Shut down P-400 Clarifier Feed Pump	1 foot differential auto reset	Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor								
200	TP-PR-10-10-05	LSH301C	TOPOCK1	LCP-001	DI	I:14/10	LSH301C	30304	LSH301C	Field Set	A1	Iron Oxidation Reactor No. 3 High High Level	HMI Alarm	Shut down P-200 Raw Water Feed Pump	1 foot differential auto reset	Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor								
185	TP-PR-10-10-05	AIT301C-1pH	TOPOCK1	LCP-001	AI	I:2.10		20371	AIT301C_1_pH_HA	8.5 pH	A	Iron Oxidation Reactor No. 3 pH #1 High	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too high.	Confirm chemical strengh.
184	TP-PR-10-10-05	AIT301C-1pH	TOPOCK1	LCP-001	AI	I:2.10		20370	AIT301C_1_pH_LA	7.5 pH	A	Iron Oxidation Reactor No. 3 pH #1 Low	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too high.	Confirm chemical strengh.
183	TP-PR-10-10-05	AIT301C-1pH	TOPOCK1	LCP-001	AI	I:2.10		30315	AIT301C_1_pH_LLA	7.3 pH	D	Iron Oxidation Reactor No. 3 pH #1 Low Low	HMI Alarm	Shutdown P-200 & P-201 pumps	Manual Reset By Operator	Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical strength too low.	Confirm chemical strengh.		
187	TP-PR-10-10-05	AIT301C-1TEMP	TOPOCK1	LCP-001	AI	I:2.11		20375	AIT301C_1_TEMP_HA	90 deg F	A	Iron Oxidation Reactor No. 3 Temperature #1 High	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor	pH sensor out of calibration							
186	TP-PR-10-10-05	AIT301C-1TEMP	TOPOCK1	LCP-001	AI	I:2.11		20374	AIT301C_1_TEMP_LA	70 deg F	A	Iron Oxidation Reactor No. 3 Temperature #1 Low	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor	pH sensor out of calibration							
189	TP-PR-10-10-05	AIT301C-2pH	TOPOCK1	LCP-001	AI	I:3.10		20373	AIT301C_2_pH_HA	8.5 pH	A	Iron Oxidation Reactor No. 3 pH #2 High	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too high.	Confirm chemical strengh.
188	TP-PR-10-10-05	AIT301C-2pH	TOPOCK1	LCP-001	AI	I:3.10		20372	AIT301C_2_pH_LA	7.5 pH	A	Iron Oxidation Reactor No. 3 pH #2 Low	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical feed pump in local mode.	Switch pump to remote mode.	Chemical strength too high.	Confirm chemical strengh.
190	TP-PR-10-10-05	AIT301C-2pH	TOPOCK1	LCP-001	AI	I:3.10		30316	AIT301C_2_pH_LLA	7.3 pH	D	Iron Oxidation Reactor No. 3 pH #2 Low Low	HMI Alarm	Shutdown P-200 & P-201 pumps	Manual Reset By Operator	Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor	pH sensor out of calibration		Chemical feed pump out of calibration	Check calibration	Chemical strength too low.	Confirm chemical strengh.		
191	TP-PR-10-10-05	AIT301C-2TEMP	TOPOCK1	LCP-001	AI	I:3.11		20377	AIT301C_2_TEMP_HA	90 deg F	A	Iron Oxidation Reactor No. 3 Temperature #2 High	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor	pH sensor out of calibration							
192	TP-PR-10-10-05	AIT301C-2TEMP	TOPOCK1	LCP-001	AI	I:3.11		20376	AIT301C_2_TEMP_LA	70 deg F	A	Iron Oxidation Reactor No. 3 Temperature #2 Low	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor	pH sensor out of calibration							
181	TP-PR-10-10-05	AIT301C_pH 1&2	TOPOCK1	LCP-001	Bit	N31:28/08	Calculated Real	20323	AAD301C_pH	0.5 pH	A	Iron Oxidation Reactor No. 3 pH Transmitter Deviation	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor	pH sensor out of calibration							
182	TP-PR-10-10-05	AIT301C_TEMP 1&2	TOPOCK1	LCP-001	Bit	N31:28/09	Calculated Real	20333	AAD301C_TEMP	5 deg	A	Iron Oxidation Reactor No. 3 Temp Transmitter Deviation	HMI Alarm			Silence Alarm	Check Iron Oxidation Reactor 3 pH Sensor	pH sensor out of calibration							
213	TP-PR-10-10-05	P400 ON	TOPOCK1	LCP-001	DI	I:14/11		20400	P400FTST	10 sec	A	Clarifier Feed Pump Fail to Start	HMI Alarm			Silence Alarm	Check Clarifier Feed Pump VFD	Pump or pump control malfunction							
212	TP-PR-10-10-05	P400 ON	TOPOCK1	LCP-001	DI	I:14/11		20405	P400FTSP	10 sec	A	Clarifier Feed Pump Fail to Stop	HMI Alarm			Silence Alarm	Check Clarifier Feed Pump VFD	Pump or pump control malfunction							
211	TP-PR-10-10-05	P400 FAIL	TOPOCK1	LCP-001	DI	I:14/13	P400 FAIL	20497	P400_FAIL	Field Set	A	Clarifier Feed Pump Drive Fail	HMI Alarm			Silence Alarm	Check Clarifier Feed Pump VFD	Pump or pump control malfunction							
243	TP-PR-10-10-06	M400A ON	TOPOCK1	LCP-001	DI	I:14/14		20401	M400AFTST	10 sec	A	Clarifier Influent Mixer Fail to Start	HMI Alarm			Silence Alarm	Check Clarifier Influent Mixer Motor Starter	Mixer malfunction							
244	TP-PR-10-10-06	M400A ON	TOPOCK1	LCP-001	DI	I:14/14		20406	M400AFTSP	10 sec	A	Clarifier Influent Mixer Fail to Stop	HMI Alarm			Silence Alarm	Check Clarifier Influent Mixer Motor Starter	Mixer malfunction							
251	TP-PR-10-10-06	NSH400	TOPOCK1	LCP-001	DI	I:15/0	NSH400	20421	NSH400	Field Set	A	Clarifier Sludge Rake High Torque	HMI Alarm			Silence Alarm	Check Clarifier Rake For Jamming, Reset High Torque Switch	Clarifier rake drive malfunction							
246	TP-PR-10-10-06	M400B ON	TOPOCK1	LCP-001	DI	I:15/1		20402	M400BFTST	10 sec	A	Clarifier Secondary Mixer Fail to Start	HMI Alarm			Silence Alarm	Check Clarifier Secondary Mixer Motor Starter	Mixer malfunction							
245	TP-PR-10-10-06	M400B ON	TOPOCK1	LCP-001	DI	I:15/1		20407	M400BFTSP	10 sec	A	Clarifier Secondary Mixer Fail to Stop	HMI Alarm			Silence Alarm	Check Clarifier Secondary Mixer Motor Starter	Mixer malfunction							
247	TP-PR-10-10-06	M400C ON	TOPOCK1	LCP-001	DI	I:15/3		20403	M400CFTST	10 sec	A	Clarifier Sludge Rake Fail to Start	HMI Alarm			Silence Alarm	Check Clarifier Sludge Rake Motor Starter	Clarifier rake drive malfunction							
248	TP-PR-10-10-06	M400C ON	TOPOCK1	LCP-001	DI	I:15/3		20408	M400CFTSP	10 sec	A	Clarifier Sludge Rake Fail to Stop	HMI Alarm			Silence Alarm	Check Clarifier Sludge Rake Motor Starter	Clarifier rake drive malfunction							
259	TP-PR-10-10-06	ZSO400	TOPOCK1	LCP-001	DI	I:15/5		30421	FV400_VSW	10 sec	A	Clarifier Drain Valve Fail to Open	HMI Alarm			Silence Alarm	Check Clarifier Drain Valve for Jamming, Check Limit Switch	Sludge valve malfunction							
257	TP-PR-10-10-06	ZSC400	TOPOCK1	LCP-001	DI	I:15/6		30422	FV400_VSW	10 sec	A	Clarifier Drain Valve Fail to Close	HMI Alarm			Silence Alarm	Check Clarifier Drain Valve for Jamming, Check Limit Switch	Sludge valve malfunction							
222	TP-PR-10-10-06		TOPOCK1	LCP-001	Bit			30423	FV400_VSW	Immediate	A	Clarifier Drain Valve Double Limits	HMI Alarm			Silence Alarm	Check Clarifier Drain Valve for Jamming, Check Limit Switch	Sludge valve malfunction							
254	TP-PR-10-10-06	ZSC/0_400	TOPOCK1	LCP-001	Bit			30424	FV400_VSW	10 sec	A	Clarifier Drain Valve No Limits	HMI Alarm			Silence Alarm	Check Clarifier Drain Valve for Jamming, Check Limit Switch	Sludge valve malfunction							
241	TP-PR-10-10-06	LSH900	TOPOCK1	LCP-001	DI	I:15/8	LSH900	20901	LSH900	Field Set	A	Process Drain Tank Containment High Level	HMI Alarm			Silence Alarm	Visually Check Drain Tank Containment Area For Water	Waste accumulating in containment.							
238	TP-PR-10-10-06	LIT900	TOPOCK1	LCP-001	AI	I:3.0		30903	LIT900_HA	7 ft	A	Process Drain Tank Level High	HMI Alarm	Shutdown Pump Raw Water Pump P-200		Silence Alarm	Visually Check Level On Process Drains Tank	Set points incorrect	Check setpoints.	Pump malfunction.	Operate pump manually and confirm discharge at Raw Water Tank	Stuck check valve or downstream valve shut.	Check valve settings.		
237	TP-PR-10-10-06	LIT900	TOPOCK1	LCP-001	AI	I:3.0		20924	LIT900_LA	1.5 ft	A	Process Drain Tank Level Low	HMI Alarm			Silence Alarm	Visually Check Level On Process Drains Tank	Set points incorrect	Check setpoints.	Pump doesn't turn off.	Manually turn off pump.				
236	TP-PR-10-10-06	LIT900	TOPOCK1	LCP-001	AI	I:3.0		30923	LIT900_LLA	1 ft	A1	Process Drain Tank Level Low	HMI Alarm	Shutdown P-900 Process Drain Tank Pump	1 foot differential auto reset	Silence Alarm	Visually Check Level On Process Drains Tank	Set points incorrect	Check setpoints.	Pump doesn't turn off.	Manually turn off pump.				

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
253	TP-PR-10-10-06	P900 ON	TOPOCK1	LCP-001	DI	I:15/9		20900	P900FTST	10 sec	A	Process Sump Drain Pump Fail to Start	HMI Alarm			Silence Alarm	Check Process Drain Pump Motor Starter	Pump malfunction.							
252	TP-PR-10-10-06	P900 ON	TOPOCK1	LCP-001	DI	I:15/9		20926	P900FTSP	10 sec	A	Process Sump Drain Pump Fail to Stop	HMI Alarm			Silence Alarm	Check Process Drain Pump Motor Starter	Pump malfunction.							
424	TP-PR-10-10-10	LSH702	TOPOCK1	LCP-001	DI	I:18/5	LSH702	20772	LSH702	Field Set	A	High Level Treated Water Storage Tank (Baker Tank)	HMI Alarm			Silence Alarm	Visually Check Level On Treated Water Baker Tank								
234	TP-PR-10-10-06	LIT402	TOPOCK1	LCP-001	AI	I:3.1		20443	LIT402_HA	11 ft	A	Sludge Holding Tank Level High	HMI Alarm			Silence Alarm	Visually Check Level On Sludge Holding Tank								
233	TP-PR-10-10-06	LIT402	TOPOCK1	LCP-001	AI	I:3.1		20442	LIT402_LA	3 ft	A	Sludge Holding Tank Level Low	HMI Alarm			Silence Alarm	Check Sludge Holding Tank Mixer Motor Starter	Mixer malfunction							
250	TP-PR-10-10-06	M402 ON	TOPOCK1	LCP-001	DI	I:15/12		20404	M402FTST	10 sec	A	Sludge Holding Tank Mixer Fail to Start	HMI Alarm			Silence Alarm	Check Sludge Holding Tank Mixer Motor Starter	Mixer malfunction							
249	TP-PR-10-10-06	M402 ON	TOPOCK1	LCP-001	DI	I:15/12		20409	M402FTSP	10 sec	A	Sludge Holding Tank Mixer Fail to Stop	HMI Alarm			Silence Alarm	Visually Check For Water in Phase Separator Containment Basin	Water accumulating in phase separator containment basin.							
242	TP-PR-10-10-06	LSHH 405	TOPOCK1	LCP-001	DI	I:16/1	LSHH 405	30433	LSHH405	Field Set	A	Phase Separator Area High High Level	HMI Alarm			Silence Alarm	Visually Check Level in Phase Separator A	Phase separator full.							
239	TP-PR-10-10-06	LSH 405A	TOPOCK1	LCP-001	DI	I:16/2	LSH 405A	30434	LSH405A	Field Set	A	Phase Separator A High Level	HMI Alarm			Silence Alarm	Visually Check Level in Phase Separator B	Phase separator full.							
240	TP-PR-10-10-06	LSH 405B	TOPOCK1	LCP-001	DI	I:16/3	LSH 405B	30435	LSH405B	Field Set	A	Phase Separator B High Level	HMI Alarm			Silence Alarm	Visually Check Level in Pre-Treated Water Storage Tank	P-400 is pumping faster than P-500	Check microfilter system permeate flow rate and strainer backpressure.	Consult microfilter manual if flux is below acceptable range. Clean strainer if clogged. Confirm that P 500 discharge valves are set correctly.					
283	TP-PR-10-10-07	LIT500	TOPOCK1	LCP-001	AI	I:2.14		30507	LIT500_HHA	16 ft	A1	Pretreated Water Tank Level High High	HMI Alarm	Shut down P-400 Clarifier Feed Pump	1 foot differential auto reset	Silence Alarm	Visually Check Level in Pre-Treated Water Storage Tank	P-400 is pumping faster than P-499	Check microfilter system permeate flow rate and strainer backpressure.	Consult microfilter manual if flux is below acceptable range. Clean strainer if clogged. Confirm that P 500 discharge valves are set correctly.					
282	TP-PR-10-10-07	LIT500	TOPOCK1	LCP-001	AI	I:2.14		20509	LIT500_HA	15 ft	A	Pretreated Water Tank Level High	HMI Alarm			Silence Alarm	Visually Check Level in Pre Treated Water Storage Tank	P-500 is pumping faster than P-400.	Check overall system flow.						
285	TP-PR-10-10-07	LIT500	TOPOCK1	LCP-001	AI	I:2.14		20508	LIT500_LA	3 ft	A	Pretreated Water Tank Level Low	HMI Alarm			Silence Alarm	Check Pretreated Water Transfer Pump Motor Starter	Pump malfunction.							
284	TP-PR-10-10-07	LIT500	TOPOCK1	LCP-001	AI	I:2.14		30525	LIT500_LLA	2 ft	A1	Pretreated Water Tank Level Low Low	HMI Alarm	Shut down P-500 Pretreated Water Xfr Pump	1 foot differential auto reset	Silence Alarm	Visually Check Level in Pre Treated Water Storage Tank	P-500 is pumping faster than P-400.	Check overall system flow.						
290	TP-PR-10-10-07	P500 ON	TOPOCK1	LCP-001	DI	I:16/4		20500	P500FTST	10 sec	A	Pretreated Water Transfer Pump Fail to Start	HMI Alarm			Silence Alarm	Check Pretreated Water Transfer Pump Motor Starter	Pump malfunction.							
291	TP-PR-10-10-07	P500 ON	TOPOCK1	LCP-001	DI	I:16/4		20501	P500FTSP	10 sec	A	Pretreated Water Transfer Pump Fail to Stop	HMI Alarm			Silence Alarm	Visually Check Level in Reverse Osmosis Feed Tank	Level control set point incorrect.	Confirm level set point.	Membrane elements or cartridge filters may be fouled.	Check RO pressure elements and permeate flow. Consult manual regarding RO element cleaning if indicated. Check cartridge filter backpressure.	Valve settings incorrect.	Check valve settings.	Too much concentrate being recycled.	Check conductivity probes and setpoints.
358	TP-PR-10-10-08	LIT600	TOPOCK1	LCP-001	AI	I:2.15		30626	LIT600_HHA	15 ft	A1	Reverse Osmosis Feed Tank Level High High	HMI Alarm	Shutdown Microfilter System	5 foot differential auto reset	Silence Alarm	Visually Check Level in Reverse Osmosis Feed Tank	Level control set point incorrect.	Confirm level set point.	Membrane elements or cartridge filters may be fouled.	Check RO pressure elements and permeate flow. Consult manual regarding RO element cleaning if indicated. Check cartridge filter backpressure.	Valve settings incorrect.	Check valve settings.	Too much concentrate being recycled.	Check conductivity probes and setpoints.
361	TP-PR-10-10-08	LIT600	TOPOCK1	LCP-001	AI	I:2.15		20639	LIT600_HA	14 ft	A	Reverse Osmosis Feed Tank Level High	HMI Alarm			Silence Alarm	Visually Check Level in Reverse Osmosis Feed Tank	Level control set point incorrect.	Confirm level set point.	Permeate recycle line obstructed.	Check for recycle flow.	Upstream malfunction.	Confirm upstream systems.		
360	TP-PR-10-10-08	LIT600	TOPOCK1	LCP-001	AI	I:2.15		20640	LIT600_LA	3 ft	A	Reverse Osmosis Feed Tank Level Low	HMI Alarm			Silence Alarm	Check Filtered Water Transfer Pump Motor Starter	Pump malfunction.							
359	TP-PR-10-10-08	LIT600	TOPOCK1	LCP-001	AI	I:2.15		30627	LIT600_LLA	2 ft	A1	Reverse Osmosis Feed Tank Level Low Low	HMI Alarm	Shutdown P-620 Filtered Water Xfr Pump & RO System	5 foot differential auto reset	Silence Alarm	Visually Check Level in Reverse Osmosis Feed Tank	Level control set point incorrect.	Confirm level set point.	Permeate recycle line obstructed.	Check for recycle flow.	Upstream malfunction.	Confirm upstream systems.		
367	TP-PR-10-10-08	P620 ON	TOPOCK1	LCP-001	DI	I:16/6		20616	P620FTST	10 sec	A	Filtered Water Transfer Pump Fail to Start	HMI Alarm			Silence Alarm	Check Filtered Water Transfer Pump Motor Starter	Pump malfunction.							
368	TP-PR-10-10-08	P620 ON	TOPOCK1	LCP-001	DI	I:16/6		20617	P620FTSP	10 sec	A	Filtered Water Transfer Pump Fail to Stop	HMI Alarm			Silence Alarm	Inspect and/or Clean Conductivity Sensor								
325	TP-PR-10-10-08	AIT 600 COND	TOPOCK1	LCP-001	AI	I:3.12		20543	AIT600_COND_HHA	11000 us/cm	A	Microfilter Unit Effluent Conductivity High High	HMI Alarm			Silence Alarm	Inspect and/or Clean Conductivity Sensor								
326	TP-PR-10-10-08	AIT 600 COND	TOPOCK1	LCP-001	AI	I:3.12		20544	AIT600_COND_HA	10000us/cm	A	Microfilter Unit Effluent Conductivity High	HMI Alarm			Silence Alarm	Inspect and/or Clean Conductivity Sensor	Excessive RO Concentrate recycle to T-600.	Check AIT604 set point. Check FCV-602.						
328	TP-PR-10-10-08	AIT 601 COND	TOPOCK1	LCP-001	AI	I:3.13		20645	AIT601_COND_HHA	110% (AIT600)	A	R.O. Unit Influent Conductivity High High	HMI Alarm			Silence Alarm	Inspect and/or Clean Conductivity Sensor	Excessive RO Concentrate recycle to T-600.	Check AIT604 set point. Check FCV-602.						
327	TP-PR-10-10-08	AIT 601 COND	TOPOCK1	LCP-001	AI	I:3.13		20646	AIT601_COND_HA	105%(AIT600)	A	R.O. Unit Influent Conductivity High	HMI Alarm			Silence Alarm	Inspect and/or Clean Conductivity Sensor	Excessive RO Concentrate recycle to T-600.	Check AIT604 set point. Check FCV-602.						
330	TP-PR-10-10-08	AIT 604 COND	TOPOCK1	LCP-001	AI	I:3.14		20647	AIT604_COND_HHA	110% (AIT600)	A	R.O. Unit Blended Recycle Conductivity High High	HMI Alarm			Silence Alarm	Inspect and/or Clean Conductivity Sensor	Excessive RO Concentrate recycle to T-600.	Check AIT604 set point. Check FCV-602.						
329	TP-PR-10-10-08	AIT 604 COND	TOPOCK1	LCP-001	AI	I:3.14		20648	AIT604_COND_HA	105%(AIT600)	A	R.O. Unit Blended Recycle Conductivity High	HMI Alarm			Silence Alarm	Visually Check Level in FD Aerator Basin	Level control set point incorrect.	Confirm level set point.	Level control valve LCV 604 malfunction.	Check level control valve.				
354	TP-PR-10-10-08	LIT 604	TOPOCK1	LCP-001	AI	I:5.3		30628	LIT604_HHA	30 in	A1	F.D. Aerator Basin Level High High	HMI Alarm	Shutdown RO System	Manual Operator Restart	Silence Alarm	Visually Check Level in FD Aerator Basin	Level control set point incorrect.	Confirm level set point.	Level control valve LCV 604 malfunction.	Check level control valve.				
355	TP-PR-10-10-08	LIT 604	TOPOCK1	LCP-001	AI	I:5.3		20649	LIT604_HA	28 in	A	F.D. Aerator Basin Level High	HMI Alarm			Silence Alarm	Visually Check Level in FD Aerator Basin	Level control set point incorrect.	Confirm level set point.	Level control valve LCV 604 malfunction.	Check level control valve.				
356	TP-PR-10-10-08	LIT 604	TOPOCK1	LCP-001	AI	I:5.3		20650	LIT604_LA	20 in	A	F.D. Aerator Basin Level Low	HMI Alarm			Silence Alarm	Visually Check Level in RO Concentrate Storage Tank	Set points incorrect	Confirm level set point.	Pump discharge valves incorrectly set.	Check valve settings.	Pump malfunction.	Check pump.		

