SANTA FE IRRIGATION DISTRICT
Est. 1923

San Dieguito Water District

Joint Facilities Master Plan

March 2012

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WQTS

Infrastructure
ENGINEERING CORPORATION

JOINT FACILITIES MASTER PLAN

R.E. Badger Water Filtration Plant

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Prepared for

SANTE FE IRRIGATION DISTRICT &
SAN DIEGUITO WATER DISTRICT

March 2012

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ABBREVIATIONS

AF	acre-feet
AF/yr	acre-feet per year
AL	action level
AMMP	Asset Management Master Plan
CARB	California Air Resources Board
CDPH	California Department of Public Health
CFD	Cumulative Frequency Distribution
CFS	cubic feet per second
CIP	Capital Improvement Program
ClO_2	chlorine dioxide
CMLC	cement mortar lined and coated
CPS	Cielo Pump Station
CRW	Colorado River Water
CSI	California Solar Initiative
CT	contact time
cu ft	cubic feet
cy	cubic yard
CWA	San Diego County Water Authority
°C	degrees Celsius
D/DBP	Disinfectant/Disinfection By-Products
DBPs	Disinfection By-Products
DO	dissolved oxygen
DODS	Division of Dam Safety
DWR	California Department of Water Resources
EC	enhanced coagulation
EEBR	Energy Efficiency Business Rebates
ESB	Energy Savings Bid Program
ft	feet/foot
ft/min	feet per minute
ft^2	square feet
FTW	filter-to-waste
FWW	filter waste washwater
gal	gallon(s)
gal/day	gallons per day
$gal/ft^2/run$	gallons per square foot per run
gpm	gallons per minute
gpm/ft^2	gallons per minute per square feet

HAAs	haloacetic acids
HDPE	high-density polyethylene
hp	horsepower
hrs	hours
hrs/day	hours per day
HPU	hydraulic power unit
HRT	hydraulic retention time
I&C	Instrumentation & Control
JFMP	Joint Facilities Master Plan
kV	kilovolt
kVA	kilovolt-ampere
kW	kilowatt
kWhr	kilowatt hour
lb/yr	pounds per year
LED	light emitting diodes
LID	low impact development
LRAA	locational running annual average
LSI	Langelier Saturation Index
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
MnO_2	manganese dioxide
MCL	maximum contaminant level
µg/L	micrograms per liter
Mgal	milligals
MG	million gallons
mg/L	million gallons per liter
mgd	million gallons per day
MIB	2-methylisoborneol
min	minute(s)
mL	milliliter
mm	millimeter
NDMA	nitroso-di-methyl amine
NEC	National Electrical Code
NF	nanofiltration
ng/L	nanograms per liter
NMS	Network Management System
No.	number
NOM	natural organic matter
NPV	Net Present Value
NTU	Nephelometric Turbidity Units
O&M	Operation and Maintenance
OBF	On-Bill Financing Option
OMWD	Olivenhain Municipal Water District
OSHA	Occupational Safety and Health Administration

PACL	polyaluminum chloride
ppd	pounds per day
PPE	personal protective equipment
PRF	Prioritization Rating Factors
PLC	Programmable Logic Controller
psi	pounds per square inch
psf	pounds per square foot
PV	photovoltaic
RAA	running annual average
RO	reverse osmosis
rpm	revolutions per minute
RTW	rinse-to-waste
sec^{-1}	1/seconds
SCADA	Supervisory Control and Data Acquisition
SDCWA	San Diego County Water Authority
SDG&E	San Diego Gas & Electric
SDPS	San Diguito Pump Station
SDR	San Dieguito Reservoir
SDWD	San Dieguito Water District
SFID	Santa Fe Irrigation District
SDW	sludge decant water
SL	sludge
SWP	State Water Project
SWTR	Surface Water Treatment Rule
T&O	taste and odor
TDS	total dissolved solids
THMs	trihalomethanes
TOC	total organic carbon
TSS	total suspended solids
TTHMs	total trihalomethanes
UV	ultraviolet
UBWV	unit backwash volume
UFRV	unit filter run volume
USPR	unit solids production rate
UMWP	Urban Water Management Plan
VFDs	variable frequency drives
WFP	R.E. Badger Water Filtration Plant

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BACKGROUND

In order to serve current and projected potable water demands, the Santa Fe Irrigation District (SFID) and the San Dieguito Water District (SDWD) rely on three water supplies. These supplies include imported raw water, local raw surface water, and imported treated water.

The term “Joint Facilities” refers to the infrastructure and treatment facilities jointly owned by SFID and SDWD (SFID/SDWD) that are required to convey and treat raw water supplies, and store and transmit treated water to the SFID/SDWD’s separate potable water distribution systems. A critical component of the Joint Facilities is the 40 million gallons per day (mgd) R.E. Badger Water Filtration Plant (WFP). Typically, over 95 percent of the potable water supply for SFID/SDWD is derived from raw water treated at the WFP. The San Diego County Water Authority’s (SDCWA) second aqueduct pipeline 5 is located immediately adjacent to the WFP and provides the source of raw imported water to the WFP. Prior to treatment at the WFP, imported raw water from the high-pressure aqueduct pipeline is conveyed through the SFID/SDWD’s hydroelectric facility to generate electricity. Generated power not used by the WFP is sold to San Diego Gas and Electric (SDG&E).

The local raw water supply is derived from surface water captured in Lake Hodges from the surrounding San Pasqual Valley. Raw water from Lake Hodges can be pumped directly to the WFP. However, due to dynamic water quality fluctuations, raw water from Lake Hodges is typically conveyed to the San Dieguito Reservoir (SDR) for pre-conditioning prior to conveyance to the WFP. Therefore, though there is one basic raw water supply in the area, Lake Hodges and SDR provide two distinct local raw water “sources” to the WFP. The source water quality of Lake Hodges and the SDR may vary based upon the time of year and other factors. Figure ES-1 provides a schematic of the existing Joint Facilities.

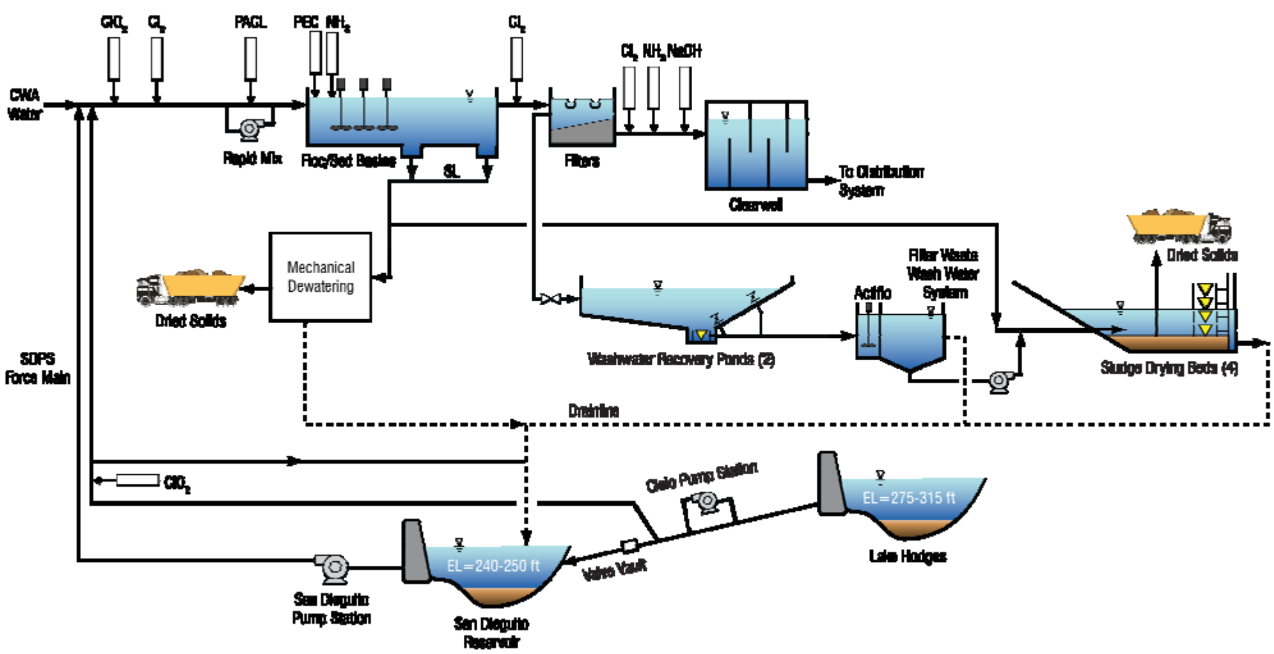

Figure ES.1 Schematic of the Existing Joint Facilities

PURPOSE OF THE JOINT FACILITIES MASTER PLAN

In the past, SFID/SDWD has completed various studies considering multiple aspects of the Joint Facilities. The most recent was the 2009 Asset Management Master Plan (AMMP). The AMMP formed the basis of SFID/SDWD's 10 year Capital Improvement Program (CIP) based upon a general assessment of the Joint Facilities. The AMMP recommended that a more detailed evaluation of the Joint Facilities be conducted in order to better define required improvements. As a result, this Joint Facilities Master Plan (JFMP) was commissioned with the following goals:

1. Reassess the capabilities of existing facilities to achieve current and projected process performance and physical integrity requirement.
2. Define specific capital projects that achieve SFID/SDWD's needs at the lowest possible capital and operating costs.
3. Prioritize projects and update the 10 year Joint Facilities CIP.

KEY COST AND PROCESS PERFORMANCE BASELINES

Baselines established for base case costs, water supplies and demands, and evaluation criteria are presented.

Base Case Cost Determination

In order to provide a benchmark that helps define the value added by each proposed Joint Facility Improvement, the JFMP estimated the baseline cost for treating raw water at the WFP under current conditions. Since the cost and quality of the raw water supply (imported vs. local) varies significantly, the cost of treating raw water varies widely depending upon the assumed volume and raw water supply source. Table ES.1 presents the current supply cost for imported and local raw water supplies.

Table ES.1 FY 2012 Water Supply Cost

Raw Water Supply Option	Supply Cost per Acre Foot ($/AF)
Local Raw Water	$52
Imported Raw Water [1,2]	$699

Notes
1. Cost includes transportation fee.
2. Cost does not include the imported supply fixed cost of $187/AF.

The quality and consistency of the local raw water supply is lower than imported raw water and is more challenging to treat. However, due to the relatively low supply cost, the overall cost of treated local water has historically been lower than the cost of treated imported raw water. The cost for imported treated water has historically been the highest treated water supply option.

Table ES.2 provides a breakdown of the estimated base case raw water treatment cost assuming a 30 percent local raw water supply to 70 percent imported raw water supply blend scenario. Though higher percentages of local water have been utilized in the past 3 years, the 30 percent local assumption is consistent with long-term historic trends and reflects anticipated future demands and local water supply availability as discussed in the following paragraphs. Costs in Table ES.2 only reflect operations and maintenance (O&M) costs, Capital costs are not included in the unit costs. All costs are in 2012 dollars.

Table ES.2 Base Case Treatment Costs

Treatment Cost Category	Units	5,700 AF/yr of Local Water[1,2]
Percent Local Water	%	30
Water Supply Cost[3]	$/AF	506
Imported Supply Fixed Cost[3]	$/AF	187
Power	$/AF	70
Hydroelectric Revenue	$/AF	(19)
Chemical	$/AF	30
Residuals Management[4]	$/AF	12
Labor	$/AF	95
Maintenance[3]	$/AF	72
TOTAL	$/AF	953

Notes
1. Average annual demand of 19,124 AF/yr was used per the 2010 Urban Water Management Plan.
2. Equates to a 30/70 split of local/imported raw water supply blend.
3. Cost calculated based on FY 2012 from information provided by SFID/SDWD.
4. Assumes plant staff manages solids with existing drying beds and contract mechanical dewatering. Solids in excess of the drying bed capacity are discharged to SDR.

Future Demands And Supply Availability

SFID and SDWD recently completed Urban Water Management Plans (UWMP) that defined future potable demand projections for 2030. The combined SFID/SDWD demand was estimated at 19,124 acre-feet per year (AF/yr). Per an agreement with the City of San Diego, SFID/SDWD have property rights to local surface water equivalent to approximately 5,700 AF/yr (based upon historic precipitation data per the existing agreement). In order to establish base costs, and evaluate potential future improvements, the JFMP utilizes the demands projected in the UWMP and the estimated available local water supply volume of 5,700 AF/yr identified in the existing agreement. This percentage of local supply results in a 30/70 ratio, which is similar to long-term historic usage. It is assumed that the percentage of imported treated water used will be minimal. A maximum day demand of 30 mgd was also assumed based upon historic and projected trends.

Key Evaluation Criteria

The JFMP evaluated each component of the joint facilities considering the following key criteria:

- Achieve current and projected regulatory requirements
- Provide safe work environment
- Provide realiable facilities
- Enhance economic performance where possible
- Elimination of solids discharge to SDR
- Annual demand of 19,124 AF/yr
- Maximum day demand of 30 mgd
- Annual local raw water availability of 5,700 AF/yr

IDENTIFICATION OF POTENTIAL CAPITAL PROJECTS

The evaluation identified 28 projects required to meet near and/or long term Joint Facility needs. Total capital cost estimates were established for each project. In addition, operation and maintenance costs were identified for each project in order to determine the impact of each project on the estimated base cost of treated water (presented as dollars per acre feet [$/AF] of treated water).

Table ES.3 provides a summary of identified potential projects, a brief project description, estimated total capital cost, associated cost per acre-foot to implement, and anticipated project benefits. Based upon a prioritization process discussed in the next section, the first 21 projects were selected for inclusion in the recommended 10-year CIP.

The majority of the projects are recommended to replace aging infrastructure, improve health and safety, and minimize the discharge of solids to the SDR. The existing facilities have sufficient hydraulic capacity.

With regards to process performance, a key finding was that with relatively minor process modifications, the existing facilities could achieve existing and projected regulatory requirements as long as the volume of local water treated was limited to approximately 5,700 AF/yr. However, due to challenges associated with lower quality local supplies, it was determined that the addition of substantial ozone treatment facilities would be required to assure reliable treatability at larger volumes. If local water supplies were consistently available up to 8,600 AF/yr then the addition of ozone would be cost effective.

RECOMMENDED 10 YEAR CAPITAL IMPROVEMENT PROGRAM FOR THE JOINT FACILITIES

A project prioritization process was established to help define the relative importance of each project and develop an implementation program that spreads the projects over the ten-year planning horizon. This process included the development of evaluation categories and category weighting factors as shown in Table ES.4.