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
357	TP-PR-10-10-08	LIT 604	TOPOCK1	LCP-001	AI	I:5.3		20679	LIT604_LLA	18 in	A1	F.D. Aerator Basin Level Low Low	HMI Alarm	Shutdown P-605A/B RO Permeate Pumps	1 foot differential auto reset	Silence Alarm	Visually Check Level in FD Aerator Basin	Level control set point incorrect.	Confirm level set point.	Level control valve LCV 604 malfunction.	Check level control valve.				
365	TP-PR-10-10-08	LIT701	TOPOCK1	LCP-001	AI	I:4.1		30630	LIT701_HHA	13 ft	A1	R.O. Concentrate Tank Level High High	HMI Alarm	Shutdown RO System		Silence Alarm	Visually Check Level in RO Concentrate Storage Tank	Set points incorrect	Confirm level set point.	Pump discharge valves incorrectly set.	Check valve settings.	Pump malfunction.	Check pump.		
363	TP-PR-10-10-08	LIT701	TOPOCK1	LCP-001	AI	I:4.1		20651	LIT701_HA	12.5 ft	A	R.O. Concentrate Tank Level High	HMI Alarm			Silence Alarm	Visually Check Level in RO Concentrate Storage Tank	Set points incorrect	Confirm level set point.						
364	TP-PR-10-10-08	LIT701	TOPOCK1	LCP-001	AI	I:4.1		20652	LIT701_LA	1.5 ft	A	R.O. Concentrate Tank Level Low	HMI Alarm			Silence Alarm	Check RO Concentrate Transfer Pump Motor Starter	Pump malfunction.							
362	TP-PR-10-10-08	LIT701	TOPOCK1	LCP-001	AI	I:4.1		30631	LIT701_LLA	1.0 ft	A1	R.O. Concentrate Tank Level Low Low	HMI Alarm	Shutdown P-701 RO Concentrate XFR Pump	1 foot differential auto reset	Silence Alarm	Visually Check Level in RO Concentrate Storage Tank	Set points incorrect	Confirm level set point.						
371	TP-PR-10-10-08	P701 ON	TOPOCK1	LCP-001	DI	I:16/13		20701	P701FTST	10 sec	A	RO Concentrate Transfer Pump Fail to Start	HMI Alarm			Silence Alarm	Check RO Concentrate Transfer Pump Motor Starter	Pump malfunction.							
370	TP-PR-10-10-08	P701 ON	TOPOCK1	LCP-001	DI	I:16/13		20706	P701FTSP	10 sec	A	RO Concentrate Transfer Pump Fail to Stop	HMI Alarm			Silence Alarm	Inspect and/or Clean Conductivity Sensor								
343	TP-PR-10-10-08	AIT701 COND	TOPOCK1	LCP-001	AI	I:4.2		30655	AIT701_COND_HHA	35000us/cm	A	R.O. Concentrate Conductivity High High	HMI Alarm			Silence Alarm	Inspect and/or Clean Conductivity Sensor								
342	TP-PR-10-10-08	AIT701 COND	TOPOCK1	LCP-001	AI	I:4.2		20656	AIT701_COND_HA	32500us/cm	A	R.O. Concentrate Conductivity High	HMI Alarm			Silence Alarm	Inspect and/or Clean Conductivity Sensor	Damaged element.							
334	TP-PR-10-10-08	AIT605 COND	TOPOCK1	LCP-001	AI	I:4.3		30632	AIT605_COND_HHA	700us/cm	C	R.O. Permeate Conductivity High High	HMI Alarm	Shutdown RO System	Manual Operator Restart	Silence Alarm	Inspect and/or Clean Conductivity Sensor	Damaged element.							
335	TP-PR-10-10-08	AIT605 COND	TOPOCK1	LCP-001	AI	I:4.3		20657	AIT605_COND_HA	650us/cm	A	R.O. Permeate Conductivity High	HMI Alarm			Silence Alarm	Inspect and/or Clean pH Sensor	pH sensor out of calibration	Check sensor calibration						
336	TP-PR-10-10-08	AIT606 pH	TOPOCK1	LCP-001	AI	I:4.4		20658	AIT606_pH_HA	8 pH	A	R.O. Permeate pH High	HMI Alarm			Silence Alarm	Inspect and/or Clean pH Sensor	pH sensor out of calibration	Check sensor calibration						
337	TP-PR-10-10-08	AIT606 pH	TOPOCK1	LCP-001	AI	I:4.4		20659	AIT606_pH_LA	6 pH	A	R.O. Permeate pH Low	HMI Alarm			Silence Alarm	Inspect and/or Clean pH Sensor	pH sensor out of calibration	Check sensor calibration						
339	TP-PR-10-10-08	AIT606 TEMP	TOPOCK1	LCP-001	AI	I:4.5		20660	AIT606_TEMP_HA	90 deg F	A	R.O. Permeate Temperature High	HMI Alarm			Silence Alarm	Inspect and/or Clean pH Sensor	pH sensor out of calibration	Check sensor calibration						
338	TP-PR-10-10-08	AIT606 TEMP	TOPOCK1	LCP-001	AI	I:4.5		20661	AIT606_TEMP_LA	70 deg F	A	R.O. Permeate Temperature Low	HMI Alarm			Silence Alarm	Check Status of Pump Power Disconnect Switch	Pump malfunction.							
414	TP-PR-10-10-09	P800 ON	TOPOCK1	LCP-001	DI	I:16/15	P800_ON	30815	P800_ON	Not On	D	Ferrous Chloride Pump Power Off	HMI Alarm	Shutdown all process pumps,RO system, uFilter system after 30 second time delay	Manual Operator Restart	Silence Alarm	Check Status of Pump Power Disconnect Switch	Pump malfunction.							
406	TP-PR-10-10-09	FSL800	TOPOCK1	LCP-001	DI	I:21/0	FSL800	30832	FSL800	Field Set	D	Ferrous Chloride Pump Low Flow	HMI Alarm	Shutdown all process pumps,RO system, uFilter system after 30 second time delay	Manual Operator Restart	Silence Alarm	Check Pump Operation, Chemical Level in Tote	Pump malfunction.		Chemical container empty					
415	TP-PR-10-10-09	P801 ON	TOPOCK1	LCP-001	DI	I:17/1	P801_ON	20817	P801_ON	Not On	A	Sulfuric Acid Pump Power Off	HMI Alarm			Silence Alarm	Check Pump Operation, Chemical Level in Tote	Pump malfunction.		Chemical container empty					
407	TP-PR-10-10-09	FSL801	TOPOCK1	LCP-001	DI	I:21/1	FSL801A	20833	FSL801A	Field Set	A	Sulfuric Acid Pump Low Flow	HMI Alarm			Silence Alarm	Check Polyelectrolyte System Control Panel	System malfunction							
416	TP-PR-10-10-09	P802A ON	TOPOCK1	LCP-001	DI	I:17/3	P802A_ON	20825	P802A_ON	Not On	A5	Sodium Hydroxide Pump A Power Off	HMI Alarm	Shutdown all process systems after 30 second time delay	Manual Operator Restart	Silence Alarm	Check Status of Pump Power Disconnect Switch	Pump malfunction.							
408	TP-PR-10-10-09	FSL802A	TOPOCK1	LCP-001	DI	I:21/2	FSL802A	30834	FSL802A	Field Set	A5	Sodium Hydroxide Pump A Low Flow	HMI Alarm	Shutdown all process systems after 30 second time delay	Manual Operator Restart	Silence Alarm	Check Pump Operation, Chemical Level in Tote	Pump malfunction.		Chemical container empty					
417	TP-PR-10-10-09	P802B ON	TOPOCK1	LCP-001	DI	I:17/5	P802B_ON	30819	P802B_ON	Not On	A5	Sodium Hydroxide Pump B Power Off	HMI Alarm	Shutdown all process systems after 30 second time delay	Manual Operator Restart	Silence Alarm	Check Status of Pump Power Disconnect Switch	Pump malfunction.							
409	TP-PR-10-10-09	FSL802B	TOPOCK1	LCP-001	DI	I:21/3	FSL802B	30835	FSL802B	Field Set	A5	Sodium Hydroxide Pump B Low Flow	HMI Alarm	Shutdown all process systems after 30 second time delay	Manual Operator Restart	Silence Alarm	Check Pump Operation, Chemical Level in Tote	Pump malfunction.		Chemical container empty					
418	TP-PR-10-10-09	P802C ON	TOPOCK1	LCP-001	DI	I:17/7	P802C_ON	30821	P802C_ON	Not On	A5	Sodium Hydroxide Pump C Power Off	HMI Alarm	Shutdown all process systems after 30 second time delay	Manual Operator Restart	Silence Alarm	Check Status of Pump Power Disconnect Switch	Pump malfunction.							
410	TP-PR-10-10-09	FSL802C	TOPOCK1	LCP-001	DI	I:21/4	FSL802C	30836	FSL802C	Field Set	A5	Sodium Hydroxide Pump C Low Flow	HMI Alarm	Shutdown all process systems after 30 second time delay	Manual Operator Restart	Silence Alarm	Check Pump Operation, Chemical Level in Tote	Pump malfunction.		Chemical container empty					
419	TP-PR-10-10-09	P802D ON	TOPOCK1	LCP-001	DI	I:17/9	P802D_ON	30823	P802D_ON	Not On	A5	Sodium Hydroxide Pump D Power Off	HMI Alarm	Shutdown all process systems after 30 second time delay	Manual Operator Restart	Silence Alarm	Check Status of Pump Power Disconnect Switch	Pump malfunction.							
411	TP-PR-10-10-09	FSL802D	TOPOCK1	LCP-001	DI	I:21/5	FSL801B	30837	FSL801B	Field Set	A5	Sodium Hydroxide Pump D Low Flow	HMI Alarm	Shutdown all process systems after 30 second time delay	Manual Operator Restart	Silence Alarm	Check Pump Operation, Chemical Level in Tote	Pump malfunction.		Chemical container empty					
413	TP-PR-10-10-09	LSL804	TOPOCK1	LCP-001	DI	I:17/12	LSL804	20828	LSL804	Field Set	A	Polyelectrolyte System Feed Hopper Low Level	HMI Alarm			Silence Alarm	Check Polyelectrolyte System Control Panel								
412	TP-PR-10-10-09	M804 FAIL	TOPOCK1	LCP-001	DI	I:17/14	LSL804	20830	M800_FAIL	Field Set	A	Polyelectrolyte System Failed	HMI Alarm			Silence Alarm	Check Polyelectrolyte System Control Panel	Chemical container empty							
395	TP-PR-10-10-09	B300 ON	TOPOCK1	LCP-001	DI	I:17/15		20304	B300FTST	10 sec	A	Oxidation Air Blower Fail to Start	HMI Alarm			Silence Alarm	Check Aeration Blower Motor Starter	Blower malfunction							
394	TP-PR-10-10-09	B300 ON	TOPOCK1	LCP-001	DI	I:17/15		20309	B300FTSP	10 sec	A	Oxidation Air Blower Fail to Stop	HMI Alarm			Silence Alarm	Check Aeration Blower Motor Starter	Blower malfunction							
420	TP-PR-10-10-09	PIT1000	TOPOCK1	LCP-001	AI	I:5.7		21169	PIT1000_HA	140 psig	A	Plant Instrument Air Pressure High	HMI Alarm			Silence Alarm	Check Instrument Air Compressor for Proper Shutoff Setting								
421	TP-PR-10-10-09	PIT1000	TOPOCK1	LCP-001	AI	I:5.7		21170	PIT1000_LA	110 psig	A	Plant Instrument Air Pressure Low	HMI Alarm			Silence Alarm	Check Instrument Air Compressor, Inspect For Air Leaks								

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
396	TP-PR-10-10-09	CMP1000 FAIL	TOPOCK1	LCP-001	DI	I:18/2	CMP1000 FAIL	21166	CMP1000_FAIL	Field Set	A	Plant Instrument Air Compressor Fail Alarm	HMI Alarm			Silence Alarm	Check Instrument Air Compressor Control Panel								
397	TP-PR-10-10-09	FIT 300A	TOPOCK1	LCP-001	AI	I:4.6		20359	FIT300A_HA	95 scfm	A	Iron Oxidation Reactor No. 1 Air Flow High	HMI Alarm			Silence Alarm	Check Air Flow Indicator A, Check Butterfly Valve Position								
398	TP-PR-10-10-09	FIT 300A	TOPOCK1	LCP-001	AI	I:4.6		20358	FIT300A_LA	80 scfm	A	Iron Oxidation Reactor No. 1 Air Flow Low	HMI Alarm			Silence Alarm	Check Air Flow Indicator A, Check Butterfly Valve Position								
399	TP-PR-10-10-09	FIT 300A	TOPOCK1	LCP-001	AI	I:4.6		30317	FIT300A_LLA	70 scfm	D	Iron Oxidation Reactor No. 1 Air Flow Low Low	HMI Alarm	Shutdown all process systems after 1 minute time delay	Manual Operator Restart	Silence Alarm	Check Air Flow Indicator A, Check Butterfly Valve Position								
402	TP-PR-10-10-09	FIT 300B	TOPOCK1	LCP-001	AI	I:4.7		20369	FIT300B_HA	95 scfm	A	Iron Oxidation Reactor No. 2 Air Flow High	HMI Alarm			Silence Alarm	Check Air Flow Indicator B, Check Butterfly Valve Position								
401	TP-PR-10-10-09	FIT 300B	TOPOCK1	LCP-001	AI	I:4.7		20368	FIT300B_LA	80 scfm	A	Iron Oxidation Reactor No. 2 Air Flow Low	HMI Alarm			Silence Alarm	Check Air Flow Indicator B, Check Butterfly Valve Position								
400	TP-PR-10-10-09	FIT 300B	TOPOCK1	LCP-001	AI	I:4.7		30318	FIT300B_LLA	70 scfm	D	Iron Oxidation Reactor No. 2 Air Flow Low Low	HMI Alarm	Shutdown all process systems after 1 minute time delay	Manual Operator Restart	Silence Alarm	Check Air Flow Indicator B, Check Butterfly Valve Position								
404	TP-PR-10-10-09	FIT 300C	TOPOCK1	LCP-001	AI	I:4.8		20379	FIT300C_HA	95 scfm	A	Iron Oxidation Reactor No. 3 Air Flow High	HMI Alarm			Silence Alarm	Check Air Flow Indicator C, Check Butterfly Valve Position								
403	TP-PR-10-10-09	FIT 300C	TOPOCK1	LCP-001	AI	I:4.8		20378	FIT300C_LA	80 scfm	A	Iron Oxidation Reactor No. 3 Air Flow Low	HMI Alarm			Silence Alarm	Check Air Flow Indicator C, Check Butterfly Valve Position								
405	TP-PR-10-10-09	FIT 300C	TOPOCK1	LCP-001	AI	I:4.8		30319	FIT300C_LLA	70 scfm	D	Iron Oxidation Reactor No. 3 Air Flow Low Low	HMI Alarm	Shutdown all process systems after 1 minute time delay	Manual Operator Restart	Silence Alarm	Check Air Flow Indicator C, Check Butterfly Valve Position								
425	TP-PR-10-10-10	LSH703	TOPOCK1	LCP-001	DI	I:18/6	LSH703	20773	LSH703	Field Set	A	High Level R O Concentrate Storage Tank (Baker Tank)	HMI Alarm			Silence Alarm	Visually Check Level on RO Concentrate Baker Tank								
24	TP-PR-10-10-03	LSH201A-P	TOPOCK1	LCP-001	DI	I:18/4	LSH201A-P	30210	LSH201A_P	Field Set	A	Pipeline Leak Detection Control Panel Leak Alarm	HMI Alarm	Shutdown all extraction well pumps	Operator Manual Restart	Silence Alarm	Check Leak Detection Control Panel For Source of Leak, Repair								
232	TP-PR-10-10-06	AIT400 TURB	TOPOCK1	LCP-001	AI	I:4.9		30400	AIT400_TURB_HHA	30 NTU	A	Clarifier Effluent Turbidity High High	HMI Alarm			Silence Alarm	Check Turbidimeter, Calibrate if Required	No polymer addition or incorrect dose.	Verify polymer addition	Sludge blanket level in clarifier too high	Increase sludge wasting rate				
231	TP-PR-10-10-06	AIT400 TURB	TOPOCK1	LCP-001	AI	I:4.9		20435	AIT400_TURB_HA	20 NTU	A	Clarifier Effluent Turbidity High	HMI Alarm			Silence Alarm	Check Turbidimeter, Calibrate if Required	No polymer addition or incorrect dose.	Verify polymer addition	Sludge blanket level in clarifier too high	Increase sludge wasting rate				
2	NONE	LSH1250	TOPOCK1	LCP-001	DI	I:18/7	LSH1250	21299	LSH1250	Field Set	A	Sewage Tank High Level	HMI Alarm			Silence Alarm	Visually Inspect Sewage Tank Level, Call Pump Truck								
453	TP-PR-10-10-11	LT1201 (future)	TOPOCK2	ICP-001	AI	I:1.0		21213	LT1201_HA	TBD	A	Injection Well No. 1 Level High	HMI Alarm			Silence Alarm	Investigate Injection Well No 1 Problem at Wellhead								
454	TP-PR-10-10-11	LT1201 (future)	TOPOCK2	ICP-001	AI	I:1.0		21212	LT1201_LA	TBD	A	Injection Well No. 1 Level Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 1 Problem at Wellhead								
473	TP-PR-10-10-11	PIT1201 (future)	TOPOCK2	ICP-001	AI	I:1.1		21215	PIT1201_HA	TBD	A	Injection Well No. 1 Line Pressure High	HMI Alarm			Silence Alarm	Investigate Injection Well No 1 Problem at Wellhead								
474	TP-PR-10-10-11	PIT1201 (future)	TOPOCK2	ICP-001	AI	I:1.1		21214	PIT1201_LA	TBD	A	Injection Well No. 1 Line Pressure Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 1 Problem at Wellhead								
431	TP-PR-10-10-11	FIT1201 (future)	TOPOCK2	ICP-001	AI	I:1.2		21211	FIT1201_HA	TBD	A	Injection Well No. 1 Flow High	HMI Alarm			Silence Alarm	Investigate Injection Well No 1 Problem at Wellhead								
430	TP-PR-10-10-11	FIT1201 (future)	TOPOCK2	ICP-001	AI	I:1.2		21210	FIT1201_LA	TBD	A	Injection Well No. 1 Flow Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 1 Problem at Wellhead								
455	TP-PR-10-10-11	LT1202	TOPOCK2	ICP-001	AI	I:1.3		21223	LT1202_HA	110% normal	A	Injection Well No. 2 Level High	HMI Alarm			Silence Alarm	Investigate Injection Well No 2 Problem at Wellhead								
456	TP-PR-10-10-11	LT1202	TOPOCK2	ICP-001	AI	I:1.3		21222	LT1202_LA	85% normal	A	Injection Well No. 2 Level Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 2 Problem at Wellhead								
476	TP-PR-10-10-11	PIT1202	TOPOCK2	ICP-001	AI	I:1.4		31223	PIT1202_HA	110% normal	A	Injection Well No. 2 Line Pressure High	HMI Alarm	Shutdown Pump P-700 after one minute time delay		Silence Alarm	Investigate Injection Well No 2 Problem at Wellhead								
477	TP-PR-10-10-11	PIT1202	TOPOCK2	ICP-001	AI	I:1.4		21224	PIT1202_LA	85% normal	A	Injection Well No. 2 Line Pressure Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 2 Problem at Wellhead								
432	TP-PR-10-10-11	FIT1202	TOPOCK2	ICP-001	AI	I:1.5		21221	FIT1202_HA	110% normal	A	Injection Well No. 2 Flow High	HMI Alarm			Silence Alarm	Investigate Injection Well No 2 Problem at Wellhead								
433	TP-PR-10-10-11	FIT1202	TOPOCK2	ICP-001	AI	I:1.5		21220	FIT1202_LA	85% normal	A	Injection Well No. 2 Flow Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 2 Problem at Wellhead								
457	TP-PR-10-10-11	LT1203	TOPOCK2	ICP-001	AI	I:1.6		21233	LT1203_HA	110% normal	A	Injection Well No. 3 Level High	HMI Alarm			Silence Alarm	Investigate Injection Well No 3 Problem at Wellhead								
458	TP-PR-10-10-11	LT1203	TOPOCK2	ICP-001	AI	I:1.6		21232	LT1203_LA	85% normal	A	Injection Well No. 3 Level Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 3 Problem at Wellhead								
480	TP-PR-10-10-11	PIT1203	TOPOCK2	ICP-001	AI	I:1.7		31233	PIT1203_HA	110% normal	A	Injection Well No. 3 Line Pressure High	HMI Alarm	Shutdown Pump P-700 after one minute time delay		Silence Alarm	Investigate Injection Well No 3 Problem at Wellhead								
478	TP-PR-10-10-11	PIT1203	TOPOCK2	ICP-001	AI	I:1.7		21234	PIT1203_LA	85% normal	A	Injection Well No. 3 Line Pressure Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 3 Problem at Wellhead								
434	TP-PR-10-10-11	FIT1203	TOPOCK2	ICP-001	AI	I:1.8		21231	FIT1203_HA	110% normal	A	Injection Well No. 3 Flow High	HMI Alarm			Silence Alarm	Investigate Injection Well No 3 Problem at Wellhead								
435	TP-PR-10-10-11	FIT1203	TOPOCK2	ICP-001	AI	I:1.8		21230	FIT1203_LA	85% normal	A	Injection Well No. 3 Flow Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 3 Problem at Wellhead								

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
460	TP-PR-10-10-11	LT1204 (future)	TOPOCK2	ICP-001	AI	I:1.9		21243	LT1204_HA	TBD	A	Injection Well No. 4 Level High	HMI Alarm			Silence Alarm	Investigate Injection Well No 4 Problem at Wellhead								
459	TP-PR-10-10-11	LT1204 (future)	TOPOCK2	ICP-001	AI	I:1.9		21242	LT1204_LA	TBD	A	Injection Well No. 4 Level Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 4 Problem at Wellhead								
482	TP-PR-10-10-11	PIT1204 (future)	TOPOCK2	ICP-001	AI	I:1.10		21245	PIT1204_HA	TBD	A	Injection Well No. 4 Line Pressure High	HMI Alarm			Silence Alarm	Investigate Injection Well No 4 Problem at Wellhead								
481	TP-PR-10-10-11	PIT1204 (future)	TOPOCK2	ICP-001	AI	I:1.10		21244	PIT1204_LA	TBD	A	Injection Well No. 4 Line Pressure Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 4 Problem at Wellhead								
436	TP-PR-10-10-11	FIT1204 (future)	TOPOCK2	ICP-001	AI	I:1.11		21241	FIT1204_HA	TBD	A	Injection Well No. 4 Flow High	HMI Alarm			Silence Alarm	Investigate Injection Well No 4 Problem at Wellhead								
437	TP-PR-10-10-11	FIT1204 (future)	TOPOCK2	ICP-001	AI	I:1.11		21240	FIT1204_LA	TBD	A	Injection Well No. 4 Flow Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 4 Problem at Wellhead								
461	TP-PR-10-10-11	LT1205 (future)	TOPOCK2	ICP-001	AI	I:1.12		21253	LT1205_HA	TBD	A	Injection Well No. 5 Level High	HMI Alarm			Silence Alarm	Investigate Injection Well No 5 Problem at Wellhead								
462	TP-PR-10-10-11	LT1205 (future)	TOPOCK2	ICP-001	AI	I:1.12		21252	LT1205_LA	TBD	A	Injection Well No. 5 Level Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 5 Problem at Wellhead								
483	TP-PR-10-10-11	PIT1205 (future)	TOPOCK2	ICP-001	AI	I:1.13		21255	PIT1205_HA	TBD	A	Injection Well No. 5 Line Pressure High	HMI Alarm			Silence Alarm	Investigate Injection Well No 5 Problem at Wellhead								
484	TP-PR-10-10-11	PIT1205 (future)	TOPOCK2	ICP-001	AI	I:1.13		21254	PIT1205_LA	TBD	A	Injection Well No. 5 Line Pressure Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 5 Problem at Wellhead								
439	TP-PR-10-10-11	FIT1205 (future)	TOPOCK2	ICP-001	AI	I:1.14		21251	FIT1205_HA	TBD	A	Injection Well No. 5 Flow High	HMI Alarm			Silence Alarm	Investigate Injection Well No 5 Problem at Wellhead								
438	TP-PR-10-10-11	FIT1205 (future)	TOPOCK2	ICP-001	AI	I:1.14		21250	FIT1205_LA	TBD	A	Injection Well No. 5 Flow Low	HMI Alarm			Silence Alarm	Investigate Injection Well No 5 Problem at Wellhead								
464	TP-PR-10-10-11	LT1206 (future)	TOPOCK2	ICP-001	AI	I:1.14		FUTURE	LT1206_HA	TBD	A	Injection Well No. 6 Level High	HMI Alarm			Silence Alarm									
463	TP-PR-10-10-11	LT1206 (future)	TOPOCK2	ICP-001	AI	I:1.14		FUTURE	LT1206_LA	TBD	A	Injection Well No. 6 Level Low	HMI Alarm			Silence Alarm									
486	TP-PR-10-10-11	PIT1206 (future)	TOPOCK2	ICP-001	AI	I:2.0		FUTURE	PIT1206_HA	TBD	A	Injection Well No. 6 Line Pressure High	HMI Alarm			Silence Alarm									
485	TP-PR-10-10-11	PIT1206 (future)	TOPOCK2	ICP-001	AI	I:2.0		FUTURE	PIT1206_LA	TBD	A	Injection Well No. 6 Line Pressure Low	HMI Alarm			Silence Alarm									
441	TP-PR-10-10-11	FIT1206 (future)	TOPOCK2	ICP-001	AI	I:2.1		FUTURE	FIT1206_HA	TBD	A	Injection Well No. 6 Flow High	HMI Alarm			Silence Alarm									
440	TP-PR-10-10-11	FIT1206 (future)	TOPOCK2	ICP-001	AI	I:2.1		FUTURE	FIT1206_LA	TBD	A	Injection Well No. 6 Flow Low	HMI Alarm			Silence Alarm									
466	TP-PR-10-10-11	LT1207 (future)	TOPOCK2	ICP-001	AI	I:2.2		FUTURE	LT1207_HA	TBD	A	Injection Well No. 7 Level High	HMI Alarm			Silence Alarm									
465	TP-PR-10-10-11	LT1207 (future)	TOPOCK2	ICP-001	AI	I:2.2		FUTURE	LT1207_LA	TBD	A	Injection Well No. 7 Level Low	HMI Alarm			Silence Alarm									
487	TP-PR-10-10-11	PIT1207 (future)	TOPOCK2	ICP-001	AI	I:2.3		FUTURE	PIT1207_HA	TBD	A	Injection Well No. 7 Line Pressure High	HMI Alarm			Silence Alarm									
488	TP-PR-10-10-11	PIT1207 (future)	TOPOCK2	ICP-001	AI	I:2.3		FUTURE	PIT1207_LA	TBD	A	Injection Well No. 7 Line Pressure Low	HMI Alarm			Silence Alarm									
442	TP-PR-10-10-11	FIT1207 (future)	TOPOCK2	ICP-001	AI	I:2.4		FUTURE	FIT1207_HA	TBD	A	Injection Well No. 7 Flow High	HMI Alarm			Silence Alarm									
443	TP-PR-10-10-11	FIT1207 (future)	TOPOCK2	ICP-001	AI	I:2.4		FUTURE	FIT1207_LA	TBD	A	Injection Well No. 7 Flow Low	HMI Alarm			Silence Alarm									
468	TP-PR-10-10-11	LT1208 (future)	TOPOCK2	ICP-001	AI	I:2.5		FUTURE	LT1208_HA	TBD	A	Injection Well No. 8 Level High	HMI Alarm			Silence Alarm									
467	TP-PR-10-10-11	LT1208 (future)	TOPOCK2	ICP-001	AI	I:2.5		FUTURE	LT1208_LA	TBD	A	Injection Well No. 8 Level Low	HMI Alarm			Silence Alarm									
490	TP-PR-10-10-11	PIT1208 (future)	TOPOCK2	ICP-001	AI	I:2.6		FUTURE	PIT1208_HA	TBD	A	Injection Well No. 8 Line Pressure High	HMI Alarm			Silence Alarm									
489	TP-PR-10-10-11	PIT1208 (future)	TOPOCK2	ICP-001	AI	I:2.6		FUTURE	PIT1208_LA	TBD	A	Injection Well No. 8 Line Pressure Low	HMI Alarm			Silence Alarm									
444	TP-PR-10-10-11	FIT1208 (future)	TOPOCK2	ICP-001	AI	I:2.7		FUTURE	FIT1208_HA	TBD	A	Injection Well No. 8 Flow High	HMI Alarm			Silence Alarm									
445	TP-PR-10-10-11	FIT1208 (future)	TOPOCK2	ICP-001	AI	I:2.7		FUTURE	FIT1208_LA	TBD	A	Injection Well No. 8 Flow Low	HMI Alarm			Silence Alarm									
469	TP-PR-10-10-11	LT1209 (future)	TOPOCK2	ICP-001	AI	I:2.8		FUTURE	LT1209_HA	TBD	A	Injection Well No. 9 Level High	HMI Alarm			Silence Alarm									
470	TP-PR-10-10-11	LT1209 (future)	TOPOCK2	ICP-001	AI	I:2.8		FUTURE	LT1209_LA	TBD	A	Injection Well No. 9 Level Low	HMI Alarm			Silence Alarm									
491	TP-PR-10-10-11	PIT1209 (future)	TOPOCK2	ICP-001	AI	I:2.9		FUTURE	PIT1209_HA	TBD	A	Injection Well No. 9 Line Pressure High	HMI Alarm			Silence Alarm									

APPENDIX G: ALARMS AND TROUBLESHOOTING SUMMARY
PG&E Topock Compressore Station, Interim Measures No. 3 Facility

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
492	TP-PR-10-10-11	PIT1209 (future)	TOPOCK2	ICP-001	AI	I:2.9		FUTURE	PIT1209_LA	TBD	A	Injection Well No. 9 Line Pressure Low	HMI Alarm			Silence Alarm									
446	TP-PR-10-10-11	FIT1209 (future)	TOPOCK2	ICP-001	AI	I:2.10		FUTURE	FIT1209_HA	TBD	A	Injection Well No. 9 Flow High	HMI Alarm			Silence Alarm									
447	TP-PR-10-10-11	FIT1209 (future)	TOPOCK2	ICP-001	AI	I:2.10		FUTURE	FIT1209_LA	TBD	A	Injection Well No. 9 Flow Low	HMI Alarm			Silence Alarm									
472	TP-PR-10-10-11	LT1210 (future)	TOPOCK2	ICP-001	AI	I:2.11		FUTURE	LT1210_HA	TBD	A	Injection Well No. 10 Level High	HMI Alarm			Silence Alarm									
471	TP-PR-10-10-11	LT1210 (future)	TOPOCK2	ICP-001	AI	I:2.11		FUTURE	LT1210_LA	TBD	A	Injection Well No. 10 Level Low	HMI Alarm			Silence Alarm									
493	TP-PR-10-10-11	PIT1210 (future)	TOPOCK2	ICP-001	AI	I:2.12		FUTURE	PIT1210_HA	TBD	A	Injection Well No. 10 Line Pressure High	HMI Alarm			Silence Alarm									
494	TP-PR-10-10-11	PIT1210 (future)	TOPOCK2	ICP-001	AI	I:2.12		FUTURE	PIT1210_LA	TBD	A	Injection Well No. 10 Line Pressure Low	HMI Alarm			Silence Alarm									
448	TP-PR-10-10-11	FIT1210 (future)	TOPOCK2	ICP-001	AI	I:2.13		FUTURE	FIT1210_HA	TBD	A	Injection Well No. 10 Flow High	HMI Alarm			Silence Alarm									
449	TP-PR-10-10-11	FIT1210 (future)	TOPOCK2	ICP-001	AI	I:2.13		FUTURE	FIT1210_LA	TBD	A	Injection Well No. 10 Flow Low	HMI Alarm			Silence Alarm									
299	TP-PR-10-10-07	QSTOP	TOPOCKMF	Pall	Bit	B22:0/1	QSTOP	30511	MF_QSTOP	By Vendor	A1	Skid Quick Stop	HMI Alarm	Shutdown MF Skid	Shutdown Pump P 500	Silence Alarm	See Microfilter O&M manual								
271	TP-PR-10-10-07	FIT1Fail	TOPOCKMF	Pall	Bit	B22:0/2	FIT1Fail	30522	MF_FIT1_FAIL	By Vendor	A1	Effluent Flow Instrument Failure	HMI Alarm	Shutdown MF Skid	Shutdown Pump P 500	Silence Alarm	See Microfilter O&M manual								
275	TP-PR-10-10-07	LIT1 Fail	TOPOCKMF	Pall	Bit	B22:0/3	LIT1 Fail	30523	MF_LT1_FAIL	By Vendor	A1	T-501 Level Instrument Failure	HMI Alarm	Shutdown MF Skid	Shutdown Pump P 500	Silence Alarm	See Microfilter O&M manual								
279	TP-PR-10-10-07	LIT2 Fail	TOPOCKMF	Pall	Bit	B22:0/4	LIT2 Fail	30524	MF_LT2_FAIL	By Vendor	A1	T-502 Level Instrument Failure	HMI Alarm	Shutdown MF Skid	Shutdown Pump P 500	Silence Alarm	See Microfilter O&M manual								
297	TP-PR-10-10-07	PSL1	TOPOCKMF	Pall	Bit	B22:0/5	PSL1	30525	MF_PSL1	By Vendor	A1	Instrument Air Pressure Low Low	HMI Alarm	Shutdown MF Skid	Shutdown Pump P 500	Silence Alarm	See Microfilter O&M manual								
298	TP-PR-10-10-07	PSL2	TOPOCKMF	Pall	Bit	B22:0/6	PSL2	20526	MF_PSL2	By Vendor	A1	Instrument Air Pressure Low	HMI Alarm	Pause Filtration		Silence Alarm	See Microfilter O&M manual								
292	TP-PR-10-10-07	PIT1 Fail	TOPOCKMF	Pall	Bit	B22:0/7	PIT1 Fail	30527	MF_PIT1_FAIL	By Vendor	A1	Strainer Outlet Pressure Instrument Failure	HMI Alarm	Shutdown MF Skid	Shutdown Pump P 500	Silence Alarm	See Microfilter O&M manual								
294	TP-PR-10-10-07	PIT2 Fail	TOPOCKMF	Pall	Bit	B22:0/8	PIT2 Fail	30528	MF_PIT2_FAIL	By Vendor	A1	Effluent Pressure Instrument Failure	HMI Alarm	Shutdown MF Skid	Shutdown Pump P 500	Silence Alarm	See Microfilter O&M manual								
296	TP-PR-10-10-07	PIT3 Fail	TOPOCKMF	Pall	Bit	B22:0/9	PIT3 Fail	30529	MF_PIT3_FAIL	By Vendor	A1	Strainer Inlet Pressure Instrument Failure	HMI Alarm	Shutdown MF Skid	Shutdown Pump P 500	Silence Alarm	See Microfilter O&M manual								
303	TP-PR-10-10-07	TT1 Fail	TOPOCKMF	Pall	Bit	B22:0/10	TT1 Fail	20540	MF_TT1_FAIL	By Vendor	A	Effluent Temperature Instrument Failure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
305	TP-PR-10-10-07	VFD1 Fail	TOPOCKMF	Pall	Bit	B22:0/11	VFD1 Fail	30531	MF_VFD1_FAIL	By Vendor	A1	Pump P-501 VFD Failure	HMI Alarm	Shutdown MF Skid	Shutdown Pump P 500	Silence Alarm	See Microfilter O&M manual								
306	TP-PR-10-10-07	VFD2 Fail	TOPOCKMF	Pall	Bit	B22:0/12	VFD2 Fail	30532	MF_VFD2_FAIL	By Vendor	A1	Pump P-502 VFD Failure	HMI Alarm	Shutdown MF Skid	Shutdown Pump P 500	Silence Alarm	See Microfilter O&M manual								
301	TP-PR-10-10-07	T1 Pause	TOPOCKMF	Pall	Bit	B22:0/13	T1 Pause	20510	MF_T1_PAUSE	By Vendor	A	T-501Level Instrument Pause	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
262	TP-PR-10-10-07	AIT1 Fail	TOPOCKMF	Pall	Bit	B22:1/4	AIT1 Fail	20515	MF_AIT1_FAIL	By Vendor	A	Feed Turbidimeter Failure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
265	TP-PR-10-10-07	AIT2 Fail	TOPOCKMF	Pall	Bit	B22:1/5	AIT2 Fail	30535	MF_AIT2_FAIL	By Vendor	D	Effluent Turbidimeter Failure	HMI Alarm	Shutdown MF Skid	Shutdown Pump P 500	Silence Alarm	See Microfilter O&M manual								
286	TP-PR-10-10-07	LT50 Fail	TOPOCKMF	Pall	Bit	B22:2/4	LT50 Fail	30544	MF_LT50_FAIL	By Vendor	A	Filtrate Tank Level Instrument Failure	HMI Alarm	Shutdown transfer pump P-700		Silence Alarm	Visually Check Level On Treated Water Baker Tank								
289	TP-PR-10-10-07	LT50 Pause	TOPOCKMF	Pall	Bit	B22:2/5	LT50 Pause	20545	MF_LT50_PAUSE	By Vendor	A	Filtrate Tank Level Pause	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
277	TP-PR-10-10-07	LIT1 Low	TOPOCKMF	Pall	Bit	B22:2/8	LIT1 Low	30536	MF_LT1_LOW	By Vendor	A	Tank T-501 Low Level	HMI Alarm	Shutdown brine transfer pump P-701		Silence Alarm	Visually Check Level on RC Concentrate Baker Tank								
276	TP-PR-10-10-07	LIT1 High	TOPOCKMF	Pall	Bit	B22:2/9	LIT1 High	30537	MF_LT1_HIGH	By Vendor	A	Tank T-501 High Level	HMI Alarm	Shutdown Injection Pump P-700		Silence Alarm	Investigate Cause at Injection Well No. 3 Vault								
281	TP-PR-10-10-07	LIT2 Low	TOPOCKMF	Pall	Bit	B22:2/10	LIT2 Low	30538	MF_LT2_LOW	By Vendor	A1	Tank T-502 Low Level	HMI Alarm	Pause MF Skid		Silence Alarm	See Microfilter O&M manual								
280	TP-PR-10-10-07	LIT2 High	TOPOCKMF	Pall	Bit	B22:2/11	LIT2 High	30539	MF_LT2_HIGH	By Vendor	A1	Tank T-502 High Level	HMI Alarm	Pause MF Skid		Silence Alarm	See Microfilter O&M manual								
293	TP-PR-10-10-07	PIT1 High	TOPOCKMF	Pall	Bit	B22:2/12	PIT1 High	30542	MF_PIT1_HIGH	By Vendor	A1	Strainer Outlet Pressure High	HMI Alarm	Shutdown MF Skid	Shutdown Pump P 500	Silence Alarm	See Microfilter O&M manual								
295	TP-PR-10-10-07	PIT2 High	TOPOCKMF	Pall	Bit	B22:2/13	PIT2 High	30543	MF_PIT2_HIGH	By Vendor	A1	Effluent Pressure High	HMI Alarm	Shutdown MF Skid	Shutdown Pump P 500	Silence Alarm	See Microfilter O&M manual								
268	TP-PR-10-10-07	DPIT12 High	TOPOCKMF	Pall	Bit	B22:2/14	DPIT12 High	20554	MF_DPIT12_HIGH	By Vendor	A	RO Membrane High Differential Pressure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
304	TP-PR-10-10-07	TT1 High	TOPOCKMF	Pall	Bit	B22:2/15	TT1 High	30545	MF_TT1_HIGH	By Vendor	A	Effluent Temperature High	HMI Alarm	Shutdown RO. Stop Treated Water discharge pump P-700		Silence Alarm	Inspect and/or Clean pH Sensor	pH sensor out of calibration	Check sensor calibration						
270	TP-PR-10-10-07	FIT1 Low	TOPOCKMF	Pall	Bit	B22:3/0	FIT1 Low	20560	MF_FIT1_LOW	By Vendor	A	Pump P-502 Low Flow	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
263	TP-PR-10-10-07	AIT1 High	TOPOCKMF	Pall	Bit	B22:3/6	AIT1 High	20516	MF_AIT1_HIGH	By Vendor	A	Feed Turbidity High	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
264	TP-PR-10-10-07	AIT1 High High	TOPOCKMF	Pall	Bit	B22:3/7	AIT1 High High	20517	MF_AIT1_HIHI	By Vendor	A	Feed Turbidity High High	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
266	TP-PR-10-10-07	AIT2 High	TOPOCKMF	Pall	Bit	B22:3/8	AIT2 High	20542	MF_AIT2_HIGH	By Vendor	A	Effluent Turbidity High	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
267	TP-PR-10-10-07	AIT2 High High	TOPOCKMF	Pall	Bit	B22:3/9	AIT2 High High	30549	MF_AIT2_HIHI	By Vendor	A1	Effluent Turbidity High High	HMI Alarm	Shutdown MF Skid	Shutdown Pump P 500	Silence Alarm	See Microfilter O&M manual								
288	TP-PR-10-10-07	LT50 Low	TOPOCKMF	Pall	Bit	B22:4/6	LT50 Low	20526	MF_LT50_LOW	By Vendor	A	Filtrate Tank Level Low	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
287	TP-PR-10-10-07	LT50 High	TOPOCKMF	Pall	Bit	B22:4/7	LT50 High	30548	MF_LT50_HIGH	By Vendor	A	Filtrate Tank Level High	HMI Alarm	Shutdown RO. Stop Treated Water discharge pump P-700		Silence Alarm	Inspect and/or Clean pH Sensor	pH sensor out of calibration	Check sensor calibration						
278	TP-PR-10-10-07	LIT2 Change	TOPOCKMF	Pall	Bit	B22:4/14	LIT2 Change	30540	MF_LT2_CHANGE	By Vendor	A	Tank T-502 Level Change During CIP	HMI Alarm	Shutdown Injection Pump P-700		Silence Alarm	Investigate Cause at Injection Well No. 2 Vault								