Based on project rankings and an assessment of project need, a recommended 10 Year Joint Facilities CIP was prepared as shown on Table ES.5.

In addition to project ranking, several factors were key in determining project priorities within the CIP. These factors include impact of the project on health and safety, regulatory compliance, financial benefits, and end of useful life determination (for equipment needing replacement). Impact of these drivers is evidenced when reviewing the recommended CIP. In the first four years, 14 projects totaling about $19.1 million dollars are recommended for implementation. Four of these 14 projects total $8.8 million dollars and address health and safety: new San Dieguito Pump Station (SDPS); electrical distribution improvements; clearwell seismic improvements; and the washwater tank. Three projects totaling $2.65 million address siltation, mounding, and inlet flow at SDR. Two other projects totaling $4.75 million provide long-term financial benefits to the Joint Facilities: the new 30-inch parallel pipeline from Cielo Pump Station to SDR and a new high voltage substation at WFP. One project totaling $0.4 million improves plant process control. The remaining recommended projects within the first four years total about $2.5 million and address regulatory compliance issues and initiation of the hydroelectric project.

Table ES.3 Summary of Potential Joint Facilities Projects

Project No.	Recommended Improvement	Project Description	Preliminary Cost Estimate: Estimated Project Cost ($)	Preliminary Cost Estimate: Project + O&M Unit Cost ($/AF)	Project Benefits
Joint Facilities					
1	New 15 MGD San Dieguito Pump Station (SDPS)	Replace existing SDPS with new facilities and add handrail on the dam.	$4,200,000	$15.92	Increase reliability and safety by replacing a facility that is past its useful life.
2	New 30-inch Parallel Pipeline from Cielo Pump Station (CPS) to SDR	Parallel existing 18-inch line with a new 30-inch line, move valves out of street, replace pump station (PS) isolation valves.	$4,150,000	$4.47	Replace pumped conveyance with gravity conveyance from Cielo PS to SDR, increase functionality and reliability.
3	Install Permanent Chlorine Dioxide Generation	Replace the existing California Department of Public Health (CDPH) "pilot approved" system with a permanent system.	$1,300,000	$5.45	Increase operational reliability of a necessary chemical system.
4	Electrical Distribution Improvements	Upgrade plant power distribution system.	$2,400,000	$10.05	Increase reliability, redundancy, and safety by replacing aging equipment.
5	SDR Pretreatment Enhancements	Enhance existing system to handle flow increase from Lake Hodges to SDR.	$150,000	$0.63	Increase SDR lake management capacities to correspond with increases in flow through SDR.
6	Chemical Storage and Feed Improvements	Provide additional chemical feed points at various points throughout the plant, upgrade polyaluminum chloride (PACL) tank and chlorinators, provide spare chemical tank, and increase reliability of utility water to the chemical systems.	$305,000	$1.28	Provide operational flexibility to improve treated water quality and increase functionality and reliability of the chemical storage and feed systems.
7	Clearwell Seismic Improvements	Provide seismic upgrades to the clearwell.	$700,000	$2.93	Increase safety and reliability.
8	SDR Siltation Basins	Install basins to reduce urban runoff sediment deposits.	$350,000	$1.47	Reduce maintenance and increase water quality of SDR.
9	Washwater Tank	Retrofit/Replace the existing tank.	$1,500,000	$6.28	Bring tank into compliance with seismic standards.
10	High Voltage Substation	Construct new electrical substation.	$600,000	$0.43	Reduce electrical costs and improve reliability.
11	SDR Sediment Mound Reduction	Lower current mound elevation.	$1,000,000	$4.19	Improve aesthetics of inflow through SDR.
12	SCADA Upgrades	Replace outdated equipment	$400,000	$1.68	Improve plant control system.
13	SDR Inlet Channel Modifications	Improve channel configuration.	$1,300,000	$5.45	Improve conveyance of inflow through SDR.
14	Replace or Upgrade Hydroelectric Facility	Replace or refurbish existing facility.	$7,600,000	$31.84	Increase cost effectiveness of the facility.
15	Mechanical Dewatering and Filter Waste Washwater Improvements	Increase mechanical dewatering capacity and improve residuals management.	$6,330,000	$51.92	Eliminate solids discharge to SDR by dewatering solids onsite and improve quality of filter waste washwater.
16	Reline or replace 15-inch Drain Line to SDR	Reline or replace existing pipeline. Future inspection of pipeline will dictate reline or replacement.	$2,000,000	$8.38	Increase reliability by refurbishing or replacing an aging pipeline.
17	Natural Treatment Wetlands	Install wetlands to improve the quality of urban runoff.	$750,000	$3.14	Increase water quality of SDR.
18	Reline Existing 30-inch SDPS Force Main to Plant or Construct New 30-inch Line	Reline or replace existing pipeline. Future inspection of pipeline will dictate reline or replacement.	$4,500,000	$18.85	Increase reliability by refurbishing or replacing an aging pipeline.
19	New Flocculators	Replace existing flocculators and connect to standby power.	$1,000,000	$4.19	Increase functionality and reliability by replacing aging equipment.
20	New Sludge Collection Equipment	Replace existing sludge collection equipment.	$1,500,000	$6.28	Increase functionality and reliability by replacing aging equipment.
21	SDR Vegetation Removal	Remove nuisance vegetation in and adjacent to SDR.	$750,000	$3.14	Increase aesthetics of SDR.
		SUBTOTAL	$42,785,000	$188	
22	Pre-ozonation	Provide a 1,300 ppd ozone system.	$10,200,000	$69.50	Ozone "pays for itself" by increasing local water supply from 5,700 to 8,600 AF/yr.
23	Ozone Pilot Testing	Initial testing to verify efficacy of ozone.	$500,000	$2.09	Confirm efficacy of ozone.
24	Construct New Third Floc/Sed Basin	Construct a third floc/sed basin adjacent to existing.	$6,200,000	$25.97	Increase reliable pretreatment capacity above 30 mgd.
25	Filter Improvements	Rehab filter underdrains, surface wash, launders, electrical, and control.	$5,800,000	$24.30	Increase useful life.
26	Ultraviolet (UV) Disinfection	Add UV disinfection upstream of clearwell.	$5,300,000	$23.09	Provides enhanced disinfection if required by change in raw water quality or future regulations.
27	Reline/Rehabilitate Old 54-inch Treated Water Line	Rehabilitate the old 54-inch treated water line from the plant to near SDPS. Future inspection of pipeline will dictate reline or replacement.	$7,500,000	$31.42	Increase reliability by refurbishing an aging pipeline.
28	SDR Volume Enhancement through Dredging or Outlet Elevation Modifications	Increase SDR storage through dredging or raising the water level.	$5,000,000	$20.94	Increase storage capacity of SDR.
		SUBTOTAL	$40,500,000	$197	
		TOTAL	$83.3 M	$385	

Table ES.4 Prioritization Rating Factor Descriptions

CIP Evaluation Categories and Weights		Prioritization Rating Factors (PRF) and Definitions			
Evaluation Criteria	Category Weight	3	2	1	0
Regulatory Compliance and/or Flow-Pressure Objectives	10	Project is critical to achieving compliance, or is a prerequisite project to a project critical to achieving compliance	Project will moderately improve ability to achieve compliance	Project may have a low level of impact on the ability to achieve compliance.	Project has no impact on ability to achieve compliance.
Staff Safety and Working Environment	10	Project could significantly reduce the risk of an accident, or would improve the work environment to the point where the protection of the employee's health would be significantly improved.	Project could have a moderate impact on the reduction accident risk or moderate improvement of the work environment.	Project may have a low level of impact on the ability to reduce accidents or improve the work environment.	Project has no impact on ability to improve staff safety and work environment.
Reliability - Remaining Useful Life, Condition, Accessibility	9	Project would substantially improve reliability of a current unreliable asset.	Project would improve the reliability of a moderately reliable asset, or the project would enable better access to the existing asset to facilitate regular monitoring and/or maintenance.	Project may further improve the reliability of an asset that is currently considered reliable.	Project has no impact on improving the reliability of an existing asset.
Operation and Maintenance (O&M) Cost Efficiency	8	Provides significant O&M savings.	Provides moderate O&M savings.	Project may result in a low level of O&M savings.	Project will provide no O&M savings.
Redundancy - Joint Facilities	8	Project provides redundant improvements that are critical to the Joint Facility should the primary system component fail to operate. Effected system users would be unreasonably burdened by the loss of the primary system component.	Project provides redundant system improvements that may not be critical to the treatment of water but would reduce a potentially unreasonable burden on the effected system users.	Project provides redundant system improvements that would reduce the impact on system users. However, the impact to users could most probably be reasonable.	Project has no impact on redundancy.
Increased Local Water Usage	7	Project substantially improves our ability to increase local water use.	Project moderately improves our ability to increase local water use.	Project may have a lower level impact on our ability to increase local water use.	Project will not increase local water usage.
Water Quality Enhancement and Taste and Odor (T&O) Control	7	Project would substantially improve product water aesthetics and significantly reduce T&O complaints.	Project would result in moderate aesthetic improvements and potentially reduce certain T&O complaints.	Project may have a limited impact on product water aesthetics and a relatively low impact on T&O complaints.	Project has no impact on water quality aesthetics.
Enhanced Operational Control	6	Project substantially increases system flexibility and/or operational control.	Project moderately increases system flexibility and/or operational control.	Project may result in some increase in system flexibility and/or operational control.	Project has no impact on system flexibility and/or operational control.

Table ES.5 Recommended 10-Year Capital Improvement Program for the Joint Facilities

		Costs in Thousands of Dollars										
Project Description	Total Project Cost	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	Total
New 15 MGD SDPS	$4,200,000	$400	$1,520	$2,280								$4,200
Install Permanent Chlorine Dioxide Generation	$1,300,000	$130	$470	$700								$1,300
Electrical Distribution Improvements	$2,400,000	$240	$860	$1,300								$2,400
Chemical Storage and Feed Improvements	$305,000	$55	$250									$305
High Voltage Substation	$600,000	$60	$220	$320								$600
New 30-inch Parallel Pipeline from CPS to SDR	$4,150,000		$400	$1,500	$2,250							$4,150
SDR Pretreatment Enhancements	$150,000		$150									$150
Clearwell Seismic Improvements	$700,000		$700									$700
SDR Siltation Basins	$350,000		$40	$120	$190							$350
Washwater Tank	$1,500,000		$200	$520	$780							$1,500
SDR Sediment Mound Reduction	$1,000,000		$100	$360	$540							$1,000
SCADA Upgrades	$400,000		$200	$200								$400
SDR Inlet Channel Modifications	$1,300,000			$150	$1,150							$1,300
Replace or Upgrade Hydroelectric Facility	$7,600,000				$750	$2,740	$4,110					$7,600
Mechanical Dewatering and Filter Waste Washwater Improvements	$6,330,000					$600	$2,290	$3,440				$6,330
Reline or Replace 15-inch Drain Line to SDR	$2,000,000							$200	$720	$1,080		$2,000
Natural Treatment Wetlands	$750,000							$80	$270	$400		$750
Reline Existing 30-inch SDPS Force Main to Plant or Construct New 30-inch Line	$4,500,000									$500	$4,000	$4,500
New Flocculators	$1,000,000									$100	$900	$1,000
New Sludge Collection Equipment	$1,500,000									$150	$1,350	$1,500
SDR Vegetation Removal	$750,000									$80	$670	$750
Total	$42,800,000	$885	$5,110	$7,450	$5,660	$3,340	$6,400	$3,720	$990	$2,310	$6,920	$42,800

Individual projects are represented in the CIP with a design phase (preliminary and final) and a construction phase (bidding and construction). Design is generally shown as approximately 10 percent of the overall project cost. Some smaller projects are shown in the CIP to occur in one year because it was determined that the project could realistically be completed in this time period, such as the SDR Pretreatment Enhancements.

The potential capital projects not included in the 10-year recommended CIP are listed below. Rationale for their exclusion follows.

- Pre-ozonation
- Ozone Pilot Testing
- Construct New Third Floc/Sed Basin
- Filter Improvements
- UV Disinfection
- Reline/Rehabilitate Old 54-inch Treated Water Line
- SDR Volume Enhancement through Dredging or Outlet Elevation Modifications

Pre-ozonation and its ancillary ozone pilot study were not included because ozone becomes cost effective if the annual local water supply could be consistently increased from 5,700 to 8,600 AF/yr. A third floc/sed basin becomes necessary when maximum day production reliably increases over 30 mgd. Maximum day demands have been slowly declining over the last several years, and it is not anticipated that production will exceed 30 mgd in the next ten years. Improvements to the filters and the old 54-inch treated water line are based on the end of their useful life. It is not anticipated that these components will need to be replaced in the next ten years. Installation of UV disinfection is based on potential future regulations for enhanced disinfection not achievable with the current treatment scheme. This is not anticipated to occur in the next ten years. SDR volume enhancement, i.e., increasing the current storage capacity of SDR, is not necessary for pre-conditioning of Lake Hodges water at projected flows during the planning horizon. Similar to a third floc/sed basin, this project should be revisited if maximum day demands begin to reliably increase above 30 mgd.

ASSOCIATED COST OF WATER INCREASE

Table ES.6 shows the cost impact of the recommended 10-year CIP with respect to the current cost to treat raw water supplies at the WFP. The costs shown in Table ES.6 are all based on 2012 values. Costs for the raw water supplies result from adding the base case O&M cost per AF with a unit cost for the recommended Joint Facilities CIP that includes both amortized capital and O&M costs.

For comparison purposes, Table ES.6 also includes an estimated cost assuming an all imported treated water supply scenario. The cost of imported treated water is based upon 2012 values with no projected increases. If the Districts were to rely totally on imported treated water, storage facilities would need to be constructed to accommodate regularly scheduled annual maintenance on the imported treated water system. A minimum of 10 days of treated water storage is required to accommodate system maintenance. Therefore, in addition to the purchase price of imported treated water, the amortized capital ($135 million for 30 years at 5%) to construct a 180 million gallon (MG) storage facility must be added to the purchase cost of imported treated water.

Table ES.6 Comparison of Increased Costs to Treat Raw Water Supplies to 100 Percent Treated CWA Water Costs[1]

	Estimated Cost of Water per AF[2] ($/AF)	
	Raw Water Supplies[3]	100% Treated CWA
Base Case O&M Cost per AF (per Table ES.2)	953	1,185
Estimated Capital Improvement Costs per AF		
Treated Water Storage[4]	0	458
Recommended Joint Facilities 10-year CIP[5]	188	0
Estimated Total Cost per AF (O&M plus amortized project cost)	1,141	1,643

Notes
1. Based on average annual demand of 19,124 AF/yr.
2. All costs based on 2012 dollars.
3. Assumes 30 percent local water on an annual basis.
4. Includes the cost for a 180 million gallon storage facility ($135 million amortized for 30 years at 5%).
5. As shown in Table ES.3, unit costs for each capital project included both amortized capital and O&M costs. Amortization terms for all projects were 20 years at 5%.