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
302	TP-PR-10-10-07	T-2 Not Ready FM	TOPOCKMF	Pall	Bit	B22:4/15	T-2 Not Ready FM	20525	MF_T-2_NOT_READY_FM	By Vendor	A	Tank T-502 Not Ready for FM	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
273	TP-PR-10-10-07	IT Press Decay Hi	TOPOCKMF	Pall	Bit	B22:5/0	IT Press Decay Hi	20530	MF_IT_PRESS_DECAY_HI	By Vendor	A	IT Pressure Decay High	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
274	TP-PR-10-10-07	IT Press Decay Hi Hi	TOPOCKMF	Pall	Bit	B22:5/1	IT Press Decay Hi Hi	30591	MF_IT_PRESS_DECAY_HIHI	By Vendor	A1	IT Pressure Decay High High	HMI Alarm	Shutdown MF Skid	Shutdown Pump P-500	Silence Alarm	See Microfilter O&M manual								
300	TP-PR-10-10-07	Strainer Backwash Fail	TOPOCKMF	Pall	Bit	B22:5/2	Strainer Backwash Fail	30592	MF_STRAINER_BACKWASH_FAIL	By Vendor	A1	Strainer Backwash Failure	HMI Alarm	Shutdown MF Skid	Shutdown Pump P-500	Silence Alarm	See Microfilter O&M manual								
269	TP-PR-10-10-07	Fill Cycle Timeout	TOPOCKMF	Pall	Bit	B22:5/3	Fill Cycle Timeout	30593	MF_FILL_CYCLE_TIMEOUT	By Vendor	A1	Fill Cycle Watchdog Timeout	HMI Alarm	Shutdown MF Skid	Shutdown Pump P-500	Silence Alarm	See Microfilter O&M manual								
272	TP-PR-10-10-07	IT Cycle Timeout	TOPOCKMF	Pall	Bit	B22:5/4	IT Cycle Timeout	30594	MF_IT_CYCLE_TIMEOUT	By Vendor	A1	IT Cycle Watchdog Timeout	HMI Alarm	Pause EFM/CIP and shutdown all other sequences		Silence Alarm	See Microfilter O&M manual								
344	TP-PR-10-10-08	ALARM_SHUTDOWN	TOPOCKRO	Ecolochem	Bit	B3/2	Shutdown	40603		By Vendor	A1	RO System Shutdown	HMI Alarm	Shutdown RO System		Silence Alarm	Investigate Cause at RO Skid and Control Panel								
387	TP-PR-10-10-08	PSL1	TOPOCKRO	Ecolochem	Timer	T4:2/DN	PSL1	30601	RO_PSL1	15 sec	A1	RO System Inlet Pressure Low	HMI Alarm	Shutdown RO System		Silence Alarm	Investigate Cause at RO Skid and Control Panel								
386	TP-PR-10-10-08	PSH2	TOPOCKRO	Ecolochem	Timer	T4:4/DN	PSH2	30603	RO_PSH2	0.1 sec	A1	RO System Outlet Pressure High	HMI Alarm	Shutdown RO System		Silence Alarm	Investigate Cause at RO Skid and Control Panel								
388	TP-PR-10-10-08	TSH3	TOPOCKRO	Ecolochem	Timer	T4:6/DN	TSH3	30605	RO_TSH3	15 sec	A1	RO System Inlet Temperature High	HMI Alarm	Shutdown RO System		Silence Alarm	Investigate Cause at RO Skid and Control Panel								
372	TP-PR-10-10-08	PHAH/L4	TOPOCKRO	Ecolochem	Timer	T4:8/DN	PHAH/L4	30607	RO_PHA4	40 sec	A1	RO System pH High or Low	HMI Alarm	Shutdown RO System		Silence Alarm	Investigate Cause at RO Skid and Control Panel								
345	TP-PR-10-10-08	FAH/L5	TOPOCKRO	Ecolochem	Timer	T4:10/DN	FAH/L5	30609	RO_FA5	40 sec	A1	RO System Flow High or Low	HMI Alarm	Shutdown RO System		Silence Alarm	Investigate Cause at RO Skid and Control Panel								
346	TP-PR-10-10-08	FAL/ANTISCALE	TOPOCKRO	Ecolochem	Timer	T4:16/DN	FAL/7	30615	RO_FAL7	15 sec	A1	RO System Anti Scalent Flow Low	HMI Alarm	Shutdown RO System		Silence Alarm	Investigate Cause at RO Skid and Control Panel								
385	TP-PR-10-10-08	POWER FAIL	TOPOCKRO	Ecolochem	DO	O:2/5	POWER FAIL	30600	RO_POWERFAIL		A1	RO System Power Fail	HMI Alarm	Shutdown RO System		Silence Alarm	Investigate Cause at RO Skid and Control Panel								
366	TP-PR-10-10-08	LSH6	TOPOCKRO	Ecolochem	Timer	T4:3/DN	LSH6	30602	RO_LSH6	15 sec	A1	RO System FDA Basin Level High	HMI Alarm	Shutdown RO System		Silence Alarm	Investigate Cause at RO Skid and Control Panel								
348	TP-PR-10-10-08	FIT601	TOPOCKRO	Ecolochem	AI	I:3.0		20601	FIT601_HA	145 gpm	A	RO System Inlet Flow High	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
347	TP-PR-10-10-08	FIT601	TOPOCKRO	Ecolochem	AI	I:3.0		20600	FIT601_LA	135 gpm	A	RO System Inlet Flow Low	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
349	TP-PR-10-10-08	FIT611	TOPOCKRO	Ecolochem	AI	I:3.1		20603	FIT611_HA	.80 (FIT601)	A	RO System Permeate Flow High	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
350	TP-PR-10-10-08	FIT611	TOPOCKRO	Ecolochem	AI	I:3.1		20602	FIT611_LA	.70 (FIT601)	A	RO System Permeate Flow Low	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
353	TP-PR-10-10-08	FIT612	TOPOCKRO	Ecolochem	AI	I:3.2		20605	FIT612_HA	(FIT601/FIT612) >= 1.43	A	RO System Concentrate Flow High	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
351	TP-PR-10-10-08	FIT612	TOPOCKRO	Ecolochem	AI	I:3.2		20604	FIT612_LA	(FIT601/FIT612)<= 1.27	A	RO System Concentrate Flow Low	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
352	TP-PR-10-10-08	FIT612	TOPOCKRO	Ecolochem	AI	I:3.2		30632	FIT612_LLA	(FIT601/FIT612) <= 1.25	A1	RO System Concentrate Flow Low Low	HMI Alarm	Shutdown all process systems after 1 minute time delay		Silence Alarm	Investigate Cause at RO Skid and Control Panel								
333	TP-PR-10-10-08	AIT604 pH	TOPOCKRO	Ecolochem	AI	I:4.0		20607	AIT604_pH_HA	8 pH	C	RO System Inlet pH High	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
332	TP-PR-10-10-08	AIT604 pH	TOPOCKRO	Ecolochem	AI	I:4.0		20606	AIT604_pH_LA	6 pH	C	RO System Inlet pH Low	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
341	TP-PR-10-10-08	AIT610 COND	TOPOCKRO	Ecolochem	AI	I:4.1		20608	AIT610_COND_HHA	700 us/cm	A	RO System Outlet Conductivity High High	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
340	TP-PR-10-10-08	AIT610 COND	TOPOCKRO	Ecolochem	AI	I:4.1		20609	AIT610_COND_HA	600 us/cm	A	RO System Outlet Conductivity High	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
373	TP-PR-10-10-08	PIT602	TOPOCKRO	Ecolochem	AI	I:5.0		20630	DPA_PIT602_3	(PIT601-PIT603) > = 5 psid	A	RO System Pre Filter Differential Pressure High	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
375	TP-PR-10-10-08	PIT606	TOPOCKRO	Ecolochem	AI	I:5.2		20615	PIT606_HA	125 psig	A	RO System Inlet Pressure High	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
376	TP-PR-10-10-08	PIT606	TOPOCKRO	Ecolochem	AI	I:5.2		20614	PIT606_LA	75 psig	A	RO System Inlet Pressure Low	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
374	TP-PR-10-10-08	PIT606	TOPOCKRO	Ecolochem	AI	I:5.2		20631	DPA_PIT606_7	(PIT606-PIT607) >= 12 psid	A	RO System Stage 1 Differential Pressure High	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
377	TP-PR-10-10-08	PIT607	TOPOCKRO	Ecolochem	AI	I:5.3		20632	DPA_PIT607_8	(PIT607-PIT608) >= 12 psid	A	RO System Stage 2 Differential Pressure High	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
378	TP-PR-10-10-08	PIT608	TOPOCKRO	Ecolochem	AI	I:6.0		20633	DPA_PIT608_12	(PIT608-PIT612) >= 18 psid	A	RO System Stage 3 Differential Pressure High	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
379	TP-PR-10-10-08	PIT609	TOPOCKRO	Ecolochem	AI	I:6.1		20625	PIT609_HA	5 psig	A	RO System Final Pressure	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
380	TP-PR-10-10-08	PIT609	TOPOCKRO	Ecolochem	AI	I:6.1		20624	PIT609_LA	0.5 psig	A	RO System Final Pressure	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
381	TP-PR-10-10-08	PIT610	TOPOCKRO	Ecolochem	AI	I:6.2		20628	PIT620_HA	5 psig	A	RO System Permeate Pressure	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
382	TP-PR-10-10-08	PIT610	TOPOCKRO	Ecolochem	AI	I:6.2		20627	PIT610_LA	0.5 psig	A	RO System Permeate Pressure	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
384	TP-PR-10-10-08	PIT612	TOPOCKRO	Ecolochem	AI	I:6.3		20626	PIT612_HA	33 psig	A	RO System Concentrate Pressure	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
383	TP-PR-10-10-08	PIT612	TOPOCKRO	Ecolochem	AI	I:6.3		20629	PIT612_LA	27 psig	A	RO System Concentrate Pressure	HMI Alarm			Silence Alarm	Investigate Cause at RO Skid and Control Panel								
497	TP-PR-10-10-11	ZSC/O_1202	TOPOCK2	ICP-001	Bit			21261	FV1202_VSW	10 sec	A	Injection Well No. 2 Block Valve Double Limits	HMI Alarm												
498	TP-PR-10-10-11	ZSC/O_1202	TOPOCK2	ICP-001	Bit			21262	FV1203_VSW	10 sec	A	Injection Well No. 2 Block Valve No Limits	HMI Alarm												
501	TP-PR-10-10-11	ZSO 1202	TOPOCK2	ICP-001	DI	I:4/2		21263	FV1202_VSW	10 sec	A	Injection Well No. 2 Block Valve Fail to Close	HMI Alarm												
495	TP-PR-10-10-11	ZSC 1202	TOPOCK2	ICP-001	DI	I:4/3		21264	FV1202_VSW	10 sec	A	Injection Well No. 2 Block Valve Fail to Open	HMI Alarm												
500	TP-PR-10-10-11	ZSC/O_1203	TOPOCK2	ICP-001	Bit			21266	FV1202_VSW	10 sec	A	Injection Well No. 3 Block Valve Double Limits	HMI Alarm												
499	TP-PR-10-10-11	ZSC/O_1203	TOPOCK2	ICP-001	Bit			21265	FV1203_VSW	10 sec	A	Injection Well No. 3 Block Valve No Limits	HMI Alarm												
502	TP-PR-10-10-11	ZSO 1203	TOPOCK2	ICP-001	DI	I:4/4		21268	FV1203_VSW	10 sec	A	Injection Well No. 3 Block Valve Fail to Close	HMI Alarm												
496	TP-PR-10-10-11	ZSC 1203	TOPOCK2	ICP-001	DI	I:4/5		21267	FV1203_VSW	10 sec	A	Injection Well No. 3 Block Valve Fail to Open	HMI Alarm												
255	TP-PR-10-10-06	ZSC/0_410	TOPOCK1	LCP-001	Bit			30427	FV410_VSW	Immediate	A	Clarifier to T-402 Valve Double Limits	HMI Alarm			Silence Alarm	Check Clarifier to T-402 Valve for Jamming, Check Limit Switch								
258	TP-PR-10-10-06	ZSC410	TOPOCK1	LCP-001	DI	I:18/9		30426	FV410_VSW	10 sec	A	Clarifier to T-402 Valve Fail to Close	HMI Alarm			Silence Alarm	Check Clarifier to T-402 Valve for Jamming, Check Limit Switch								

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
260	TP-PR-10-10-06	ZSO410	TOPOCK1	LCP-001	DI	I:18/8		30425	FV410_VSW	10 sec	A	Clarifier to T-402 Valve Fail to Open	HMI Alarm			Silence Alarm	Check Clarifier to T-402 Valve for Jamming, Check Limit Switch								
256	TP-PR-10-10-06	ZSC/0_410	TOPOCK1	LCP-001	Bit			30428	FV410_VSW	10 sec	A	Clarifier to T-402 Valve No Limits	HMI Alarm			Silence Alarm	Check Clarifier to T-402 Valve for Jamming, Check Limit Switch								
1	NONE		TOPOCK1	LCP-001	Bit		PLC COMM ERR	31100	PLC_COMM_ERROR	1000 msec	A	PLC Communications Error	HMI Alarm			Silence Alarm	Verify PLC Operation; Check Ethernet Connections								
9	TP-PR-10-10-03		TOPOCK1	LCP-001	DI	I:12/2	P100REM	20114	P100_REM	Not in Remote	A	Pump P-100 Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
8	TP-PR-10-10-03		TOPOCK1	LCP-001	DI	I:12/5	P101REM	20115	P101_REM	Not in Remote	A	Pump P-101 Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
7	TP-PR-10-10-03		TOPOCK1	LCP-001	DI	I:12/8	P102REM	20116	P102_REM	Not in Remote	A	Pump P-102 Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
6	TP-PR-10-10-03		TOPOCK1	LCP-001	DI	I:12/11	P103REM	20117	P103_REM	Not in Remote	A	Pump P-103 Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
57	TP-PR-10-10-04		TOPOCK1	LCP-001	DI	I:13/2	FV100REM	20152	FV100_REM	Not in Remote	A	Raw Water Tank Influent Valve Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
51	TP-PR-10-10-04		TOPOCK1	LCP-001	DI	I:13/4	P200REM	20204	P200_REM	Not in Remote	A	Raw Water Feed Pump Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
54	TP-PR-10-10-04		TOPOCK1	LCP-001	DI	I:13/6	P700REM	20710	P700_REM	Not in Remote	A	Treated Water Transfer Pump Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
126	TP-PR-10-10-05		TOPOCK1	LCP-001	DI	I:13/10	FV201REM	20202	FV201_REM	Not in Remote	A	Treatment Plant Influent Valve Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
120	TP-PR-10-10-05		TOPOCK1	LCP-001	DI	I:13/13	P201REM	20220	P201_REM	Not in Remote	A	Chemical Mixing Pump Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
121	TP-PR-10-10-05		TOPOCK1	LCP-001	DI	I:13/15	M300REM	20310	M300_REM	Not in Remote	A	Chromium Reduction Reactor Mixer Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
122	TP-PR-10-10-05		TOPOCK1	LCP-001	DI	I:14/0	SV302REM	20315	SV302_REM	Not in Remote	A	Demister Wash Valve Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
123	TP-PR-10-10-05		TOPOCK1	LCP-001	DI	I:14/3	M301AREM	20311	M301A_REM	Not in Remote	A	Iron Oxidation Reator No. 1 Mixer Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
124	TP-PR-10-10-05		TOPOCK1	LCP-001	DI	I:14/6	M301BREM	20312	M301B_REM	Not in Remote	A	Iron Oxidation Reator No. 2 Mixer Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
119	TP-PR-10-10-05		TOPOCK1	LCP-001	DI	I:14/9	M301CREM	20313	M301C_REM	Not in Remote	A	Iron Oxidation Reator No. 3 Mixer Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
225	TP-PR-10-10-06		TOPOCK1	LCP-001	DI	I:14/15	M400AREM	20411	M400A_REM	Not in Remote	A	Clarifier Influent Mixer Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
224	TP-PR-10-10-06		TOPOCK1	LCP-001	DI	I:15/2	M400BREM	20412	M400B_REM	Not in Remote	A	Clarifier Secondary Mixer Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
223	TP-PR-10-10-06		TOPOCK1	LCP-001	DI	I:15/4	M400CREM	20416	M400C_REM	Not in Remote	A	Clarifier Rake Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
221	TP-PR-10-10-06		TOPOCK1	LCP-001	DI	I:15/7	FV400REM	20413	FV400_REM	Not in Remote	A	Sludge Recycle Valve Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
226	TP-PR-10-10-06		TOPOCK1	LCP-001	DI	I:15/10	P900REM	20910	P900_REM	Not in Remote	A	Process Drain Pump Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
216	TP-PR-10-10-06		TOPOCK1	LCP-001	DI	I:15/11	P401REM	20418	P401_REM	Not in Remote	A	Sludge Withdrawal Pump Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
230	TP-PR-10-10-06		TOPOCK1	LCP-001	DI	I:15/13	M402REM	20414	M402_REM	Not in Remote	A	Sludge Holding Tank Mixer Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
229	TP-PR-10-10-06		TOPOCK1	LCP-001	DI	I:15/14	P403REM	20415	P403_REM	Not in Remote	A	Phase Separator Feed Pump Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
228	TP-PR-10-10-06		TOPOCK1	LCP-001	DI	I:15/15	P404REM	20417	P404_REM	Not in Remote	A	Sludge Recycle Pump Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
261	TP-PR-10-10-07		TOPOCK1	LCP-001	DI	I:16/5	P500REM	20502	P500_REM	Not in Remote	A	Pre-Treated Water Transfer Pump Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
369	TP-PR-10-10-08	P620 REM	TOPOCK1	LCP-001	DI	I:16/7	P620REM	20619	P620_REM	Not in Remote	A	Filtered Water Transfer Pump Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
322	TP-PR-10-10-08		TOPOCK1	LCP-001	DI	I:16/14	P701REM	20711	P701_REM	Not in Remote	A	RO Concentrate Transfer Pump Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
391	TP-PR-10-10-09		TOPOCK1	LCP-001	DI	I:18/0	B300REM	20314	B300_REM	Not in Remote	A	Oxidation Air Blower Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
392	TP-PR-10-10-09		TOPOCK1	LCP-001	DI	I:18/1	P807REM	20865	P807_REM	Not in Remote	A	Sodium Hypochlorite Pump Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
217	TP-PR-10-10-06		TOPOCK1	LCP-001	DI	I:18/10	FV410REM	20410	FV410_REM	Not in Remote	A	Sludge Withdrawal Valve Not In Remote	HMI Alarm			Silence Alarm	Check LOR Field Switch								
422	TP-PR-10-10-10		TOPOCK1	LCP-001	DI	I:18/11	LSHH702	30769	LSHH702	Field Set	A	HiHi Level Treated Water Storage Tank (Baker Tank)	HMI Alarm	Shutdown P-700		Silence Alarm									
423	TP-PR-10-10-10		TOPOCK1	LCP-001	DI	I:18/12	LSHH703	30770	LSHH703	Field Set	A	HiHi Level R O Concentrate Storage Tank (Baker Tank)	HMI Alarm	Shutdown P-701		Silence Alarm									
331	TP-PR-10-10-08	AIT 600 COND	TOPOCK1	LCP-001	AI	I:3.12		20662	AIT600_COND_LA	0 uS	A	Microfilter Unit Effluent Conductivity Low				Silence Alarm									
323	TP-PR-10-10-08	AIT 601 COND	TOPOCK1	LCP-001	AI	I:3.13		20664	AIT601_COND_LA	0 uS	A	RO Unit Influent Conductivity Lo				Silence Alarm									
313	TP-PR-10-10-08	AIT 604 COND	TOPOCK1	LCP-001	AI	I:3.14		20666	AIT604_COND_LA	-9999	A	Ro Permeate to T-600 Conductivity Lo				Silence Alarm									
110	TP-PR-10-10-05		TOPOCK1	LCP-001	AO	O:6.1		20498	P400_SPDOUT_LA	-1 %	A	Clarifier Feed Pump Speed Lo													
111	TP-PR-10-10-05		TOPOCK1	LCP-001	AO	O:6.1		20499	P400_SPDOUT_HA	100%	A	Clarifier Feed Pump Speed High													
312	TP-PR-10-10-08	AIT701 COND	TOPOCK1	LCP-001	AI	I:4.2		20718	AIT701_COND_LA	-5 uS	A	RO Concentrate Conductivity Lo				Silence Alarm									
311	TP-PR-10-10-08	AIT605 COND	TOPOCK1	LCP-001	AI	I:4.3		20668	AIT605_COND_LA	10 uS	A	RO Permeate to Storage Conductivity Lo				Silence Alarm									
218	TP-PR-10-10-06	AIT400 TURB	TOPOCK1	LCP-001	AI	I:4.9		20433	AIT400_TURB_LA	0	A	Clarifier Effluent Turbidity Lo				Silence Alarm									
429	TP-PR-10-10-11	AIT702	TOPOCK1	LCP-001	AI	I:4.10		20730	AIT702_COND_LA	4,000 us	A	Injection Water Low Conductivity	HMI Alarm			Silence Alarm									
428	TP-PR-10-10-11	AIT702	TOPOCK1	LCP-001	AI	I:4.10		20731	AIT702_COND_HA	7,000 us	A	Injection Water High Conductivity	HMI Alarm			Silence Alarm									
53	TP-PR-10-10-04		TOPOCK1	LCP-001	AI	I:5.1		20210	ZT200_LA	0 %	A	Conrol Valve 200 Position High				Silence Alarm	Check Valve for Jamming, Check Positioner								
55	TP-PR-10-10-04		TOPOCK1	LCP-001	AI	I:5.1		20211	ZT200_HA	101%	A	Conrol Valve 603 Position High				Silence Alarm	Check Valve for Jamming, Check Positioner								
310	TP-PR-10-10-08		TOPOCK1	LCP-001	AI	I:5.4		20680	ZT602_LA	0 %	A	Conrol Valve 602 Position Lo				Silence Alarm	Check Valve for Jamming, Check Positioner								