BACKGROUND

In order to serve current and projected potable water demands, the Santa Fe Irrigation District (SFID) and the San Dieguito Water District (SDWD) rely on three water supplies. These supplies include imported raw water, local raw surface water, and imported treated water.

The term “Joint Facilities” refers to the infrastructure and treatment facilities jointly owned by SFID and SDWD (SFID/SDWD) that are required to convey and treat raw water supplies, and store and transmit treated water to the SFID/SDWD’s separate potable water distribution systems. A critical component of the Joint Facilities is the 40 million gallons per day (mgd) R.E. Badger Water Filtration Plant (WFP). Typically, over 95 percent of the potable water supply for SFID/SDWD is derived from raw water treated at the WFP. The San Diego County Water Authority’s (SDCWA) second aqueduct pipeline 5 is located immediately adjacent to the WFP and provides the source of raw imported water to the WFP. Prior to treatment at the WFP, imported raw water from the high pressure aqueduct pipeline is conveyed through the SFID/SDWD’s hydroelectric facility to generate electricity. Generated power not used by the WFP is sold to San Diego Gas and Electric (SDG&E).

The local raw water supply is derived from surface water captured in Lake Hodges from the surrounding San Pasqual Valley. Raw water from Lake Hodges can be pumped directly to the WFP. However, due to dynamic water quality fluctuations, raw water from Lake Hodges is typically conveyed to the San Dieguito Reservoir (SDR) for pre-conditioning prior to conveyance to the WFP. Therefore, though there is one basic raw water supply in the area, Lake Hodges and SDR provide two distinct local raw water “sources” to the WFP. The source water quality of Lake Hodges and the SDR may vary based upon the time of year and other factors. Figure 1-1 provides a schematic of the existing Joint Facilities.

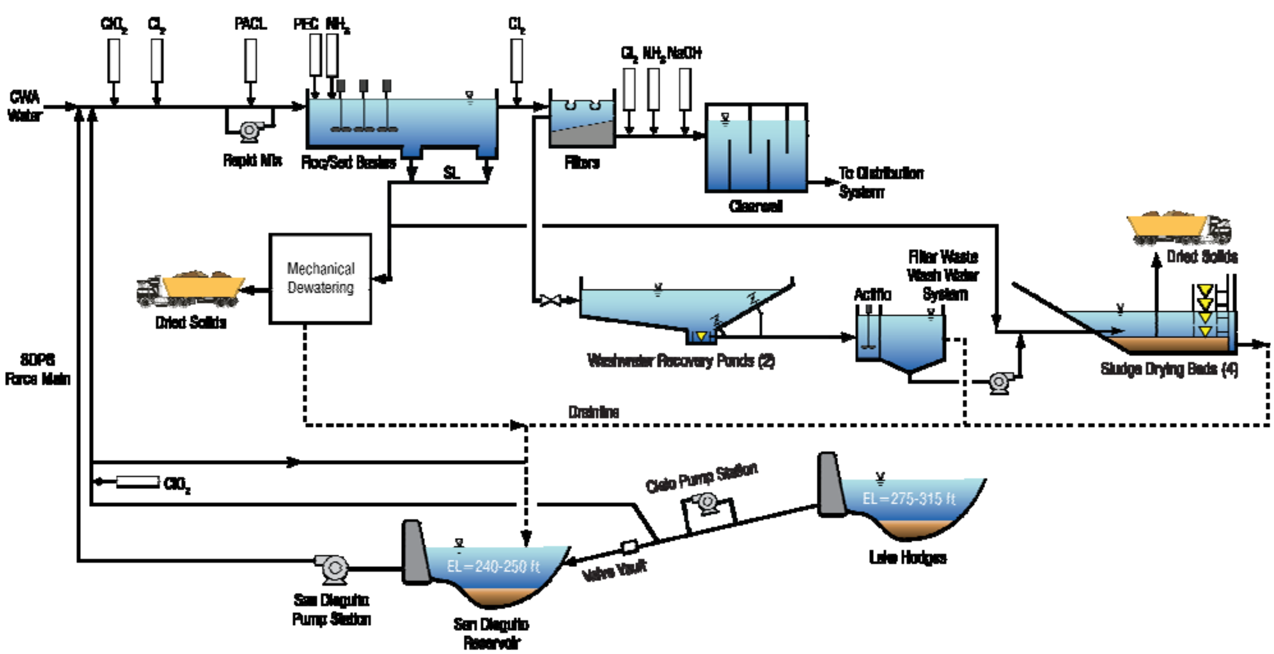

Figure 1.1 Schematic of the Existing Joint Facilities

PAST STUDIES

In the past, SFID/SDWD has commissioned studies to identify improvements to the raw water supply system and the WFP. These studies include the following:

1. 1999 San Dieguito Reservoir Rehabilitation Study (1999 SDR Study)
2. 2003 R.E. Badger Water Filtration Plant Master Plan Final Report (2003 Master Plan)
3. 2006 Final Report on the Blue Ribbon Panel R.E. Badger Process Study (2006 Report)
4. 2009 Asset Management Master Plan (2009 AMMP)
5. 2009 Mass-Balance and 1-D Water Quality Modeling of San Dieguito Reservoir: Development of Management Strategies (Anderson, M.A., 2009a).
6. 2009 Review of Available Water Quality Data for San Dieguito Reservoir and Lake Hodges Inflow (Anderson, M.A., 2009b).
7. 2011 Bathymetry and Basin Characteristics of San Dieguito Reservoir (Anderson, M.A., 2011).

Each of the above studies has made recommendations for improvements to the raw water system or the WFP. Many of these recommendations have been or are in the process of completion. The most recent master plan (2009 AMMP) primarily focused on the treated water distribution system. The 2009 AMMP recommended a separate master plan be completed for the WFP. As a result, SFID/SDWD commissioned Carollo Engineers to prepare a JFMP for the WFP and its associated raw water facilities. This master plan is being undertaken to provide a 10-year road map for SFID/SDWD with respect to the Joint Facilities.

JOINT FACILITIES

A general description of the Joint Facilities follows.

Raw Water System

Raw water entering the WFP primarily comes from SDR via the SDPS and an inter-tie from the CWA system. Water from SDR consists primarily of water from Lake Hodges with a small portion coming from the local watershed. Water is transferred from Lake Hodges to SDR through a 36-inch steel pipeline that reduces to an 18-inch high-density polyethylene (HDPE) pipeline. The CPS can be used to increase flows from Lake Hodges to SDR. The primary purpose of the CPS is to provide water from Lake Hodges directly to the WFP; however, it is infrequently used this way because water from Lake Hodges is more difficult to treat with out first flowing through SDR for pre-conditioning. A schematic of the raw water system is shown in Figure 1.2.