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
309	TP-PR-10-10-08		TOPOCK1	LCP-001	AI	I:5.4		20681	ZT602_HA	100%	A	Conrol Valve 602 Position High				Silence Alarm	Check Valve for Jamming, Check Positioner								
324	TP-PR-10-10-08		TOPOCK1	LCP-001	AI	I:5.5		20682	ZT603_LA	0 %	A	Conrol Valve 603 Position Low				Silence Alarm	Check Valve for Jamming, Check Positioner								
308	TP-PR-10-10-08		TOPOCK1	LCP-001	AI	I:5.5		20683	ZT603_HA	100%	A	Conrol Valve 603 Position High				Silence Alarm	Check Valve for Jamming, Check Positioner								
316	TP-PR-10-10-08		TOPOCK1	LCP-001	AI	I:5.6		20684	ZT604_LA	0 %	A	Conrol Valve 603 Position High				Silence Alarm	Check Valve for Jamming, Check Positioner								
314	TP-PR-10-10-08		TOPOCK1	LCP-001	AI	I:5.6		20685	ZT604_HA	100%	A	Conrol Valve 604 Position Lo				Silence Alarm	Check Valve for Jamming, Check Positioner								
315	TP-PR-10-10-08		TOPOCK1	LCP-001	AI	I:5.8		20686	ZT615_LA	0 %	A	Conrol Valve 615 Position Lo				Silence Alarm	Check Valve for Jamming, Check Positioner								
307	TP-PR-10-10-08		TOPOCK1	LCP-001	AI	I:5.8		20687	ZT615_HA	105%	A	Conrol Valve 615 Position High				Silence Alarm	Check Valve for Jamming, Check Positioner								
450	TP-PR-10-10-11	LIT301C	TOPOCK1	LCP-001	AI	I:2.13		20319	LIT301C_HHA	14.5 ft	A	Iron Oxidation Reactor No. 3 Level HiHi	HMI Alarm	Shutdown P-200 Raw Water Feed Pump		Silence Alarm	Visually Check Level on Raw Water Storage Tank								
220	TP-PR-10-10-06		TOPOCK1	LCP-001	AI	I:3.1		20444	LIT402_LLA	0 ft	A	Sludge Holding Tank Level Lo Lo				Silence Alarm									
235	TP-PR-10-10-06	LIT402	TOPOCK1	LCP-001	AI	I:3.1		20445	LIT402_HHA	11.5 ft	A	Sludge Holding Tank Level High High	HMI Alarm			Silence Alarm	Visually Check Level On Sludge Holding Tank		Transfer sludge to the Phase Separators.						
114	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/00		20246	AIT202_pH_SEL_LA	5.0 pH	A	Chemical Mixing Loop pH Selected Low	HMI Alarm			Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
113	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/01		20247	AIT202_pH_SEL_HA	6.8 pH	A	Chemical Mixing Loop pH Selected High	HMI Alarm			Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
112	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/02		20248	AIT202_TEMP_SEL_LA	70 deg F	A	Chemical Mixing Loop Temperature Selected Low	HMI Alarm			Silence Alarm									
125	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/03		20249	AIT202_TEMP_SEL_HA	90 deg F	A	Chemical Mixing Loop Temperature Selected High	HMI Alarm			Silence Alarm									
115	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/04		20382	AIT300_pH_SEL_LA	5.0 pH	A	Chromium Reduction Reactor pH Selected Low	HMI Alarm			Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
117	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/05		20383	AIT300_pH_SEL_HA	6.8 pH	A	Chromium Reduction Reactor pH Selected High	HMI Alarm			Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
116	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/06		20348	AIT300_TEMP_SEL_LA	60 deg F	A	Chromium Reduction Reactor Temperature Selected Low	HMI Alarm			Silence Alarm									
118	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/07		20349	AIT300_TEMP_SEL_HA	90 deg F	A	Chromium Reduction Reactor Temperature Selected High	HMI Alarm			Silence Alarm									
109	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/08		20328	AIT301A_pH_SEL_LA	7.5 pH	A	Iron Oxidation Reactor No. 1 pH Selected Low	HMI Alarm			Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
97	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/09		20329	AIT301A_pH_SEL_HA	8.5 pH	A	Iron Oxidation Reactor No. 1 pH Selected High	HMI Alarm			Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
89	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/10		20386	AIT301A_TEMP_SEL_LA	70 deg F	A	Iron Oxidation Reactor No. 1 Temperature Selected Low	HMI Alarm			Silence Alarm									
88	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/11		20387	AIT301A_TEMP_SEL_HA	90 deg F	A	Iron Oxidation Reactor No. 1 Temperature Selected High	HMI Alarm			Silence Alarm									
87	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/12		20388	AIT301B_pH_SEL_LA	7.5 pH	A	Iron Oxidation Reactor No. 2 pH Selected Low	HMI Alarm			Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
90	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/13		20389	AIT301B_pH_SEL_HA	8.5 pH	A	Iron Oxidation Reactor No. 2 pH Selected High	HMI Alarm			Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
85	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/14		20392	AIT301B_TEMP_SEL_LA	70 deg F	A	Iron Oxidation Reactor No. 2 Temperature Selected Low	HMI Alarm			Silence Alarm									
84	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:50/15		20393	AIT301B_TEMP_SEL_HA	90 deg F	A	Iron Oxidation Reactor No. 2 Temperature Selected High	HMI Alarm			Silence Alarm									
83	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:51/00		20394	AIT301C_pH_SEL_LA	7.5 pH	A	Iron Oxidation Reactor No. 3 pH Selected Low	HMI Alarm			Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
80	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:51/01		20395	AIT301C_pH_SEL_HA	8.5 pH	A	Iron Oxidation Reactor No. 3 pH Selected High	HMI Alarm			Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
77	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:51/02		20398	AIT301C_TEMP_SEL_LA	70 deg F	A	Iron Oxidation Reactor No. 3 Temperature Selected Low	HMI Alarm			Silence Alarm									
78	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:51/03		20399	AIT301C_TEMP_SEL_HA	90 deg F	A	Iron Oxidation Reactor No. 3 Temperature Selected High	HMI Alarm			Silence Alarm									
79	TP-PR-10-10-05		TOPOCK1	LCP-001	AI	I:1.5		40111	FIT101_LLA	46 gpm	A	LoLo Flow Shutoff P-101	HMI Alarm	Shutdown P-101 Extraction Well Pump		Silence Alarm	Investigate Low Flow Condition;Check Pump								
475	TP-PR-10-10-11	PIT1202	TOPOCK2	ICP-001	AI	I:1.4		31224	PIT1202_HHA	25 psig	A	Injection Well No. 2 Line Pressure HiHi	HMI Alarm	Shutdown P-700		Silence Alarm	Investigate Injection Well No 2 Problem at Wellhead								
479	TP-PR-10-10-11	PIT1203	TOPOCK2	ICP-001	AI	I:1.7		31234	PIT1203_HHA	25 psig	A	Injection Well No. 3 Line Pressure HiHi	HMI Alarm	Shutdown P-700		Silence Alarm	Investigate Injection Well No 2 Problem at Wellhead								
451	TP-PR-10-10-11	LSH1202	TOPOCK2	ICP-001	DI	I:4/0	LSH1202	31222	LSH1202	Field Set	A	Injection Well No. 2 Vault High Level Switch	HMI Alarm	Shutdown P-700		Silence Alarm	Investigate Injection Well No 2 Problem at Wellhead								
452	TP-PR-10-10-11	LSH1203	TOPOCK2	ICP-001	DI	I:4/1	LSH1203	31232	LSH1203	Field Set	A	Injection Well No. 3 Vault High Level Switch	HMI Alarm	Shutdown P-700		Silence Alarm	Investigate Injection Well No 2 Problem at Wellhead								
227	TP-PR-10-10-06		TOPOCK1	LCP-001	AI	I:3.0		20902	LIT900_HHA	7.5 ft	A	Process Drain Tank Level HiHi	HMI Alarm	Shutdown P-200 Raw Water Feed Pump		Silence Alarm	Visually Check Level On Process Drains Tank								
3	TP-PR-10-10-03		TOPOCK1	LCP-001	AI	I:1.4		20144	PIT101_LLA	10 psig	A	Extraction Well TW-2D Low Pressure				Silence Alarm	Investigate Cause at Extraction Well TW-2D		Check Valve Vault No. 1.						
4	TP-PR-10-10-03		TOPOCK1	LCP-001	AI	I:1.4		20143	PIT101_HHA	150 psig	A	Extraction Well TW-2D Line Pressure High High	HMI Alarm	Shutdown Extraction Well Pump P-101		Silence Alarm	Investigate Cause at Extraction Well TW-2D		Check valve settings.						
5	TP-PR-10-10-03		TOPOCK1	LCP-001	AI	I:1.5		20141	FIT101_HHA	9999	A	Extraction Well TW-2D High Flow				Silence Alarm									
82	TP-PR-10-10-05		TOPOCK1	LCP-001	AI	I:2.2		20242	AIT202_1_pH_LLA	-9999	A	Chemical Mixing Loop pH #1 Low				Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
81	TP-PR-10-10-05	AIT300-1pH	TOPOCK1	LCP-001	AI	I:2.4		20324	AIT300_1_pH_LLA	0 pH	A	Chromium Reduction Reactor pH-1 Lo Lo				Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
86	TP-PR-10-10-05	AIT301A-1pH	TOPOCK1	LCP-001	AI	I:2.6		20325	AIT301A_1_pH_HHA	8.5 pH	A	Iron Reduction Reactor A pH-1 High High				Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
167	TP-PR-10-10-05	AIT301B pH	TOPOCK1	LCP-001	AI	I:2.8		20326	AIT301B_1_pH_HHA	8.5 pH	A	Iron Reduction Reactor B pH-1 High High				Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
180	TP-PR-10-10-05	AIT301C pH	TOPOCK1	LCP-001	AI	I:2.10		20327	AIT301C_1_pH_HHA	8.5 pH	A	Iron Oxidation Reactor 3 pH-1 High High				Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
100	TP-PR-10-10-05		TOPOCK1	LCP-001	AI	I:3.2		20243	AIT202_2_pH_LLA	-9999	A	Pipe Reator Loop pH-2 Lo Lo				Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
107	TP-PR-10-10-05	AIT300-2pH	TOPOCK1	LCP-001	AI	I:3.4		20334	AIT300_2_pH_LLA	0 pH	A	Chromium Reduction Reactor pH-2 Lo Lo				Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
106	TP-PR-10-10-05	AIT301A-2pH	TOPOCK1	LCP-001	AI	I:3.6		20335	AIT301A_2_pH_HHA	8.5 pH	A	Iron Oxidation Reactor 1 pH-2 High High				Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
105	TP-PR-10-10-05	AIT301B-2pH	TOPOCK1	LCP-001	AI	I:3.8		20336	AIT301B_2_pH_HHA	8.5 pH	A	Iron Oxidation Reactor 2 pH-2 High High				Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
104	TP-PR-10-10-05	AIT301C-2pH	TOPOCK1	LCP-001	AI	I:3.10		20337	AIT301C_2_pH_HHA	8.5 pH	A	Iron Oxidation Reactor 3 pH-2 High High				Silence Alarm	Check Probe for Fouling		Check Chemical Injection Systems						
321	TP-PR-10-10-08	AIT 600 COND	TOPOCK1	LCP-001	AI	I:3.12		20672	AIT600_COND_LLA	0 uS	A	RO Feed Tank Influent Conductivity Lo Lo				Silence Alarm									
320	TP-PR-10-10-08	AIT 601 COND	TOPOCK1	LCP-001	AI	I:3.13		20674	AIT601_COND_LLA	0 uS	A	RO Unit Influent Conductivity Lo Lo				Silence Alarm									
319	TP-PR-10-10-08	AIT 604 COND	TOPOCK1	LCP-001	AI	I:3.14		20676	AIT604_COND_LLA	-9999	A	Ro Permeate to T-600 Conductivity Lo Lo				Silence Alarm									
318	TP-PR-10-10-08	AIT701 COND	TOPOCK1	LCP-001	AI	I:4.2		20719	AIT701_COND_LLA	-5 uS	A	RO Concentrate Conductivity Lo Lo				Silence Alarm									
317	TP-PR-10-10-08	AIT605 COND	TOPOCK1	LCP-001	AI	I:4.3		20678	AIT605_COND_LLA	0 uS	A	RO Permeate to Treated Water Tank Conductivity Lo Lo				Silence Alarm									
1001	TP-PR-10-10-08	AIT606 pH	TOPOCK1	LCP-001	AI	I:4.4		30675	AIT606_pH_HHA	8.3 pH	A	R.O. Permeate pH High High	HMI Alarm			Silence Alarm	Inspect and/or Clean pH Sensor	pH sensor out of calibration	Check sensor calibration						
1002	TP-PR-10-10-08	AIT606 pH	TOPOCK1	LCP-001	AI	I:4.4		30676	AIT606_pH_LLA	6.6 pH	A	R.O. Permeate pH Low Low	HMI Alarm			Silence Alarm	Inspect and/or Clean pH Sensor	pH sensor out of calibration	Check sensor calibration						
1003			TOPOCK1	LCP-001	Bit			10099	ABTCP_TOPOCK1_STAT	Immediate	A	TOPOCK1 is OFFLINE	HMI Alarm			Silence Alarm									
1004			TOPOCK2	ICP-001	Bit			40100	ABTCP_TOPOCK2_STAT	Immediate	A	TOPOCK2 is OFFLINE	HMI Alarm			Silence Alarm									
1005			TOPOCK1	LCP-001	Bit			40500	ABTCP_TOPOCKMF_STAT	Immediate	A	TOPOCKMF (MicroFilter) is OFFLINE	HMI Alarm			Silence Alarm									
1006			TOPOCK1	LCP-001	Bit			40600	ABTCP_TOPOCKRO_STAT	Immediate	A	TOPOCKRO (RO Skid) is OFFLINE	HMI Alarm			Silence Alarm									
1031			TOPOCK1	LCP-001	Bit	N30:35/01		10335	AIC301A_PH_MA	Immediate	A					Silence Alarm									
1032			TOPOCK1	LCP-001	Bit	N30:35/15		10336	AIC301A_PH_MODE	Immediate	A					Silence Alarm									
1033			TOPOCK1	LCP-001	Bit	N11:161/01		10322	AIC301A_PH_PIDB1	Immediate	A					Silence Alarm									
1034			TOPOCK1	LCP-001	Bit	N30:37/01		10337	AIC301B_PH_MA	Immediate	A					Silence Alarm									
1035			TOPOCK1	LCP-001	Bit	N30:37/15		10338	AIC301B_PH_MODE	Immediate	A					Silence Alarm									
1036			TOPOCK1	LCP-001	Bit	N11:184/01		10323	AIC301B_PH_PIDB1	Immediate	A					Silence Alarm									
1037			TOPOCK1	LCP-001	Bit	N30:39/01		10339	AIC301C_PH_MA	Immediate	A					Silence Alarm									
1038			TOPOCK1	LCP-001	Bit	N30:39/15		10340	AIC301C_PH_MODE	Immediate	A					Silence Alarm									
1039			TOPOCK1	LCP-001	Bit	N11:207/01		10324	AIC301C_PH_PIDB1	Immediate	A					Silence Alarm									
1021			TOPOCK1	LCP-001	Bit	N30:33/01		10225	AIC202_PH_MA	Immediate	A					Silence Alarm									
1022			TOPOCK1	LCP-001	Bit	N11:138/01		10202	AIC202_PH_PIDB1	Immediate	A					Silence Alarm									
1020			TOPOCK1	LCP-001	Bit	N31:9/01		20200	AIC202_CO_HA	Immediate	A					Silence Alarm									
1061			TOPOCK1	LCP-001	Bit	N30:25/01		10625	AIC604_MA	Immediate	A					Silence Alarm									
1062			TOPOCK1	LCP-001	Bit	N11:46/01		10641	AIC604_PIDB1	Immediate	A					Silence Alarm									
1063			TOPOCK1	LCP-001	Bit	N30:41/01		10662	AIC606_PH_MA	Immediate	A					Silence Alarm									
1064			TOPOCK1	LCP-001	Bit	N11:230/01		10661	AIC606_PH_PIDB1	Immediate	A					Silence Alarm									
1071			TOPOCK1	LCP-001	Bit	N30:43/01		10735	AIC702_MA	Immediate	A					Silence Alarm									
1072			TOPOCK1	LCP-001	Bit	N21:0/01		10702	AIC702_PIDB1	Immediate	A					Silence Alarm									
1060			TOPOCK1	LCP-001	Bit	N30:25/15		10645	AIC604_CAS	Immediate	A					Silence Alarm									
1023			TOPOCK1	LCP-001	Bit	N31:9/02		30200	AIC201_NODEV_AIT202_LA	Immediate	A					Silence Alarm									
1024			TOPOCK1	LCP-001	Bit	N31:9/03		40212	AIC201_NODEV_AIT202_LLA	Immediate	A					Silence Alarm									
1007			TOPOCK1	LCP-001	Bit	B3:1/12		40304	B300_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1008			TOPOCK1	LCP-001	Bit	N31:17/15		10328	B300_ON	Immediate	A														
1009			TOPOCK1	LCP-001	Bit	N30:1/12		10312	B300_RUN	Immediate	A														
1010			TOPOCK1	LCP-001	Bit	N31:16/09		10610	B600_ON	Immediate	A														
1011			TOPOCK1	LCP-001	Bit	N31:18/03		11100	CMP1000_ON	Immediate	A														
1025			TOPOCK1	LCP-001	Bit	T4:56.DN		30201	CHEM_INJ_FAILURE	Immediate	A					Silence Alarm	Check Chemical Injection Systems								
1026			TOPOCK1	LCP-001	Bit	N30:21/01		10203	FIC200_PH_MA	Immediate	A														
1027			TOPOCK1	LCP-001	Bit	N11:0/01		10200	FIC200_PH_PIDB1	Immediate	A														
1081			TOPOCK1	LCP-001	Bit	N30:31/01		10801	FIC800_PH_MA	Immediate	A														
1082			TOPOCK1	LCP-001	Bit	N11:115/01		10800	FIC800_PH_PIDB1	Immediate	A														
1089	TP-PR-10-10-09	FSL800A	TOPOCK1	LCP-001	DI	I:26/01	FSL800A	30849	FSL800A	Field Set	A5	Ferrous Chloride Pump Low Flow	HMI Alarm	Shutdown all process pumps,RO system, uFilter system after 30 second time delay	Manual Operator Restart	Silence Alarm	Check Pump Operation, Chemical Level in Tote	Pump malfunction.		Chemical container empty					
1012			TOPOCK1	LCP-001	Bit	B3:2/00		40201	FV100_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1013			TOPOCK1	LCP-001	Bit	N30:2/00		10120	FV100_OPEN	Immediate	A														
1014			TOPOCK1	LCP-001	Bit	B3:2/06		40202	FV201_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1015			TOPOCK1	LCP-001	Bit	N30:2/06		10226	FV201_OPEN	Immediate	A														
1016			TOPOCK1	LCP-001	Bit	B3:2/07		40407	FV400_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1017			TOPOCK1	LCP-001	Bit	N30:2/07		10449	FV400_OPEN	Immediate	A														
1018			TOPOCK1	LCP-001	Bit	B3:2/12		40412	FV410_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1019			TOPOCK1	LCP-001	Bit	N30:2/12		10459	FV410_OPEN	Immediate	A														
1201			TOPOCK2	ICP-001	Bit	N30:10/01		11202	FV1202_MA	Immediate	A														
1203			TOPOCK2	ICP-001	Bit	N30:0/01		11219	FV1202_OPEN	Immediate	A														
1202			TOPOCK2	ICP-001	Bit	N30:10/02		11203	FV1203_MA	Immediate	A														
1204			TOPOCK2	ICP-001	Bit	N30:0/02		11229	FV1203_OPEN	Immediate	A														
1040			TOPOCK1	LCP-001	Bit	N30:23/01		10305	LIC301C_MA	Immediate	A														
1041			TOPOCK1	LCP-001	Bit	N11:23/01		10325	LIC301C_PIDB1	Immediate	A														
1042			TOPOCK1	LCP-001	Bit	N11:23/03		10326	LIC301C_PIDB3	Immediate	A														
1065			TOPOCK1	LCP-001	Bit	N30:27/01		10627	LIC603_MA	Immediate	A														
1066			TOPOCK1	LCP-001	Bit	N11:69/01		10631	LIC603_PIDB1	Immediate	A														
1067			TOPOCK1	LCP-001	Bit	N30:29/01		10629	LIC604_MA	Immediate	A														
1068			TOPOCK1	LCP-001	Bit	N11:92/01		10642	LIC604_PIDB1	Immediate	A														
1074	TP-PR-10-10-10		TOPOCK1	LCP-001	DI	I:18/14	LSHH704	30771	LSHH704	Field Set	A	HiHi Level R O Concentrate Storage Tank (Baker Tank)	HMI Alarm	Shutdown P-701		Silence Alarm									

APPENDIX G: ALARMS AND TROUBLESHOOTING SUMMARY
PG&E Topock Compressore Station, Interim Measures No. 3 Facility

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
1043			TOPOCK1	LCP-001	Bit	B3:0/07		40300	M300_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1044			TOPOCK1	LCP-001	Bit	N31:13/14		10331	M300_ON	Immediate	A														
1045			TOPOCK1	LCP-001	Bit	B3:0/08		40301	M301A_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1046			TOPOCK1	LCP-001	Bit	N31:14/02		10332	M301A_ON	Immediate	A														
1047			TOPOCK1	LCP-001	Bit	B3:0/09		40302	M301B_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1048			TOPOCK1	LCP-001	Bit	N31:14/05		10333	M301B_ON	Immediate	A														
1049			TOPOCK1	LCP-001	Bit	B3:0/10		40303	M301C_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1050			TOPOCK1	LCP-001	Bit	N31:14/08		10334	M301C_ON	Immediate	A														
1051			TOPOCK1	LCP-001	Bit	N30:0/07		10307	M300_RUN	Immediate	A														
1052			TOPOCK1	LCP-001	Bit	N30:0/08		10308	M301A_RUN	Immediate	A														
1053			TOPOCK1	LCP-001	Bit	N30:0/09		10309	M301B_RUN	Immediate	A														
1054			TOPOCK1	LCP-001	Bit	N30:0/10		10310	M301C_RUN	Immediate	A														
1055			TOPOCK1	LCP-001	Bit	B3:0/12		40401	M400A_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1056			TOPOCK1	LCP-001	Bit	N31:14/14		10422	M400A_ON	Immediate	A														
1057			TOPOCK1	LCP-001	Bit	N30:0/12		10412	M400A_RUN	Immediate	A														
1075			TOPOCK1	LCP-001	Bit	B3:0/13		40402	M400B_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1076			TOPOCK1	LCP-001	Bit	N31:15/01		10423	M400B_ON	Immediate	A														
1077			TOPOCK1	LCP-001	Bit	N30:0/13		10413	M400B_RUN	Immediate	A														
1078			TOPOCK1	LCP-001	Bit	B3:0/14		40403	M400C_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1079			TOPOCK1	LCP-001	Bit	N31:15/03		10424	M400C_ON	Immediate	A														
1080			TOPOCK1	LCP-001	Bit	N30:0/14		10414	M400C_RUN	Immediate	A														
1083			TOPOCK1	LCP-001	Bit	B3:1/00		40404	M402_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
390	TP-PR-10-10-09		TOPOCK1	LCP-001	AI	I:4.6		20316	FIT300A_HHA	110 scfm	A	Iron Reduction Reactor A Air Flow High High				Silence Alarm	Check Aeration System								
389	TP-PR-10-10-09		TOPOCK1	LCP-001	AI	I:4.7		20317	FIT300B_HHA	110 scfm	A	Iron Reduction Reactor B Air Flow High High				Silence Alarm	Check Aeration System								
393	TP-PR-10-10-09		TOPOCK1	LCP-001	AI	I:4.8		20318	FIT300C_HHA	120 scfm	A	Iron Reduction Reactor C Air Flow High High				Silence Alarm	Check Aeration System								
219	TP-PR-10-10-06	AIT400 TURB	TOPOCK1	LCP-001	AI	I:4.9		20434	AIT400_TURB_LLA	0	A	Clarifier Effluent Turbidity Lo Lo				Silence Alarm									
426	TP-PR-10-10-11	AIT702	TOPOCK1	LCP-001	AI	I:4.10		20720	AIT702_COND_LLA	3,000 us	A	Injection Wells Low Low Conductivity Alarm	HMI Alarm			Silence Alarm									
427	TP-PR-10-10-11	AIT702	TOPOCK1	LCP-001	AI	I:4.10		20721	AIT702_COND_HHA	8,000 us	A	Injection Wells High High Conductivity Alarm	HMI Alarm			Silence Alarm									
103	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:52/00		20244	AIT202_pH_SEL_LLA	-9999	A	Chemical Mixing Loop pH Selected Lo Lo				Silence Alarm	Check Probe(s) for Fouling		Check Chemical Injection Systems						
102	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:52/01		20245	AIT202_pH_SEL_HHA	7.0 pH	A	Chemical Mixing Loop pH Selected High High	HMI Alarm	Shutdown P-200 & P-201 pumps & Chemical Injection		Silence Alarm	Check Probe(s) for Fouling		Check Chemical Injection Systems						
101	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:52/04		20384	AIT300_pH_SEL_LLA	0 pH	A	Chromium Reduction Reactor pH Selected Lo Lo				Silence Alarm	Check Probe(s) for Fouling		Check Chemical Injection Systems						
91	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:52/05		20385	AIT300_pH_SEL_HHA	7.0 pH	A	Chromium Reduction Reactor pH Selected High High	HMI Alarm	Shutdown P-200 & P-201 pumps & Chemical Injection		Silence Alarm	Check Probe(s) for Fouling		Check Chemical Injection Systems						
98	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:52/08		20338	AIT301A_pH_SEL_LLA	7.0 pH	A	Iron Oxidation Reactor No. 1 pH Selected Low Low	HMI Alarm	Shutdown P-200 & P-201 pumps		Silence Alarm	Check Probe(s) for Fouling		Check Chemical Injection Systems						
99	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:52/09		20339	AIT301A_pH_SEL_HHA	10.0 pH	A	Iron Reduction Reactor A pH Selected High High				Silence Alarm	Check Probe(s) for Fouling		Check Chemical Injection Systems						
96	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:52/12		20390	AIT301B_pH_SEL_LLA	7.0 pH	A	Iron Oxidation Reactor No. 2 pH Selected Low Low	HMI Alarm	Shutdown P-200 & P-201 pumps		Silence Alarm	Check Probe(s) for Fouling		Check Chemical Injection Systems						
95	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:52/13		20391	AIT301B_pH_SEL_HHA	10.0 pH	A	Iron Reduction Reactor B pH Selected High High				Silence Alarm	Check Probe(s) for Fouling		Check Chemical Injection Systems						
94	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:53/00		20396	AIT301C_pH_SEL_LLA	7.3 pH	A	Iron Oxidation Reactor No. 3 pH Selected Low Low	HMI Alarm	Shutdown P-200 & P-201 pumps		Silence Alarm	Check Probe(s) for Fouling		Check Chemical Injection Systems						
108	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:53/01		20397	AIT301C_pH_SEL_HHA	10.0 pH	A	Iron Reduction Reactor C pH Selected High High				Silence Alarm	Check Probe(s) for Fouling		Check Chemical Injection Systems						
1084			TOPOCK1	LCP-001	Bit	N31:15/12		10426	M402_ON	Immediate	A														
1085			TOPOCK1	LCP-001	Bit	N30:1/00		10416	M402_RUN	Immediate	A														
1086			TOPOCK1	LCP-001	Bit	B3:1/02		40501	M500_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1087			TOPOCK1	LCP-001	Bit	N30:1/02		10512	M500_RUN	Immediate	A														
1088			TOPOCK1	LCP-001	Bit	N31:17/13		10803	M800_ON	Immediate	A														
1090			TOPOCK1	LCP-001	Bit	B3:1/05		40601	M600_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1091			TOPOCK1	LCP-001	Bit	N30:1/05		10605	M600_RUN	Immediate	A														
1500	TP-PR-10-10-07	2LT	TOPOCKMF	Pall	Bit		2LT	10507	MF_2LT	By Vendor	A	Feed Turbidimeter Failure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
1501	TP-PR-10-10-07	CR120	TOPOCKMF	Pall	Bit		CR120	30504	MF_CR120	By Vendor	A	Feed Turbidimeter Failure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
1502	TP-PR-10-10-07	ENAB1	TOPOCKMF	Pall	Bit		ENAB1	10500	MF_ENAB1	By Vendor	A	Feed Turbidimeter Failure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
1503	TP-PR-10-10-07	ENAB2	TOPOCKMF	Pall	Bit		ENAB2	10502	MF_ENAB2	By Vendor	A	Feed Turbidimeter Failure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
1504	TP-PR-10-10-07	ENAB3	TOPOCKMF	Pall	Bit		ENAB3	10503	MF_ENAB3	By Vendor	A	Feed Turbidimeter Failure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
1506	TP-PR-10-10-07	PS1-1	TOPOCKMF	Pall	Bit		PS1-1	30503	MF_PS1-1	By Vendor	A	Feed Turbidimeter Failure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
1507	TP-PR-10-10-07	PS1-2	TOPOCKMF	Pall	Bit		PS1-2	20503	MF_PS1-2	By Vendor	A	Feed Turbidimeter Failure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
1508	TP-PR-10-10-07	Q-Stop	TOPOCKMF	Pall	Bit		Q-Stop	10501	MF_Q-Stop	By Vendor	A	Feed Turbidimeter Failure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
1509	TP-PR-10-10-07	TMP_HA	TOPOCKMF	Pall	Bit		TMP_HA	20554	MF_TMP_HA	By Vendor	A	Feed Turbidimeter Failure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
1511	TP-PR-10-10-07	VFD1	TOPOCKMF	Pall	Bit		VFD1	30501	MF_VFD1	By Vendor	A	Feed Turbidimeter Failure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
1512	TP-PR-10-10-07	VFD2	TOPOCKMF	Pall	Bit		VFD2	30502	MF_VFD2	By Vendor	A	Feed Turbidimeter Failure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
1100			TOPOCK1	LCP-001	Bit	B3:0/00		40101	P100_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1101			TOPOCK1	LCP-001	Bit	N31:12/01		10121	P100_ON	Immediate	A														
1103			TOPOCK1	LCP-001	Bit	N30:0/00		10100	P100_RUN	Immediate	A														

ID	P&ID No	Tag Number	PLC Name	PLC Panel	I_O Type	Input Address	Alarm	Alarm Number	HMI Alarm	Set Point	Recovery	Alarm Description	Function 1	Function 2	Function 3	Operator 1	Operator 2	Potential Cause 1	Operator 3	Potential Cause 2	Operator 4	Potential Cause 3	Operator 5	Potential Cause 4	Operator 6
1102			TOPOCK1	LCP-001	Bit	N30:10/00		10110	P100_MA	Immediate	A														
1104			TOPOCK1	LCP-001	Bit	B3:0/01		40102	P101_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1106			TOPOCK1	LCP-001	Bit	N31:12/04		10122	P101_ON	Immediate	A														
1105			TOPOCK1	LCP-001	Bit	N30:10/01		10111	P101_MA	Immediate	A														
1107			TOPOCK1	LCP-001	Bit	N30:0/01		10101	P101_RUN	Immediate	A														
1108			TOPOCK1	LCP-001	Bit	B3:0/02		40103	P102_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1505	TP-PR-10-10-07	FIT1_RF	TOPOCKMF	Pall	Bit		FIT1_RF	10504	MF_FIT1_RF	By Vendor	A	Feed Turbidimeter Failure	HMI Alarm			Silence Alarm	See Microfilter O&M manual								
1109			TOPOCK1	LCP-001	Bit	N30:10/02		10112	P102_MA	Immediate	A														
1110			TOPOCK1	LCP-001	Bit	N31:12/07		10123	P102_ON	Immediate	A														
1111			TOPOCK1	LCP-001	Bit	N30:0/02		10102	P102_RUN	Immediate	A														
1112			TOPOCK1	LCP-001	Bit	B3:0/03		40104	P103_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1113			TOPOCK1	LCP-001	Bit	N30:10/03		10113	P103_MA	Immediate	A														
1114			TOPOCK1	LCP-001	Bit	N31:12/10		10124	P103_ON	Immediate	A														
1115			TOPOCK1	LCP-001	Bit	N30:0/03		10103	P103_RUN	Immediate	A														
1146			TOPOCK1	LCP-001	Bit	B3:2/08		40408	P401_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1147			TOPOCK1	LCP-001	Bit	N30:12/08		10438	P401_MA	Immediate	A														
1148			TOPOCK1	LCP-001	Bit	N31:24/08		10428	P401_OUT	Immediate	A														
1149			TOPOCK1	LCP-001	Bit	N30:2/08		10427	P401_RUN	Immediate	A														
1121			TOPOCK1	LCP-001	Bit	B3:0/04		40200	P200_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1122			TOPOCK1	LCP-001	Bit	N31:13/03		10205	P200_ON	Immediate	A														
1123			TOPOCK1	LCP-001	Bit	N30:0/04		10204	P200_RUN	Immediate	A														
1124			TOPOCK1	LCP-001	Bit	B3:0/06		40205	P201_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1125			TOPOCK1	LCP-001	Bit	N31:13/12		10207	P201_ON	Immediate	A														
1126			TOPOCK1	LCP-001	Bit	N30:0/06		10206	P201_RUN	Immediate	A														
1143			TOPOCK1	LCP-001	Bit	B3:0/11		40400	P400_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1144			TOPOCK1	LCP-001	Bit	N31:14/11		10421	P400_ON	Immediate	A														
1150			TOPOCK1	LCP-001	Bit	B3:2/09		40409	P403_INTERLOCK	Immediate	A					Silence Alarm									
1151			TOPOCK1	LCP-001	Bit	N30:12/09		10439	P403_MA	Immediate	A														
1145			TOPOCK1	LCP-001	Bit	N30:0/11		10411	P400_RUN	Immediate	A														
1152			TOPOCK1	LCP-001	Bit	N30:2/09		10430	P403_RUN	Immediate	A														
1153			TOPOCK1	LCP-001	Bit	B3:2/10		40410	P404_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1154			TOPOCK1	LCP-001	Bit	N30:12/10		10440	P404_MA	Immediate	A														
1156			TOPOCK1	LCP-001	Bit	N30:2/10		10431	P404_RUN	Immediate	A														
1155			TOPOCK1	LCP-001	Bit	N31:24/10		10429	P404_OUT	Immediate	A														
1163			TOPOCK1	LCP-001	Bit	B3:1/01		40502	P500_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1164			TOPOCK1	LCP-001	Bit	N31:16/04		10509	P500_ON	Immediate	A														
1165			TOPOCK1	LCP-001	Bit	N30:1/01		10511	P500_RUN	Immediate	A														
1157			TOPOCK1	LCP-001	Bit	N17:11/01		10505	P501_ON	Immediate	A														
1158			TOPOCK1	LCP-001	Bit	N17:11/02		10506	P502_ON	Immediate	A														
1159			TOPOCK1	LCP-001	Bit	N31:17/02		10617	P601A_ON	Immediate	A														
1160			TOPOCK1	LCP-001	Bit	N31:17/04		10618	P601B_ON	Immediate	A														
1161			TOPOCK1	LCP-001	Bit	N31:16/08		10614	P602_ON	Immediate	A														
1162			TOPOCK1	LCP-001	Bit	N31:16/12		10612	P603_ON	Immediate	A														
1166			TOPOCK1	LCP-001	Bit	N31:16/10		10615	P605A_ON	Immediate	A														
1167			TOPOCK1	LCP-001	Bit	N31:16/11		10616	P605B_ON	Immediate	A														
1171			TOPOCK1	LCP-001	Bit	B3:0/05		40700	P700_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1172			TOPOCK1	LCP-001	Bit	N31:13/05		10706	P700_ON	Immediate	A														
1173			TOPOCK1	LCP-001	Bit	N30:0/05		10705	P700_RUN	Immediate	A														
1174			TOPOCK1	LCP-001	Bit	B3:1/04		40701	P701_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1176			TOPOCK1	LCP-001	Bit	N31:16/13		10613	P701_ON	Immediate	A														
1177			TOPOCK1	LCP-001	Bit	N30:1/04		10703	P701_RUN	Immediate	A														
1168			TOPOCK1	LCP-001	Bit	B3:1/03		40602	P620_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1169			TOPOCK1	LCP-001	Bit	N31:16/06		10611	P620_ON	Immediate	A														
1170			TOPOCK1	LCP-001	Bit	N30:1/03		10620	P620_RUN	Immediate	A														
1175			TOPOCK1	LCP-001	Bit	N30:11/04		10734	P701_MA	Immediate	A														
1178			TOPOCK1	LCP-001	Bit	B3:1/06		40800	P800_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1179			TOPOCK1	LCP-001	Bit	N30:11/06		10802	P800_MA	Immediate	A														
1180			TOPOCK1	LCP-001	Bit	N30:1/06		10806	P800_RUN	Immediate	A														
1181			TOPOCK1	LCP-001	Bit	B3:1/07		40801	P801A_INTERLOCK	Immediate	A					Silence Alarm									
1182			TOPOCK1	LCP-001	Bit	N30:1/07		10807	P801A_RUN	Immediate	A														
1183			TOPOCK1	LCP-001	Bit	B3:1/11		40802	P801B_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1184			TOPOCK1	LCP-001	Bit	N30:1/11		10811	P801B_RUN	Immediate	A														
1185			TOPOCK1	LCP-001	Bit	B3:1/08		40803	P802A_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1186			TOPOCK1	LCP-001	Bit	N30:1/08		10808	P802A_RUN	Immediate	A														
1187			TOPOCK1	LCP-001	Bit	B3:1/09		40804	P802B_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1188			TOPOCK1	LCP-001	Bit	N30:1/09		10809	P802B_RUN	Immediate	A														
1189			TOPOCK1	LCP-001	Bit	B3:1/10		40805	P802C_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1190			TOPOCK1	LCP-001	Bit	N30:1/10		10810	P802C_RUN	Immediate	A														
1191			TOPOCK1	LCP-001	Bit	B3:1/13		40807	P807_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1192			TOPOCK1	LCP-001	Bit	N30:1/13		10813	P807_RUN	Immediate	A														
1194			TOPOCK1	LCP-001	Bit	B3:0/15		40900	P900_INTERLOCK	Immediate	A					Silence Alarm	Check I-Lock Pop-Up Screen		Follow Instruction for Indicated Problem						
1195			TOPOCK1	LCP-001	Bit	N30:10/15		10925	P900_MA	Immediate	A														
1196			TOPOCK1	LCP-001	Bit	N31:15/09		10425	P900_ON	Immediate	A														
1197			TOPOCK1	LCP-001	Bit	N30:0/15		10915	P900_RUN	Immediate	A														
1198	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:9/2	Calculated Bit	30200	AIT201_NODEV_201_LA	1.35 pH	D	Plant Influent pH High	HMI Alarm			Silence Alarm	Check Plant Influent pH Sensor	pH sensor out of calibration	Recalibrate pH sensor	High pH water being recycled to Raw Water Tank	Check process drain tank pH.				
1199	TP-PR-10-10-05		TOPOCK1	LCP-001	Bit	N31:9/3	Calculated Bit	40212	AIT201_NODEV_201_LLA	1.00 pH	D	Plant Influent pH Low	HMI Alarm			Silence Alarm	Check Plant Influent pH Sensor	pH sensor out of calibration	Recalibrate pH sensor	Low pH water being recycled to Raw Water Tank	Check process drain tank pH.				

Appendix H
Daily Monitoring Checklists

Print working form in Black and White

Table 5A

On-Site Laboratory Analyses DATE:____________________DAY:____________________

Sample Tap	Sampling Location	Sample Analysis	Sample Method	Frequency	Target Time		Time Collected	Concentration	Units	Target Range	Action if Outside of Range
SC-001	Extraction Well TW-2S (if in operation)	Hexavalent chromium	Hach Kit	**1/week**					mg/L	No target	
SC-002	Extraction Well TW-2D (if in operation)	Hexavalent chromium	Hach Kit	**1/week***					mg/L	No target	
SC-300A	Upstream of T-300	Ferrous iron	Chemetrics Test	Every 4 hrs	0:00				mg/L	7-12	High: Review possible causes Low: Increase ferrous dose rate
SC-301C	Tank 301C	Hexavalent chromium	Hach Kit	1/shift	0:00				mg/L	0-0.010	Re-test sample; troubleshoot causes.
SC-700B	Blended effluent to injection wells	Hexavalent chromium	Hach Kit	Every 4 hrs	0:00				mg/L	0-0.010	**Retest, then if still outside, shut down flow to injection wells until re-tested and within target range**
SC-700B	Blended effluent to injection wells	Total chromium	Hach Kit	Every 4 hrs	0:00				mg/L	0-0.025	
SC-700B	Blended effluent to injection wells	pH	Lab Multi-meter	Every 4 hrs	0:00				pH	6.0-8.4	
SC-700B	Blended effluent to injection wells	Electrical Conductivity	Lab Multi-meter	Every 4 hrs	0:00				mS/cm	AIT702 setting	Target +/- 25% of AIT702 conductivity. If outside report to Engeineering.
SC-300A	Upstream of T-300	Ferrous iron	Chemetrics Test	Every 4 hrs	4:00				mg/L	7-12	High: Review possible causes Low: Increase ferrous dose rate
SC-700B	Blended effluent to injection wells	Hexavalent chromium	Hach Kit	Every 4 hrs	4:00				mg/L	0-0.010	**Retest, then if still outside, shut down flow to injection wells until re-tested and within target range**
SC-700B	Blended effluent to injection wells	Total chromium	Hach Kit	Every 4 hrs	4:00				mg/L	0-0.025	
SC-700B	Blended effluent to injection wells	pH	Lab Multi-meter	Every 4 hrs	4:00				pH	6.0-8.4	
SC-700B	Blended effluent to injection wells	Electrical Conductivity	Lab Multi-meter	Every 4 hrs	4:00				mS/cm	AIT702 setting	Target +/- 25% of AIT702 conductivity. If outside report to Engeineering.
SC-100B	Influent into Raw Water Tank	Hexavalent chromium	Hach Kit	1/day	8:00				mg/L	No target	
SC-300A	Upstream of T-300	Ferrous iron	Chemetrics Test	Every 4 hrs	8:00				mg/L	7-12	High: Review possible causes Low: Increase ferrous dose rate
SC-501	Microfiltration permeate	Electrical Conductivity	Lab Multi-meter	1/day	8:00				mS/cm	< 12,000	
SC-501	Microfiltration permeate	Turbidity	Lab Multi-meter	1/day	8:00				NTU	< 1.0	Check MF system for membrane failure
SC-605	Reverse osmosis permeate	Turbidity	2100 Turbidimeter	1/day	8:00				NTU	< 1.0	Check reverse osmosis system for membrane failure
SC-605	Reverse osmosis permeate	Electrical Conductivity	Lab Multi-meter	2/day	8:00				mS/cm	< 1,200	
SC-700B	Blended effluent to injection wells	Hexavalent chromium	Hach Kit	Every 4 hrs	8:00				mg/L	0-0.010	**Retest, then if still outside, shut down flow to injection wells until re-tested and within target range**
SC-700B	Blended effluent to injection wells	Total chromium	Hach Kit	Every 4 hrs	8:00				mg/L	0-0.025	
SC-700B	Blended effluent to injection wells	pH	Lab Multi-meter	Every 4 hrs	8:00				pH	6.0-8.4	
SC-700B	Blended effluent to injection wells	Electrical Conductivity	Lab Multi-meter	Every 4 hrs	8:00				mS/cm	AIT702 setting	Target +/- 25% of AIT702 conductivity. If outside report to Engeineering.

Print working form in Black and White

Table 5A

On-Site Laboratory Analyses DATE:____________________DAY:____________________

Sample Tap	Sampling Location	Sample Analysis	Sample Method	Frequency	Target Time		Time Collected	Concentration	Units	Target Range	Action if Outside of Range
PE-1	PE-1 EFFLUENT	Hexavalent chromium	Hach Kit	1/day	12:00				mg/L	No target	
PE-1	PE-1 EFFLUENT	pH	Lab Multi-meter	1/day	12:00				pH	No target	
PE-1	PE-1 EFFLUENT	Electrical Conductivity	Lab Multi-meter	1/day	12:00				mS/cm	No target	
PE-1	PE-1 EFFLUENT	ORP	Lab Multi-meter	1/day	12:00				mV	No target	
SC-201B	Upstream of T-300	pH	Lab Multi-meter	1/day	12:00				pH	<6.0	
SC-300A	Upstream of T-300	Ferrous iron	Chemetrics Test	Every 4 hrs	12:00				mg/L	7-12	High: Review possible causes Low: Increase ferrous dose rate
SC-300A	Upstream of T-300	pH	Lab Multi-meter	1/day	12:00				pH	<6.0	**Compare to in-line pH meters AIT-301A_1&2. Clean and calibrate in-line probes if not within 0.5 pH units**
SC-301C	Tank 301C	Hexavalent chromium	Hach Kit	1/shift	12:00				mg/L	0-0.010	Re-test sample; troubleshoot causes.
SC-301C	Tank 301C	TSS	See SOP	1/day	12:00				mg/L	2000-4000	
SC-400E	Clarifier Underflow	%Solids	See SOP	1/day	12:00				%	2-5%	
SC-500	After the clarifier	Turbidity	2100 Turbidimeter	1/day	12:00				NTU	< 100	
SC-700B	Blended effluent to injection wells	Hexavalent chromium	Hach Kit	Every 4 hrs	12:00				mg/L	0-0.010	**Retest, then if still outside, shut down flow to injection wells until re-tested and within target range**
SC-700B	Blended effluent to injection wells	Total chromium	Hach Kit	Every 4 hrs	12:00				mg/L	0-0.025	
SC-700B	Blended effluent to injection wells	pH	Lab Multi-meter	Every 4 hrs	12:00				pH	6.0-8.4	
SC-700B	Blended effluent to injection wells	Electrical Conductivity	Lab Multi-meter	Every 4 hrs	12:00				mS/cm	AIT702 setting	Target +/- 25% of AIT702 conductivity. If outside report to Engeineering.
SC-701	Reverse osmosis reject	Hexavalent chromium	Hach Kit	1/day	12:00				mg/L	<0.025	Report to process engineers
SC-100B	Influent into Raw Water Tank	Electrical Conductivity	Lab Multi-meter	1/day	16:00				mS/cm		
SC-300A	Upstream of T-300	Ferrous iron	Chemetrics Test	Every 4 hrs	16:00				mg/L	7-12	High: Review possible causes Low: Increase ferrous dose rate
SC-700B	Blended effluent to injection wells	Hexavalent chromium	Hach Kit	Every 4 hrs	16:00				mg/L	0-0.010	**Retest, then if still outside, shut down flow to injection wells until re-tested and within target range**
SC-700B	Blended effluent to injection wells	Total chromium	Hach Kit	Every 4 hrs	16:00				mg/L	0-0.025	
SC-700B	Blended effluent to injection wells	pH	Lab Multi-meter	Every 4 hrs	16:00				pH	6.0-8.4	
SC-700B	Blended effluent to injection wells	Electrical Conductivity	Lab Multi-meter	Every 4 hrs	16:00				mS/cm	AIT702 setting	Target +/- 25% of AIT702 conductivity. If outside report to Engeineering.
SC-700B	Blended effluent to injection wells	Turbidity	2100 Turbidimeter	1/day	16:00				NTU	< 1.0	Check MF and reverse osmosis systems for membrane failure
SC-701	Reverse osmosis reject	Electrical Conductivity	Lab Multi-meter	1/day	16:00				mS/cm	< 25,000	
SC-701	Reverse osmosis reject	Total chromium	Hach Kit	1/day	16:00				mg/L	<0.025	Report to process engineers

Print working form in Black and White

Table 5A

On-Site Laboratory Analyses DATE:_____________________DAY:____________________

Sample Tap	Sampling Location	Sample Analysis	Sample Method	Frequency	Target Time		Time Collected	Concentration	Units	Target Range	Action if Outside of Range
SC-300A	Upstream of T-300	Ferrous iron	Chemetrics Test	Every 4 hrs	20:00				mg/L	7-12	High: Review possible causes Low: Increase ferrous dose rate
SC-301C	Tank 301C	Hexavalent chromium	Hach Kit	1/shift	20:00				mg/L	0-0.010	Re-test sample; troubleshoot causes.
SC-605	Reverse osmosis permeate	Electrical Conductivity	Lab Multi-meter	2/day	20:00				mS/cm	< 1,200	
SC-700B	Blended effluent to injection wells	Hexavalent chromium	Hach Kit	Every 4 hrs	20:00				mg/L	0-0.010	**Retest, then if still outside, shut down flow to injection wells until re-tested and within target range**
SC-700B	Blended effluent to injection wells	Total chromium	Hach Kit	Every 4 hrs	20:00				mg/L	0-0.025	
SC-700B	Blended effluent to injection wells	pH	Lab Multi-meter	Every 4 hrs	20:00				pH	6.0-8.4	
SC-700B	Blended effluent to injection wells	Electrical Conductivity	Lab Multi-meter	Every 4 hrs	16:00				mS/cm	AIT702 setting	Target +/- 25% of AIT702 conductivity. If outside report to Engeineering.
DI	Blended effluent to injection wells	HEX CCV	Hach Kit		20:00				mg/L		
SC-700B	Blended effluent to injection wells	HEX MS	Hach Kit		20:00				mg/L		
DI	Blended effluent to injection wells	TOTAL CCV	Hach Kit		20:00				mg/L		
SC-700B	Blended effluent to injection wells	TOTAL MS	Hach Kit		20:00				mg/L		