Hydroelectric Facility

Raw water from CWA is at a high pressure that must be reduced before entering the WFP. This needed pressure reduction is accomplished using a hydroelectric facility that was constructed in 1985. The hydroelectric facility consists of two turbines, each having different flow capacities and has a total flow capacity of 67 cfs. The maximum power output from the turbine generators is 1,485 kW. The hydroelectric facility is connected to the SDG&E power grid and includes bi-directional revenue meter. More detailed information on the hydroelectric facility can be found in Section 6.

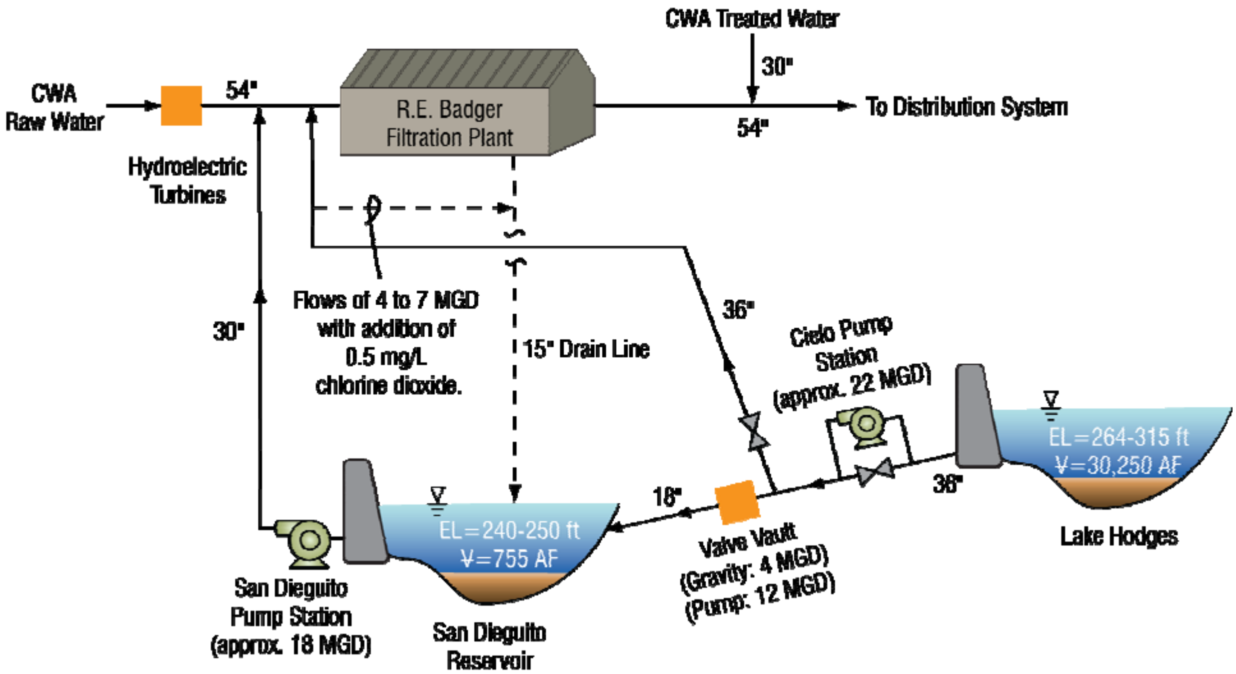

Figure 1.2 Schematic of Existing Raw Water Delivery Facilities

Treatment Plant

The WFP uses conventional treatment processes (coagulation, flocculation, sedimentation, and filtration) to treat raw water entering the plant. Water flowing into the plant enters the flocculation influent channel where it splits and flows into two flocculation/sedimentation basins. Each flocculation basin is baffled creating a serpentine style flow. Each basin contains four vertical flocculators. From the flocculation basins, water flows through the sedimentation basins to the basin effluent weir and into the basin effluent channel. Settled water from the sedimentation basins flows through a filter influent channel and over influent flow splitting weirs to one of six dual media, constant level filters. Water from the filters flows to a 13 million gallon (MG) clearwell. CWA treated water can be combined with the WFP treated water upstream or downstream of the clearwell. A schematic of the plant is shown in Figure 1.3.

Solids Handling

Settled solids from the sedimentation basins can either be pumped or flow by gravity to one of four sludge drying beds. Decant from the drying beds flows to SDR. Because the current drying beds are undersized relative to the amount of solids produced at the WFP, a majority of the solids entering the drying beds is carried through into the decant water and subsequently flows to SDR. Dried solids from the drying beds are trucked to a local landfill. The WFP does have a gravity thickener and a centrifuge that can be used for dewatering solids. This equipment has historically been problematic and is not currently operational.

Filter backwash water is sent to one of two filter washwater recovery basins. Water and solids in these basins are transferred directly to the SDR. A high-rate clarification process (Actiflo™) is available to treat the filter washwater. This equipment has not been operational for several years. When operating, discharge from Actiflo™ can either be sent to SDR or recycled into the plant influent raw water line. Solids from Actiflo™ can be sent to the gravity thickener. A schematic of the solids handling system is included in the process flow diagram shown in Figure 1.3.

Chemical Systems

The following chemical systems are located at the WFP:

1. Gaseous Chlorine
2. Chlorine Dioxide (generated onsite using chlorine gas and sodium chlorite)
3. Sodium Chlorite
4. Aqueous Ammonia
5. Liquid Polyaluminum Chloride (PACL)
6. Cationic Polymer
7. Anionic Polymer (not presently used)
8. Caustic Soda
9. Dewatering Polymer System (not presently used)
10. Actiflo™ Polymer System (not presently used)

Gaseous chlorine is used at WFP for disinfection and also to produce chlorine dioxide (using sodium chlorite) and chloramines (with aqueous ammonia). Plant staff uses free chlorine and chloramines to meet the required credits for *Giardia* and virus inactivation. Free chlorine can be injected upstream of flash mix, to settled water, to filter influent, and downstream of the filters. Chlorine dioxide can be injected in the SDPS force main, the CPS force main, upstream of flash mixing, backwash header, and filter backwash recovery system. Ammonia can be added at flash mixing and downstream of the filters.

PACL is the primary coagulant at the WFP. In addition, cationic polymer can be used to aid coagulation and anionic polymer can be used to aid flocculation. PACL can be injected at flash mixing, upstream of the filters, and upstream of the backwash recovery system. Cationic polymer can be added in flash mixing (primary location), first stage flocculation and upstream of the filters as a filter aid. Anionic polymer can be added in the first or second stage of flocculation, upstream of the filters, and as a dewatering aid.

Caustic soda can be added at the WFP to adjust the pH. There are two injection points: upstream or downstream of the filters. Polymers can also be added to the solids flow upstream of the centrifuge to assist in dewatering and in the Actiflo™ system to assist in particle agglomeration. The Actiflo™ polymer system is a dry polymer while all other polymer systems at the WFP are liquid. All of the chemicals listed above are continually used at the WFP except for anionic polymer, which has not been used consistently in the last several years.

FUTURE DEMANDS AND SUPPLY AVAILABILITY

SFID and SDWD recently completed Urban Water Management Plans (UWMP) that defined future potable demand projections for 2030. The combined SFID/SDWD demand was estimated at 19,124 acre-feet per year (AF/yr). Per an agreement with the City of San Diego, SFID/SDWD have property rights to local surface water equivalent to approximately 5,700 AF/yr (based upon historic precipitation data per the existing agreement).