PROCESS MONITORING CHECKLIST
IM3 Facility
Topock Compressor Station

Name			
Date			
Time			
	Graves	Days	Swing

Item	Tag	Units	Target	Value	Value	Value
Front of Plant Data:						
Influent pH	AIT-201	pH units	7.0 - 8.0			
Raw Water Flow Rate	FIT-200	gpm				
Raw Water Storage Tank (T-100) Level	LIT-200	ft	3.5 - 5.0			
Treated Water Stor. Tank (T-700) Level	LIT-700	ft	3.5 - 5.0			
Raw Water Feed Pump (P-200) Pressure	PI-200	psi	15 - 25			
Raw Water Feed Pump Seal Water	--	gpm	0.5			
Recirculation Pump (P-201) Pressure	PI-201	psi	10 - 15			
Recirculation Pump Seal Water	--	gpm	0.5			
Recirculation pH Meter 1	AIT-202-1	pH units	5.5 - 6.3			
Recirculation pH Meter 2	AIT-202-2	pH units	5.5 - 6.3			
T-300 pH Meter 1	AIT-300-1	pH units	5.5 - 6.3			
T-300 pH Meter 2	AIT-300-2	pH units	5.5 - 6.3			
Air Compressor Pressure	PI-1000	psi	100-110			
Fire Water Tank Level	T-1200	ft	=>17			
Iron Oxidation Tank Data:						
Mixer on Tank T-300 Operating ?	M-300	Yes/No	Yes			
Mixer on Tank T-301A Operating ?	M-301A	Yes/No	No			
T-301A pH Meter 1	AIT-301A-1	pH units	7.5 - 8.0			
T-301A pH Meter 2	AIT-301A-2	pH units	7.5 - 8.0			
Air Flow Pressure to T-301A	PI-300A	psi	4 - 8			
Mixer on Tank T-301B Operating ?	M-301B	Yes/No	No			
T-301B pH Meter 1	AIT-301B-1	pH units	7.5 - 8.0			
T-301B pH Meter 2	AIT-301B-2	pH units	7.5 - 8.0			
Air Flow Pressure to T-301B	PI-300B	psi	4 - 8			
Mixer on Tank T-301C Operating ?	M-301B	Yes/No	No			
Iron Oxidation Tank #3 (T-301C) Level	LIT-301C	ft	12			
T-301C pH Meter 1	AIT-301C-1	pH units	7.5 - 8.0			
T-301C pH Meter 2	AIT-301C-2	pH units	7.5 - 8.0			
Ambient Temperature	--	deg F	--			
Inside Plant Temperature	--		--			
Air Flow Pressure to T-301C	PI-300C	psi	4 - 8			
Clarifier Feed Pump Seal Water	--	gpm	0.5			
Clarifier Feed Pump (P-400) Pressure	PI-400	psi	5 - 12			
Process Drain Tank Level	LIT-900	ft	3 - 6			
Process Drain Tank Pump Seal Water	--	gpm	0.5			

Item	Tag	Units	Target	Value	Value	Value
Chemical Storage Area Data:						
Ferrous Chloride Tote Level (bottom tote)	--	gal	>100			
Ferrous Chloride Pump Rate	P-800	ml/min				
Ferrous Chloride Pump Stroke Percent	P-800	%	70			
Ferrous Chloride Pump Pressure	PI-800	psi	2 - 10			
Caustic Tote Level (bottom tote)	--	gal	>100			
Caustic Pump Rate	P-802A	ml/min				
Caustic Pump Stroke Percent	P-802A	%	70			
Caustic Pump Pressure	PI-802A	psi	2 - 10			
Clarifier/Sludge Treatment Data:						
Clarifier Floc (visual observation)	--	good/bad	"sand slurry"			
Sludge Blanket Level (at what tap?)	--	--	Taps 2-3			
Sludge at Tap 1 (allow to settle for 30 min)	--	ml/1000L	900-1000			
Sludge at Tap 2 (allow to settle for 30 min)	--	ml/1000L	900-1000			
Sludge at Tap 3 (allow to settle for 30 min)	--	ml/1000L	0 - 200			
Sludge at Tap 4 (allow to settle for 30 min)	--	ml/1000L	0			
Phase Separator #1 Level	PS-405A	Hi/Med/Lo	--			
Phase Separator #2 Level	PS-405B	Hi/Med/Lo	--			
Phase Separator Shipped Off Site?		1 or 2	Yes / No			
Sludge Recycle Pump	P-404	sec/min				
Sludge Recycle Pump (P-404) Pressure	PI-404	psi	7 - 13			
Sludge Holding Tank Level	T-402	ft	5-10			
Mixer on Tank T-402 Operating?	M-402	Yes/No	--			
Clarifier Effluent Turbidity (clean meter if >100 NTU during shift)	AIT-400	NTU	25-40			
Polymer Day Tank Level	--	gal	50-150			
Polymer to Clarifier Pump Rate	P-804	ml/min				
Microfilter Area Data:						
Pre-Treated Water Transfer Pump Press.	PI-500	psi	--			
Pre-Treated Water Pump Seal Water	--	gpm	0.5			
Pre-Treated Water Tank (T-500) Level	LIT-500	ft	8.5 - 9.5			
Microfilter Inlet Turbidity	AIT-501	NTU	<50			
Microfilter Effluent Turbidity	AIT-502	NTU	<0.05			
Microfilter Effluent Conductivity	AIT-600	µS/cm	8000-11,000			
Filt. Water Transfer Pump (P-620) Press.	PI-620	psi	20-30			
Filt. Water Transfer Pump Seal Water	--	gpm	0.5			
Leaks on steel piping (corrosion pitting)	MF	Yes/No	--			

Item	Tag	Units	Target	Value	Value	Value
Reverse Osmosis Data:						
RO Feed Tank (T-600) Level	LIT-600	ft	7 - 9			
RO Feed Conductivity	AIT-601	µS/cm	9000-12,000			
RO Antiscalant Tank Level	--	gal	>25			
RO Antiscalant Pump Rate	P-606	ml/min	12			
RO Prefilter Pressure	PIT-602	psi	50-60			
RO Postfilter Pressure	PIT-603	psi	50-60			
RO Permeate Pressure	PIT-610	psi	5 - 10			
RO Concentrate Pressure	PIT-612	psi	5 - 10			
RO First Stage Pressure	PIT-606	psi	220-260			
RO Second Stage Pressure	PIT-607	psi	200-250			
RO Third Stage Pressure	PIT-608	psi	200-250			
RO Final Pressure	PIT-609	psi	200 - 250			
RO Feed Pressure (gauge after pump)		psi	600 - 700			
RO Feed Flow Rate	FIT-601	gpm	134			
RO Permeate Flow Rate	FIT-611	gpm	100			
RO Concentrate Flow Rate	FIT-612	gpm	34			
RO Feed pH	AIT-604	pH units	7.5 - 8.5			
RO Feed Temperature	on RO	deg F	<105			
RO Permeate/Brine Blend Conductivity	AIT-604	µS/cm	8000-11,000			
RO Permeate Temperature	---	deg F	<105			
Leaks on steel piping (corrosion pitting)	RO	Yes/No	--			
RO Permeate/Brine Data:						
RO Permeate Conductivity	AIT-605	µS/cm	500-1000			
RO Brine Conductivity	AIT-701	µS/cm	35,000-45,000			
RO Brine Transfer Flow Rate from T-701	FIT-701	gpm	--			
Total Brine Flow	FIT-701	gal	--			
RO Brine Storage Tank (T-701) Level	LIT-701	ft	3 - 8			
RO Brine Transfer Pump (P-701) Press.	PI-701	psi	--			
RO Brine Transfer Pump Seal Water	--	gpm	0.5			
Treated Water Data:						
RO Permeate/Bypass pH	AIT-606	pH units	7.0 to 8.0			
RO Permeate/Bypass Conductivity	AIT-702	µS/cm	7,500 - 8, 500			
Treated Water Pump (P-700) Press.	PI-700	psi	50-70			
Off-Spec Flow to Baker Tanks	FIT-700	gpm	0			
Total Flow to Baker Tanks	FIT-700	gal	--			
Plant Flow to Injection Wells	FIT-702	gpm				
Total Flow to Injection Wells	FIT-702	gal	--			
Seal Water Pump Pressure	PI-1100	psi	60			

Item	Tag	Units	Target	Value	Value	Value
Readings from HMI:						
Air Flow Rate to T-301A	FIT-300A	scfm	75 - 90			
Air Flow Rate to T-301B	FIT-300B	scfm	75 - 90			
Air Flow Rate to T-301C	FIT-300C	scfm	75 - 90			
Sludge Withdrawal Pump On ?	P-401	Yes/No	--			
Sludge Withdrawal Pump Run Setting	P-401	sec/hr				
Ferrous Pump Stroke Same as Field?	P-800	Yes/No	70			
Caustic Pump Stroke Same as Field?	P-802A	Yes/No	70			
Readings from MCC:						
Incoming Meter: Volts A		volts	450 - 504			
Incoming Meter: Volts B		volts	450 - 504			
Incoming Meter: Volts C		volts	450 - 504			
(Max - Min)/(Avg of A,B,C)		%	<3%			
30 kVar Capacitors PFC1, 2 & 3 lights		On/Off	off			
Power Factor Correction Capacitors: lights for 4 wells		On/Off	off			
"Surge Protection Device" 3 lights		color	green			
Laboratory Data:						
T-300 Ferrous Residual	Fe2+	mg/L	7 - 12			
T-301C Total Suspended Solids	TSS	mg/L	2000 - 4000			
Clarifier Underflow % Solids		%	2 - 5			
MW-20 Bench Data:						
Extraction Well PE-1 Flow Rate	FIT-103	gpm	Set by DTSC			
PE-1 Pressure	PI-103	psi	50			
Extraction Well TW-3D Flow Rate	FIT-102	gpm	Set by DTSC			
TW-3D Pressure	PI-102	psi	50			
Extraction Well TW-2D Flow Rate	FIT-101	gpm	Set by DTSC			
TW-2D Pressure	PI-101	psi	50			
Extraction Well TW-2S Flow Rate	FIT-100	gpm	Set by DTSC			
TW-2S Pressure	PI-100	psi	--			
Baker Tank T-702 (East Tank) Level*	T-702	in. from top	>36			
Baker Tank T-703 (West Tank) Level*	T-703	in. from top	>36			
Baker Tank T-704 (South Tank) Level*	T-704	in. from top	>36			
* - measure from top of collar						
Injection Well Data (HMI or Field):						
IW-2 Flow Rate	FIT-1202	gpm	90% of extraction			
IW-2 Pressure	PIT-1202	psi	40			
IW-3 Flow Rate	FIT-1203	gpm	0			
IW-3 Pressure	PIT-1203	psi	0			

Item	Tag	Units	Target	Value	Value	Value
Infrequently Used Equipment:						
Polymer to Sludge Waste Pump Rate	P-805	ml/min	--			
Phase Separator Feed Pump	P-403	On/Off	--			
Separator Feed Pump (P-403) Pressure	PI-403	psi	--			
Caustic Pump Rate to T-301B	P-802B	ml/min	0	Off	Off	Off
Caustic Pump Rate to T-301C	P-802C	ml/min	0	Off	Off	Off
Sulfuric Acid Pump Rate to Loop Reactor	P-801A	ml/min	0	Off	Off	Off
Sulfuric Acid Pump Rate to RO Inlet	P-801B	ml/min	0	Off	Off	Off
Sulfuric Acid Pump Rate to RO Outlet	P-801C	ml/min	0	Off	Off	Off
Sulfuric Acid Drum	--	gal	55	Full	Full	Full
Miscellaneous Data:						
Road Conditions	--	Good/poor	--			
Rainfall Events	--	inches	--			
Power Outages	--	minutes	--			
Do Daily Flow Log each shift		3 checks				
Do Daily Compliance Site Inspection 1/day		1 check				

Notes:

DAILY SITE INSPECTION FORM
IM3 Facility
Topock Compressor Station

Name of Inspector ____________
Inspection Date ____________
Inspection Time ____________

Item	Conditions to Check	Acceptable?	Comments
Hazardous Waste			
Containers	• Good Condition • No evidence of Spills or Releases • Waste is compatible with containers • Properly labelled • Containers closed unless adding/removing waste	☐ Yes ☐ No	
Tank System			
Tanks	• Tanks are free of leaks and damage • Overflow lines are open	☐ Yes ☐ No	
Piping	• Piping is free of leaks and damage • Piping adequately supported; no evidence of vibration	☐ Yes ☐ No	
Secondary Containment	• Containment area is free of liquid • Containment area is in good condition	☐ Yes ☐ No	
Pumps	• Pumps are not vibrating or leaking • Pressure gauges read normally	☐ Yes ☐ No	
Emergency Equipment			
Spill Equipment	• Spill kit is complete; materials used have been replaced • Spill kit available for immediate use; not obstructed	☐ Yes ☐ No	
Communications	• Radios and cell phones charged and operational • Emergency alarms or horns operational	☐ Yes ☐ No	
Fire Extinguishers	• Charged and ready for use; recently inspected • Available and not obstructed	☐ Yes ☐ No	
Safety Shower, Eyewash	• Shower and eyewash are operational and not obstructed	☐ Yes ☐ No	
First Aid Supplies	• Supplies complete; materials used have been replaced • First aid kit available for immediate use; not obstructed	☐ Yes ☐ No	
Security and Safety			
Fences and Gates	• Fences and gates are in good condition	☐ Yes ☐ No	
Signs	The following signs are posted on the fence: • "No trespassing" and "No smoking" are posted • "In case of emergency" and "Danger Haz Waste Area"	☐ Yes ☐ No	
Ladders	• Ladders are in good condition	☐ Yes ☐ No	
Tools	• Tools are in good condition	☐ Yes ☐ No	
Trucking Area at IM2			
Trucking	• Connection hose to truck stowed when not in use • Drip pans are available; loading area looks clean	☐ Yes ☐ No	

Describe and problems or potential problems found during the inspection:

____

____

Describe and corrective actions taken to address problems:

____

____

____

Daily Flow Log	Name			
	Date			
IM3 Facility	Time			
		Enter every eight (8) hours per day (Green Totals Column)		
Topock Compressor Station		Graves	Days	Swing
Flow Reading	**Item**	**Value (gallons)**	**Value (gallons)**	**Value (gallons)**
Influent:				
TW2S	**A**			
TW2D	**B**			
TW3D	**C**			
PE-1	**D**			
TOTAL INFLUENT	**E**			
Effluent:				
(off spec) FIT-700	**F**			
(brine) FIT-701	**G**			
(plant) FIT-702	**H**			
(IW-2) FIT-1202	**I**			
(IW-3) FIT-1203	**J**			
Total Effluent	**K**			
Flow Ratios:				
% Injection Flow	G/E*100			
% Brine Flow	I/E*100			

Instructions:

1) Obtain the values once per shift from the HMI "Flow Totals screen
2) Grey cells must be calculated by hand
3) If IW-3 is used, add this flow into the % injection flow calculation
4) Enter every eight (8) hours per day (Green Totals Column)

Appendix I
Phone List

APPENDIX I

Phone List

Key phone numbers for quick reference are provided below.

Item	Vendor	Point of Contact	Phone Number
Key Subcontractors			
Trucking	Denbeste	Steve Hancock	707-975-1444
Electrician	Robertson Electric	Roger Holler	928-303-6023
Power Supply	City of Needles		760-326-5946
Suppliers			
Bulk Chemicals	Thatcher Chemicals	Kyle Peterson	702-564-7622
Coagulant Polymer	Nalco Chemicals	Monty Liu	909-553-7992
Antiscalent polymer	Avista		760-744-0536
Equipment Manufacturers			
Air Blower	Colorado Compressor	Steve Tyler - Sales	303-297-8100 x3009
Air Compressor	Colorado Compressor	Steve Tyler - Sales Greg Herman - Sales	303-297-8100 x3009 303-297-8100
AOD Pumps (P-401,403,404)	Quadna Pumps	Kelli Steele - Sales Mark Hibl - Sales	303-430-0521
Chem. Feed Skid	Hamilton Engineering	Bob Hamilton - Owner	303-757-7678
Chemical Waste Tank	Tank Equipment	Matt Licknosky - Sales	303-457-0513
Control Room Building	Williams Scotsman	Jenifer Sereno	951-681-0300
De-Mister	Mapco	John Youngston	231-941-5865
Diaphragm Pumps	Quadna Pumps	Kelli Steele - Sales Mark Hibl - Sales	303-430-0521
Dry Polymer Feeder	Nalco/ChemFlo	Elizabeth Garcia	630-543-1911
Firewater Tank	Mark Steel	Fred Elmen	FredE@marksteel.net
FRP Tanks	Palmer	Don Rockwell, Engineer Dave Mason, Designer	800-835-9136
Lightnin Mixers	Centennial Equipment Co.	Byron Bergman - Sales	303-278-8400
Micromedia Filter	PALL Advanced Separations Systems	Patricia Owens	607-753-6041
Miscellaneous Pumps	BF Sales	Jeff Hasse - Sales	303-216-1041
Inline Mist Eliminator	Mapco	JC	231-941-5865

Item	Vendor	Point of Contact	Phone Number
Motor Control Center/Switchgear	Eaton	Bill W. Kasper - Sales	303-738-2328
Clarifier/Gravity Settler	Parkson	Irv Rubenstein	Irv.Rubenstein@Parkson.com
Phase Separator Sump Pump Package	Quadna Pumps	Kelli Steele - Sales	303-430-0521
Plastic Process Tanks	Palmer Mfg & Tank Inc.	Dave Mason	620-275-7461
Process Pump (P-200,201,400,500,620,700,701,900)	BF Sales/Fybroc	Jeff Hasse	303-216-1041
RO Unit	Ecolochem	Ed Creecy	Ed.Creecy@ecolochem.com
Seal Water System	Quadna Pumps	Kelli Steele - Sales Mark Hibl - Sales	303-430-0521
Septic Tanks	Firewater Systems, Inc.	Jonathan Fritz	
Static & Tank Mixers	Centennial Equipment	Dave Daigler - Sales	303-278-8400
Sunshade	G&W Builders, Inc.	Mike Green	714-529-9935
Transfer Switch	Eaton	Bill W. Kasper - Account Rep.	303-738-2328
Well Pumps	Denver Industrial Pumps Inc	Michael Morton	303-233-9255
Regulatory			
Waste Discharge Requirements	Regional Water Quality Control Board	Jose Cortez	760-346-7491
Hazardous Materials Business Plan and Conditional Authorization	San Bernardino Fire Department, Hazardous Materials Division (CUPA)	Kristen Riegel	909-386-8401
Process Support			
System Design	CH2M HILL	Dennis Fink Terry DeBiase	510-251-2426

Appendix J
Treatment System Contingency Plan

APPENDIX J

PG&E Topock IM No. 3 Treatment System Contingency Plan

A contingency plan such as this one is used during design to anticipate potential problems and mitigate these problems. The objective of the following table is to outline the possible failures of the treatment system in achieving its design objectives: meeting effluent water quality requirements and meeting the design flow (defined currently as maintaining the flows in the DTSC letter of June 30, 2004, assumed to be average gallon per minute flow rates averaged over a given month. This later requirement was modified by the DTSC letter dated February 14, 2005, which requires 50 gallon per minute extraction, except during approved maintenance periods or if PG&E seeks DTSC's approval.) Other evaluations done separately (i.e., not addressed here) include: what will be done if the groundwater hydraulic gradient is not landward? And what will be done with waste and product streams generated at the site?

Causes of potential failures are mitigated in design (e.g., selecting a metallurgy that is better resistant to a corrosive environment), while others are mitigated by operational efforts (e.g., visually inspecting chemical inventory to avoid running out). Operational mitigation descriptions include the condition that an operator would observe and the action he/she would take. A rigorous preventative maintenance schedule is proposed as an overall mitigation step to minimize risk of unexpected failures. The Severity of Effect column denotes the implication of the effect if it were to occur. The mitigation measures described are taken to minimize or eliminate the likelihood of these effects and failures.

TABLE J-1
PG&E Topock Failure Mode Effect Analysis

Failure and Effect without Mitigation	Potential Cause	Mitigation – Design	Mitigation - Operations				Severity of Effect if Not Mitigated	Estimated Resulting System Downtime (days)	Notes
			Mitigation	Observable Condition		Action if Cause Occurs			
				PLC	Human				
New – Updated December 2005									
Release from dual contained pipe. Effect without Mitigation: Potential release to environment of water with Cr	Differential thermal expansion, vandalism, puncture.	Redundant pipe installed	Visual inspection of pipeline	PermAlert failure indication	See leak	Stop extraction, switch to spare pipeline, resume extraction	3	0	
Release of groundwater into (and then out of) well vault. Effect without Mitigation: Potential release to environment of water with Cr	Pipe break	Rated piping; level switches to detect and stop pump			Visual inspection of pipeline	Stop extraction, repair leak, resume extraction	3	0	
Effluent pH out of WDR limits Effect without Mitigation: Potential for non-compliance with WDR	a. Excess caustic or low acid feed. b. Low caustic or excess acid feed.	a. and b. Redundant pH Probes (AIT-202 -1/2 and AIT-301A/B/C-1/2)	Onsite lab test of pH into T700		pH in lab does not match field reading	Stop injection, return pH to target and report to compliance support.	3	0	
Onsite Hach meter giving false negative Cr(VI) readings Effect without Mitigation: Potential for non-compliance with WDR	Equipment malfunction		Matrix spikes required as part of lab QC program		MS results out of target	Check instrument	1	0	
Solids (including Cr(III) pass MF and get to effluent Effect without Mitigation: Potential for non-compliance with WDR	Membrane rupture or fiber sheet crack	MF effluent turbidity meter alarm, MF periodically does integrity test	Replace bad module	High MF Effluent Turbidity		Isolate individual vessels to identify failed module	4b	0	
Release from brine tanks at Bench Effect without Mitigation: Potential for release of non-Cr water, first to secondary containment and then to environment.	a. Overfill, b. vandalism, puncture.	a. High level switch shuts off brine pump to tanks b. Fence and locked gate	Visual inspection of bench	High level alarm in tank	See leak	Stop P701, report to compliance support, contain spill	3	0	
Lightning damages entire electrical and I&C system. Effect without Mitigation: Plant off-line for significant period.	Lightning	Transient Voltage Surge Suppressor (TVSS) for plant. UPS (surge suppressor) on 120V line (I&C eqpt)	Check MCCs TVSS lights each shift		Lights on TVSS	Contact engineering support	3	1-28	
Air release valve fails or is damaged releasing water Effect without Mitigation: Potential release of water	a. Vandalism	Raw water line - valve in locked below-grade vault. Treated water line - valve in concrete box					3	1-3	
	b. Valve malfunction		Check valve		Leak	Fix valve	3		
From Treatment System O&M Manual, April 2005									

TABLE J-1
PG&E Topock Failure Mode Effect Analysis

Failure and Effect without Mitigation	Potential Cause	Mitigation – Design	Mitigation - Operations				Severity of Effect if Not Mitigated	Estimated Resulting System Downtime (days)	Notes
			Mitigation	Observable Condition		Action if Cause Occurs			
				PLC	Human				
1. Failure: Extraction Well clogs Effect without Mitigation: The given well will not be able to contribute to meeting extraction rate goals.	a. Fouling of screen		Track water levels		Increase in differential elevation	Could redevelop well, or add acid	2	0	
2. Failure: Well pump fails Effect without Mitigation: The given well will not be able to contribute to meeting extraction rate goals until the pump is repaired or replaced.	a. Mechanical or electrical failure		Preventative maintenance schedule	RUN failure light Indication: P100 or P101 OFF		Repair or replace pump	2	0	
3. Failure: Line from extraction well clogs or leaks. Effect without Mitigation: Given pipeline unable to carry water to treatment system.	a. Puncture, crushing	Redundant pipeline installed					3	0	
	b. Solids buildup	Well-developed wells will have low suspended solids					2	0	

TABLE J-1
PG&E Topock Failure Mode Effect Analysis

Failure and Effect without Mitigation	Potential Cause	Mitigation – Design	Mitigation - Operations				Severity of Effect if Not Mitigated	Estimated Resulting System Downtime (days)	Notes
			Mitigation	Observable Condition		Action if Cause Occurs			
				PLC	Human				
4. Failure: Cr(VI) not reduced – insufficient ferrous iron Effect without mitigation: If not mitigated may result in incomplete reduction of Cr(VI).	a. $FeCl_2$ feed pump failure	Flow meter to alarm if no flow	Operators check pump drawdown			Repair or replace pump	4a	1[a]	Spare chemical feed pump will be provided onsite.
	b. Leak or clog in $FeCl_2$ feed line from pump to tank	Will add clear length of piping to visually verify chemical is being fed	Inspect $FeCl_2$ tank for nozzle obstructions, bugs, and wind-blown and foreign debris		Leak - Visible leaking Clog – Visual verification	Fix feed. If not being fed: shut down plant.	4a	1[a]	
	c. $FeCl_2$ feed line leak or clog between tote and pump	Pump (LMI Series AA) has an alarm signal back to the PLC if it has received a signal to run and no chemical flow is detected. Signal shuts down entire plant. Also, added ferrous meter after startup					4a	1[a]	
	d. Failure of flow meter that controls $FeCl_2$ feed		Routine inspection of flow meter	Flows through plant not equal to flow set for that time Meter: FIT-200		Replace or repair flow meter	4a	1[a]	
	e. $FeCl_2$ is stratified within tote	Mix using paddle	Visual observation of stratification		Stratification is observed	Modify mixer	4a	1[a]	New mixer may be added if necessary
	f. $FeCl_2$ batch has a ferrous concentration lower than specified by chemical supplier	Pump (LMI Series AA) has an alarm signal back to the PLC if it has received a signal to run and no chemical flow is detected. Signal shuts down entire plant.	1 - Track Cr(VI) in effluent 2 - Ferrous sampling of each tote upon delivery (or use QC certificates from supplier)		Concentration less than specified	Increase flow of chemical per flow of water, or add new tote	4a	1[a]	May require new totes delivery
	g. $FeCl_2$ tote empty	Pump (LMI Series AA) comes with an alarm signal back to the PLC if it has received a signal to run and no chemical flow is detected.	Daily inspection of $FeCl_2$ level		Empty tote	Add new tote	4a	1-4	
	h. Low Fe(II) dosage target (due to abrupt rises in Cr(VI) concentrations)		Perform routine tests of inlet Cr(VI) (looking for increased concentration) and could do $FeCl_2$ jar tests		Significant increase in inlet Cr(VI), OR increase in outlet Cr(VI)	Modify Fe(II) dosage	4a	1[a]	One potential source of abrupt changes in Cr(VI) concentration is pumping shifts from the wells. For example, if a low-Cr(VI) well drops in flow, the Cr(VI) concentration may increase.