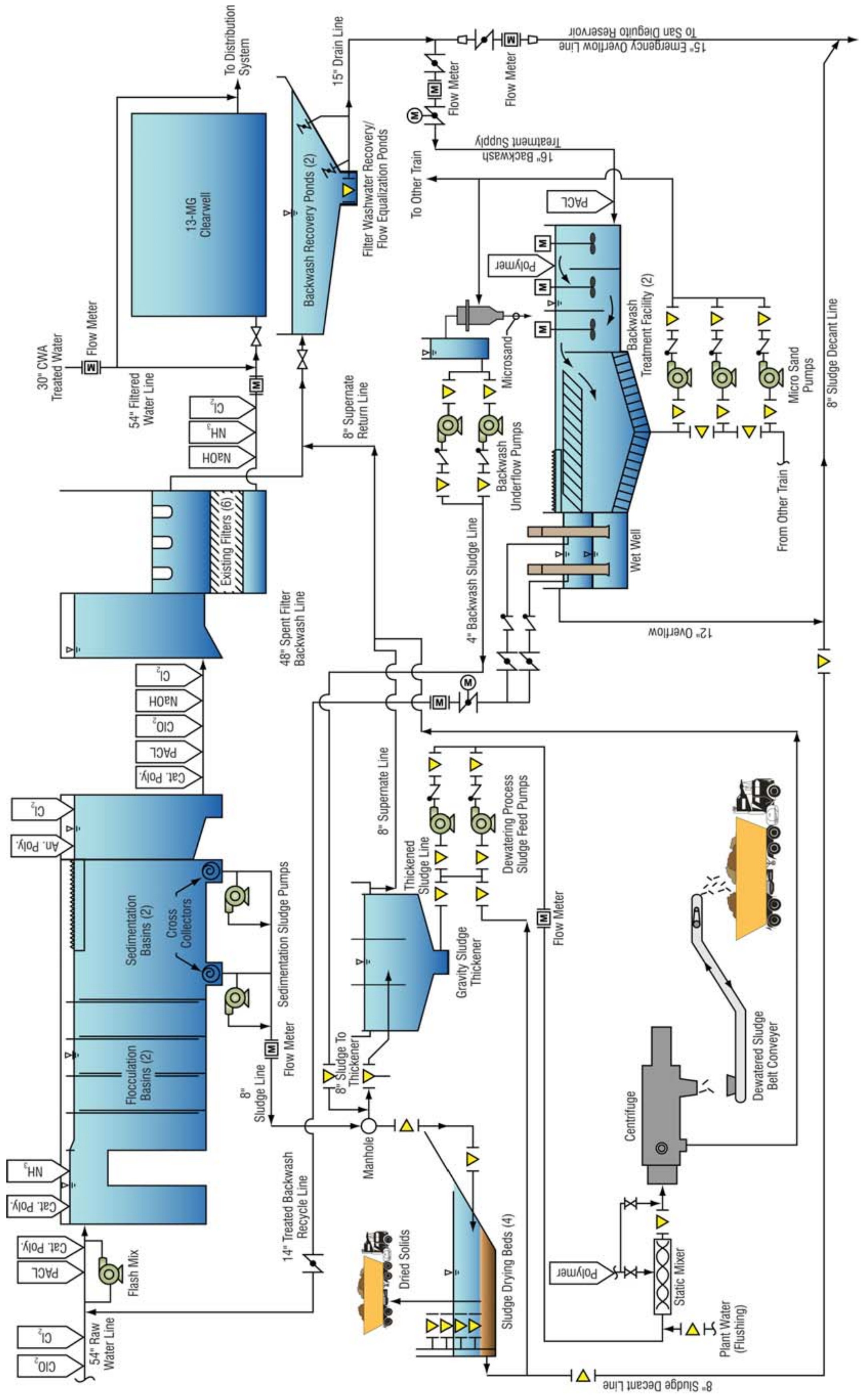

Figure 1.3 Process Flow Diagram of the Badger WFP

Historical plant influent flows at the WFP are shown in Figure 1.4. As shown, influent flows have decreased over the past four years. Plant staff has indicated that flow reductions are a result of conservation efforts that have taken place. Figure 1.5 separates flows into the three different water sources that feed the plant. This figure shows that water is not frequently pumped directly from Lake Hodges to the WFP. In addition, there has been an increasing trend of using local water sources from 2007 (37 percent local) to 2010 (64 percent local).