TABLE J-1
PG&E Topock Failure Mode Effect Analysis

Failure and Effect without Mitigation	Potential Cause	Mitigation – Design	Mitigation - Operations				Severity of Effect if Not Mitigated	Estimated Resulting System Downtime (days)	Notes
			Mitigation	Observable Condition		Action if Cause Occurs			
				PLC	Human				
5. Failure: Incomplete reduction of Cr(VI)– pH too high causing reaction kinetics to be too slow for sufficient reduction reaction to occur in available residence time. Effect without Mitigation: If not mitigated may result in incomplete reduction of Cr(VI).	a. Retention time too low	Process: Bench-scale kinetics tests have been conducted to predict the required retention time, safety factor has been applied to provide sufficient time at max design flow.					2	N/A (could function at lower flow). >30 days to install new tanks if needed	First Iron oxidation reactor could potentially be converted to a second Cr reduction reactor if needed.
	b. Mixer failure in Cr Reduction tank		Maintenance and inspection	Tank not mixed Indication: M300 OFF		Repair or replace mixer	2	1 (repair) to 40 (replace)	Would likely have sufficient mixing in just the Plug Flow Reactor.
	c. Floating cover removed, compromised, or missing		Maintenance and inspection		Cover not moving	Repair or replace cover	1	1 (repair) to 40 (replace) See Note	System could continue to operate (as IM-2 does) but air addition could cause need to use additional FeCl
6. Failure: Incomplete reduction of Cr(VI)– pH too high due to problem with acid feed system causing reaction kinetics to be too slow for sufficient reduction reaction to occur in available residence time. Effect without Mitigation: If not mitigated may result in incomplete reduction of Cr(VI).	a. Sulfuric acid feed pump failure	pH meter to monitor	Operators check pump drawdown			Repair or replace pump	2	1[a]	This failure mode does not seem plausible. None of the GW has pH high enough to inactivate Fe(II). Available oxygen should not be sufficient to compete with Cr(VI) for the Fe(II) at currently planned stoichiometry. $FeCl_2$ will also lower pH, so acid may not be needed. Batch plant operations indicate that pH is consistently reduced to less than 5.5 without sulfuric acid addition.
	b. Sulfuric acid feed line leak or clog		Look for obstructions such as bugs and wind-blown debris in tank and acid line		Acid not fed	Repair or replace feed line	2	1[a]	
	c. Failure/fouling of pH meter that can be used to control acid feed		Routine inspection and cleaning of pH probe (note – this should be less prone to fouling then later in iron oxidation tanks)	Meters found to be have lost calibration Meter: AIT-202-1 and 202-2		Calibrate; can flow-pace acid feed	2	1[a]	
	d. Acid tote empty	Pump (LMI Series AA) has an alarm signal back to the PLC if it has received a signal to run and no chemical flow is detected. Signal shuts down entire plant.	Daily inspection of acid level		Tote empty	Install new tote	2	1-4	
7. Failure: Iron and Cr(III) are not oxidized and precipitated – due to failure to raise pH to range needed to precipitate in available retention time Effect without Mitigation: If not mitigated may result in incomplete precipitation of Cr(III).	a. Sodium Hydroxide feed pump failure	pH meter to monitor	Operators check pump drawdown			Repair or replace pump	4b	1[a]	
	b. Retention time too low	Bench-scale kinetics tests have been conducted to predict the required retention time, safety factor has been applied to provide sufficient time at max design flow.					4b	N/A (could function at lower flow). >30 days to install new tanks if needed	
7. continued	c. Sodium Hydroxide feed line leak or clog	pH meter to monitor	Inspect tank for foreign substances in tank nozzle and caustic line		Caustic not being fed at tanks	Repair or replace feed line	4b	1[a]	

TABLE J-1
PG&E Topock Failure Mode Effect Analysis

Failure and Effect without Mitigation	Potential Cause	Mitigation – Design	Mitigation - Operations				Severity of Effect if Not Mitigated	Estimated Resulting System Downtime (days)	Notes
			Mitigation	Observable Condition		Action if Cause Occurs			
				PLC	Human				
	d. Failure/fouling of pH probe(s) that controls Sodium Hydroxide feed	Process: Could use flow-pacing rather than pH-pacing of sodium hydroxide feed in first two tanks as flow meter less likely to give false reading than pH probe. Process: Recirculating the sludge from clarifier will provide preferential nucleation site to help reduce solids buildup on probes. Design. Will make pH probes accessible to operators.	Routine inspection and cleaning of pH probe		Rapid loss of calibration, visual fouling	Re-calibrate. Could install hot-tap self-cleaning probes	4b	1[a]	
	e. Sodium Hydroxide tote empty	Pump (LMI Series AA) has an alarm signal back to the PLC if it has received a signal to run and no chemical flow is detected. Signal shuts down entire plant.	Daily inspection of sodium hydroxide level		Tote empty	Install new tote	4b	1-4	
	f. Caustic freezes	Mitigate by using lower concentration caustic, less than 30%, which has freezing point lower than water's so should not be encountered at site. Will also heat trace and insulate feed line.	Heat tote – with light or heat wrap				4b	2-5	
	g. Mixer failure in Iron Oxidation tanks	Blower should keep tank agitated to a great extent.	Maintenance and inspection	Tank not mixing due to motor: Indication: M301A, or M301B, or M301C OFF	Visual inspection periodically (requires removing manway)	Repair or replace mixer	4b	N/A (could function at lower flow). >30 days to install new tanks if needed	Have verified during operation that mixers are not required, air provides mixing.

TABLE J-1
PG&E Topock Failure Mode Effect Analysis

Failure and Effect without Mitigation	Potential Cause	Mitigation – Design	Mitigation - Operations				Severity of Effect if Not Mitigated	Estimated Resulting System Downtime (days)	Notes
			Mitigation	Observable Condition		Action if Cause Occurs			
				PLC	Human				
8. Failure: Iron and Cr(III) are not oxidized and precipitated – due to insufficient air Effect without Mitigation: If not mitigated may result in incomplete precipitation of Cr(III).	a. Blower failure	Flow meters (FIT-300A, FIT-300B, and FIT-300C) provided. Low flow can signal blower failure. three tanks are provided, each with a blower.					2	7	
	b. Failure of backflow valve - Water flows back to blower and shuts it down	Air duct is “looped” above water level to prevent backflow.					2	7	
	c. Air line leak or clog, upstream of flow switch	Flow meters (FIT-300A, FIT-300B, and FIT-300C) provided, can signal stop of flow. Pressure Switch Low as a surrogate measurement					2	1[a]	Given size of air lines, such an obstruction seems extremely unlikely.
	d. Air line leak or clog, downstream of flow switch	Locate flow meters close to tanks					2	1[a]	
9. Failure: Clarifier clogged Effect without Mitigation: Solids carryover – leads to increased solids load on Microfilter and increases frequency of cleaning.	a. Solids “stick” to plates .	Process. Process control of sludge recirculation will help minimize risk.	Monitor sludge blanket level using decant nozzles on clarifier thickener, control level by changing sludge wastage rate.		Estimate sludge blanket level using the side taps on the sludge section of the clarifier. For example, drain water from taps #2 and #3 and know if the sludge blanket top is between taps #2 and #3.	Clean plates. Evaluate polymer use and sludge recirculation	Initial: 1 Extreme: 2	2-4	In extreme case, could require more frequent system downtime for cleaning, and therefore reduced throughput over time.
	b. Solids wastage rate too low	Set sludge withdrawal based on dual **timer**: “frequency – dwell time” system, and turbidimeter on clarifier overflow for signs of solids carry-over.					Initial: 1 Extreme: 2	1[a]	
	c. Flow to clarifier is not increased gradually during restarts		SOPs require gradual ramp up in flow to clarifier during any system restart.		Overflow	Ramp up slower	Initial: 1 Extreme: 2	1	

TABLE J-1
PG&E Topock Failure Mode Effect Analysis

Failure and Effect without Mitigation	Potential Cause	Mitigation – Design	Mitigation - Operations				Severity of Effect if Not Mitigated	Estimated Resulting System Downtime (days)	Notes
			Mitigation	Observable Condition		Action if Cause Occurs			
				PLC	Human				
10. Failure: Excess Floc Carryover Effect without Mitigation: Solids carryover – leads to increased solids load on Microfilter and increases frequency of cleaning.	a. Poor flocculation		Improve chemistry		Poor floc formation and settling	Operator to perform jar tests to select better flocculant dosage	Initial: 1 Extreme: 2	N/A	In extreme case, could require more frequent system downtime for cleaning, and therefore reduced throughput over time.
	b. Low floc density		Improve chemistry		Poor floc formation and settling	Operator to perform jar tests to select better flocculant dosage, or increase proportion of sludge recirculated.	Initial: 1 Extreme: 2	N/A	
11. Failure: Sludge is slow in dewatering through separators Effect without Mitigation: Potentially can not dewater all produced sludge with just the 2 in-service separators	a. Sludge characteristics – poorly draining. Polymer not managed properly to optimize dewatering.	Process: provide polymer per manufacturer suggestion to condition sludge for better dewatering. Have saved room on pad for filter press, which could process sludge faster if needed.	Could ship sludge with higher moisture content at increased costs				1	2-4	
12. Failure: Microfilter fouling Effect without Mitigation: Reduced throughput	a. Iron oxide fouling is the more likely type of fouling (Acid-cleanable). Probably not silica.	Have added ability to clean some MF modules while others remain in service.	Periodic MF inspection		Maintenance of MF should include observing foulant buildup	Initiate MF backwash and/or membrane cleaning cycle	2	2-4	
13. Failure: Microfilter system general failure Effect without Mitigation: Reduced throughput, or treatment system shutdown	a. Membrane rupture	Turbidimeter provided in MF package.	Inspection and maintenance per manufacturer	Increased turbidity reading Alarm: Microfilter PLC signal AAH2		Inspect MF membranes	3	3-5	
14. Failure: RO membrane fouling Effect without Mitigation: Reduced throughput, or treatment system shutdown	a. Physical/chemical fouling		Maintenance, periodic acid cleaning	Increased differential pressure Alarm: DPAH606, or DPAH607, or DPAH608		Frequency based on membrane autopsy (Avista Technologies, the inhibitor supplier, excels at these custom and difficult applications) accumulated operating experience.	2	1-3	Fouling will occur, clean-in-place skid provided to remove the fouling

TABLE J-1
PG&E Topock Failure Mode Effect Analysis

Failure and Effect without Mitigation	Potential Cause	Mitigation – Design	Mitigation - Operations				Severity of Effect if Not Mitigated	Estimated Resulting System Downtime (days)	Notes
			Mitigation	Observable Condition		Action if Cause Occurs			
				PLC	Human				
15. Failure: RO – Deterioration of salt-rejecting layer. Effect without Mitigation: Increased TDS in permeate stream	a. Scale formation; membrane abrasion from frequent start-stop operation; and/or flow maldistribution along brine channel (high polarization effect).	Minimize start/stop operation.					Initial: 4c Extreme: 3	0-5	Initially plant would not shut down, waste production issue only. In extreme case would need to shut down the system to replace RO membranes.
15. Continued	b. Higher TDS influent than expected, or Incorrect ops in blending permeate and untreated water or brine.		Monitor discharge conductivity (AIT-610) (surrogate for TDS)		Increased TDS in periodic discharge monitoring sampling	Correct the blend ratio	Initial: 4c Extreme: 3	N/A	Initially plant would not shut down, waste production issue only. In extreme case would need to shut down the system to replace RO membranes.
16. Failure: RO – Scale formation Effect without Mitigation: Increasing pressure drop across pressure vessels, starting at most concentrated end of RO unit.	a. Failure to feed scale inhibitor; change in water chemistry.		Verify antiscalant feed. Check feed water chemistry, especially calcium, sulfate, fluoride, molybdate-reactive silica, pH, alkalinity, and TDS (or conductivity). Then look at Sr, Ba, Fe, Mn, and Al. Verify correct pressure vessel flow distributions (product can be surrogate for brine). Check operation of pH control system	Increased differential pressure Alarm: DPAH606, or DPAH607, or DPAH608		Autopsy the fouled membrane element (have Avista support).	Initial: 1 Extreme: 3	2-5	In extreme case would need to shut down the system to replace RO membranes.
17. Failure: RO – Reduced Product Water Recovery Effect without Mitigation: Higher handling, storage, transport and disposal costs	a. Flow-ratio controller on RO skid failure, or flow elements failure, or loss of calibration.		Check flow-ratio controller and flow elements on RO feed and product (permeate) for failure or calibration.	Reduced recovery Indication: F-611		Evaluate RO system operations with the manufacturer	1	0-5	Initially plant would not shut down, waste production issue only.
18. Failure: RO – UV damage of membranes Effect without Mitigation: Membrane damage	a. Sunlight	Wall down to ground around RO system to keep sunlight that comes through the 12 foot opening beneath the sidewall, and if needed, a curtain hung around RO skid					Initial: 4c Extreme: 3	5-10	

TABLE J-1
PG&E Topock Failure Mode Effect Analysis

Failure and Effect without Mitigation	Potential Cause	Mitigation – Design	Mitigation - Operations				Severity of Effect if Not Mitigated	Estimated Resulting System Downtime (days)	Notes
			Mitigation	Observable Condition		Action if Cause Occurs			
				PLC	Human				
19. Failure: Power failure Effect without Mitigation: Immediate loss of power which may not allow for systematic shutdown of plant.	a. Power grid, transmission line, or transformer failure. Typically less than 24 hours (based on Needles utility records)	There will be UPS on controls and each computer (2 computers for operator interface), and auto-dialer. Provides 15 minutes to shut down system in orderly manner. Generator provided that can power entire plant					3	1-2	The City of Needles (Ron Myers) checked logs from 8/2003 to 9/2004. It was reported that there were 7 outages, 6 of which were <8 hours and one of 20 hours. These were in the monsoon season of July to Sept due to lightning or wind-downed transmission lines.
20. Failure: Disposal – injection wells (if chosen) insufficient for flow Effect without Mitigation: Reduced system capacity.	a. Unforeseen conditions after installation and testing	Will design injection wells for 150% of max flow and can install more wells.					2	N/A	Plant would not shut down, waste production issue
	b. Rapid fouling of screen or formation due to groundwater conditions and injected water quality	Provide "backwash" capability for wells by installing pumps in the wells.	Means to mitigate decreasing flow capacity are described in Interim Measures No. 3 Injection Well Operation and Maintenance Plan				2	N/A	Plant would not shut down, waste production issue
21. Failure: Disposal – sludge trucks unable to access site due to difficult road conditions Effect without Mitigation: Once available sludge holding tank and separators are full will necessitate system flow reduction and finally shutdown	a. Monsoon-caused washouts	Two access routes are provided (from East and from West)	Road maintenance		Road impassible	Repair road	Initial: 2 Extreme: 3	1-5	Initially reduces throughput, eventually will cause shutdown if can not remove sludge.
22. Failure: Closed valves in nearly any line (process, air, vent, chemical feed, and waste) can cause system overflow. In case of chemical feeds, could cause failures described in early sections. Effect without Mitigation: System shutdown, capture overflow in plant drain system for reprocessing or off-site disposal.	a. Closed manual valves left in wrong position	Each tank has High High level that stops pump feeding tank	Careful operation, adherence to SOPs, adequate operator training, proper preventative maintenance				3	1[a]	
	b. Automatic valves moved or fail to wrong position	Select "fail open" or "fail closed" valves to avoid the negative effect					3	1[a]	
23. Failure: Pump failure Effect without Mitigation: System shutdown; If pump leaks, capture leak in plant drain system for reprocessing or off-site disposal.	a. Seal failure; starter failure (heat at site); and/or mechanical failure.		Care in operations; proper preventative maintenance	Low pressure switch alarm PSL-1100	Pump not working (audible)	Repair or replace. Improve cooling of Electronics room.	3	1-28	

TABLE J-1
PG&E Topock Failure Mode Effect Analysis

Failure and Effect without Mitigation	Potential Cause	Mitigation – Design	Mitigation - Operations				Severity of Effect if Not Mitigated	Estimated Resulting System Downtime (days)	Notes
			Mitigation	Observable Condition		Action if Cause Occurs			
				PLC	Human				
24. Failure: Line leaks, or tank leaks would necessitate stopping treatment process in order to fix. Effect without Mitigation: System shutdown. Capture leak in plant drain system for reprocessing or off-site disposal.	a. Puncture	Level alarm in process sump tank	Visual inspection of plant; proper preventative maintenance		Leaks	Fix leak	3	1-5	
25. Failure: Chemicals – lose their properties due to heat/UV Effect without Mitigation: Loss of pH control and subsequent plant shutdown	a. Extreme heat at site	Put chemicals under separate, lower roof. This area is east of the main building so is shaded from afternoon, western sun.					2	2-4	
26. Failure: Damage from wind-blown dust. Effect without Mitigation: Damage to plant causes shutdown of system	a. High winds in area Blown dust in desert conditions	Wall to within 12 feet of ground to serve as wind barrier will reduce damage. Two doors will provide “air lock” to control dust into Electronics and Control rooms.	Operations: Routine checks of the seals on critical equipment, parts; proper preventative maintenance of mechanical and electrical equipment		Abrasion damage or motors failing	Repair or replace equipment.	3	1-28	
27. Failure: Seismic damage Effect without Mitigation: Damage to plant may cause shutdown of system	a. Earthquake	Structure rated for seismic zone 3					3	Varies	
28. Failure: Air compressor failure Effect without Mitigation: Microfilter system shuts down	a. Mechanical failure or high-pressure air line rupture		Proper preventative maintenance of compressor	Low pressure or compressor stops working. Alarm: PAL-1000		Repair or replace equipment.	3	28	
29. Failure: Pipeline to injection field leaks Effect without Mitigation: Release of treated water and plant shutdown once observed	a. Puncture or crushing	Install pipe on edge of road. Use metal pipe rather than plastic.					3	1-14	
30. Failure: Freezing of groundwater Effect without Mitigation:: Flow through plant could stop, could damage pipe or instruments.	a. Cold temperatures	Flowing water should not freeze at conditions seen at this site.	Drain system to remove water		Weather forecast and anticipated outage schedule.	If plant is to be down and record lows for area are forecasted, the system should be drained.	3	1[a]	
31. Failure: Flooding Effect without Mitigation:: Damage to equipment could result in some equipment being shutdown or require replacement	a. Rising water levels in Colorado River	Construct most equipment outside of floodplain. If in floodplain, use watertight valve vault covers.					2	2-14	Only PE-1 is in flood plain

TABLE J-1
PG&E Topock Failure Mode Effect Analysis

Failure and Effect without Mitigation	Potential Cause	Mitigation – Design	Mitigation - Operations				Severity of Effect if Not Mitigated	Estimated Resulting System Downtime (days)	Notes
			Mitigation	Observable Condition		Action if Cause Occurs			
				PLC	Human				
32. Failure: System is damaged due to vandalism Effect without Mitigation:: Damage to equipment could result in some equipment being shutdown or require replacement	a. Vandalism	Fence around treatment system. Further, controls built into the system (alarms, containment, automatic cutoffs and shutdowns) are designed to help mitigate uncontrolled releases or discharges following several types of failures due to vandalism	Periodic inspections of all equipment inside and outside treatment area			Report damage to project management	1 or 3	Varies	

* - Severity of Effect codes:
1 – Does not impact water quality or throughput.
2 – If not mitigated may reduce plant's water throughput.
3 – If not mitigated may shutdown plant.
4a – If not mitigated may result in incomplete reduction of Cr(VI).
4b - If not mitigated may result in incomplete precipitation of total Cr.
4c - If not mitigated may result in reduced TDS removal from RO permeate. Note this would be initially mitigated by decreasing percent of water bypassing RO, which would provide time to correct problem.

[a] – These times are assumed to be one day when plant is manned.