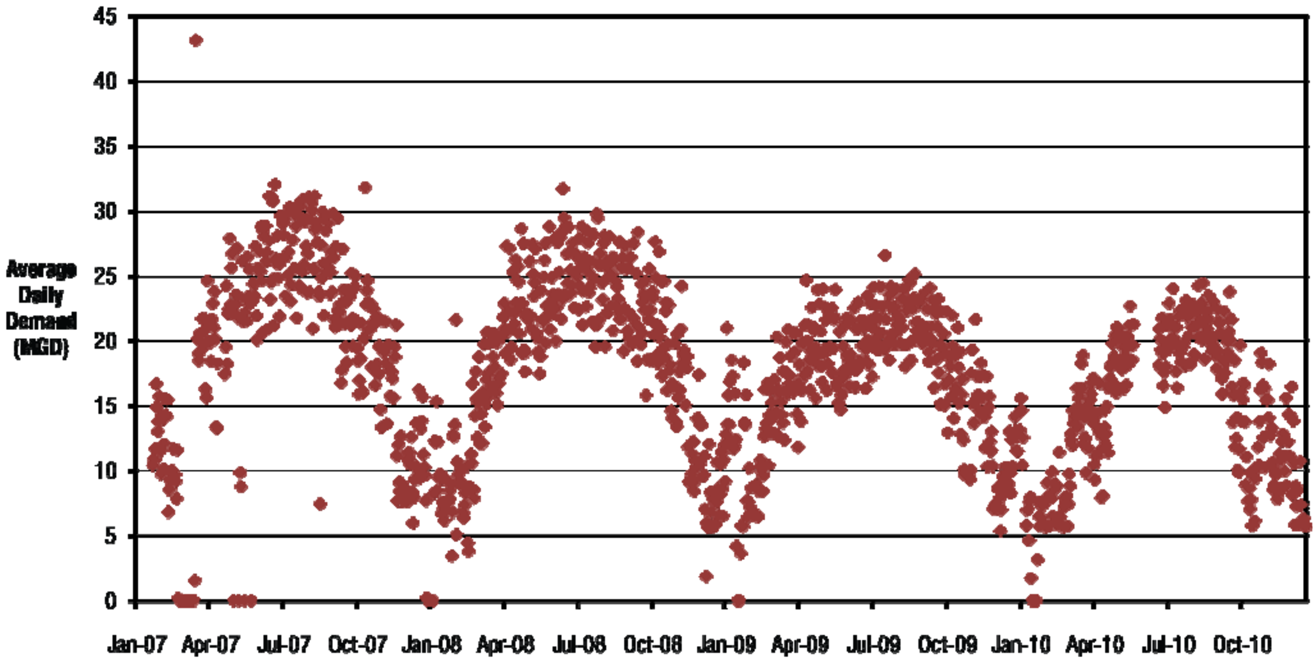

Figure 1.4 Historical Total Raw Water Influent Flow Rates

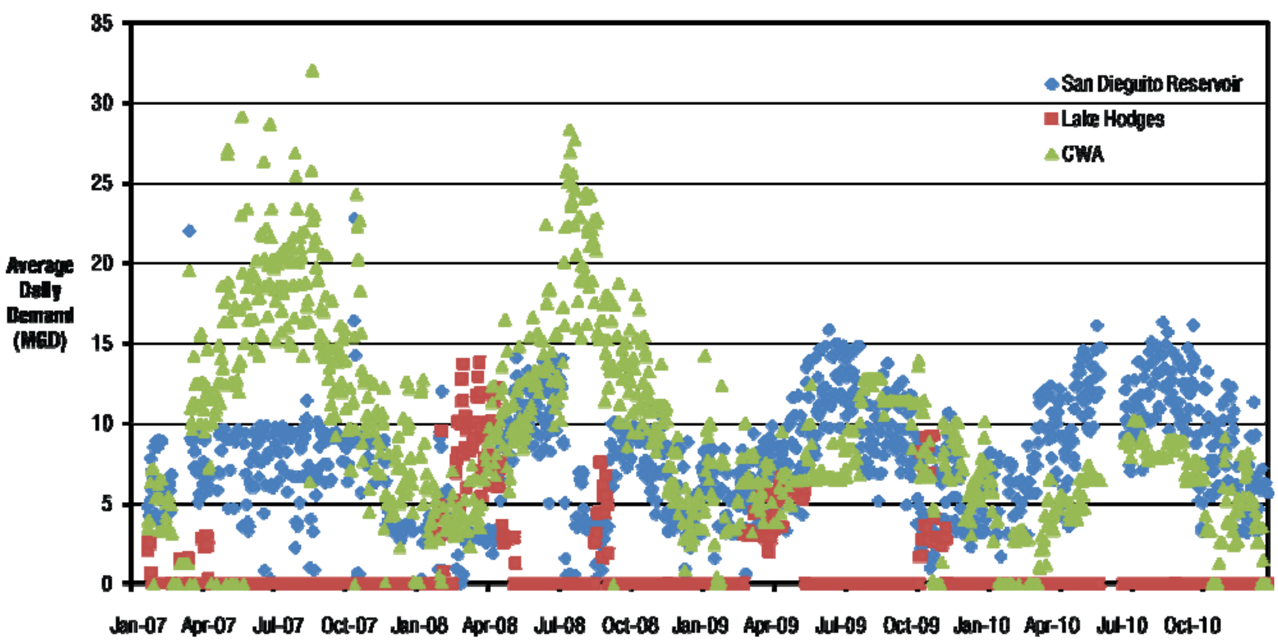

Figure 1.5 Historical Raw Water Flow Rates by Source

DESIGN CRITERIA OF THE JOINT FACILITIES

Design criteria for the Joint Facilities are summarized in Tables 1.1 and 1.2. Table 1.1 defines the design criteria for the raw water facility and Table 1.2 defines the design criteria for the WFP. This design criteria is based on information listed in plant design drawings and supplemented by discussions with staff.

Table 1.1 Design Criteria of the Raw Water System

Description	Units	Capacity
Demands		
Total	AF/yr	19,124
Local	AF/yr	5,700
Raw Water Pipelines		
Lake Hodges to CPS		
Type: Steel		
Size	in	36
CPS to WFP Turnout		
Type: Steel		
Size	in	36
WFP Turnout to WFP		
Type: Steel		
Size	in	36
WFP Turnout to SDR		
Type: HDPE		
Size	in	18
SDPS to WFP		
Type: Steel		
Size	in	30
CWA Raw Water		
Type: Steel		
Size	in	54
Drain Line from WFP to SDR		
Type: Asbestos Cement		
Size	in	15
Cielo Pump Station		
Type: Can Style Vertical Turbine		
Number of Pumps	No.	3
Flow	gpm	4,167
Total Discharge Head	ft	318
Motor Size	hp	450

Table 1.1 Design Criteria of the Raw Water System (continued)

Description	Units	Capacity
Number of Pumps	No.	1
Flow	gpm	2,083
Total Discharge Head	ft	318
Motor Size	hp	250
San Dieguito Pump Station		
Type: Can Style Vertical Turbine		
Number of Pumps	No.	4
Flow	gpm	4,200
Total Discharge Head	ft	358
Motor Size	hp	500
Number of Pumps	No.	1
Flow	gpm	2,430
Total Discharge Head	ft	358
Motor Size	hp	250
Hydroelectric Facility		
Type: Francis Turbines		
Number of Turbines	No.	2
Turbine 1		
Flow	cfs	27
Rated Net Head	ft	315
Efficiency	%	91.5
Output	kW	657
Nominal Rated Speed	rpm	1200
Generator Voltage	kV	4.16
Generator Power Output	kW	600
Generator Apparent Power	kVA	800
Generator Current	Amperes	111
Minimum Power Factor	%	75
Turbine 2		
Flow	cfs	40
Rated Net Head	ft	315
Efficiency	%	91.5
Output	kW	969
Nominal Rated Speed	rpm	1200
Generator Voltage	kV	4.16
Generator Power Output	kW	885
Generator Apparent Power	kVA	1180
Generator Current	Amperes	164
Minimum Power Factor	%	75

Table 1.2 Design Criteria of the Badger WFP

Description	Units	Capacity
Plant Capacity		
Design Flow	mgd	40
Minimum Flow	mgd	5
Average Flow	mgd	20
Plant Influent Meters		
CWA 30-inch Venturi Meter (Treated Water) Capacity	CFS	42
	mgd	27
SFID 54-inch Venturi Meter (Untreated Water) Capacity	CFS	83
	mgd	54
Flash Mixing		
Type: Pump Diffusion		
Number	No.	1
Mixing Energy, (Maximum G)	sec^{-1}	750
Pump Capacity	gpm	940
Pump Horsepower	hp	15
Flocculation Basins		
Type: Serpentine Flow with Vertical Shaft Flocculators		
Number of Basins	No.	2
Number of Compartments per Basin	No.	8
Compartment Width	ft	20
Compartment Length	ft	20
Average Water Depth	ft	10.5
Compartment Volume	cu ft	4,200
	gal	31,400
Total Volume	cu ft	67,200
	gal	502,400
Flocculation Time		
Design Flow	min	18.1
Average Flow	min	36.2
Mixing Energy G (Variable)	sec^{-1}	10 to 60
Vertical Shaft Flocculators	No.	16
Flocculator Power (each)	hp	1

Table 1.2 WFP Design Criteria (continued)

Description	Units	Capacity
Sedimentation Basins		
Type: Rectangular with Travelling Bridge and Cross Collector Sludge Collection		
Number of Basins	No.	2
Basin Width	ft	40
Basin Length	ft	220
Length to Width Ratio	-	5.5:1
Basin Surface Area (each)	ft^2	8,800
Total Basin Surface Area	ft^2	17,600
Average Water Depth	ft	10.5
Basin Volume	cu ft	92,400
	gal	691,600
Total Volume	cu ft	184,800
	gal	1,383,200
Detention Time at Design Flow	min	50
Surface Loading Rate		
Design Flow	gpm/ft^2	1.6
Average Flow	gpm/ft^2	0.8
Average Horizontal Velocity		
Design Flow	ft/min	4.4
Average Flow	ft/min	2.2
Filters		
Type: Dual Media Constant Level with Influent Flow Splitting		
Number of Filters (2 Bays per Filter)	No.	6
Filter Bay Length	ft	40
Filter Bay Width	ft	16
Media Area per Filter	sq ft	1,280
Filtration Rate at Design Flow		
All Filters in Service	gpm/ft^2	3.6
One Filter Out of Service	gpm/ft^2	4.3
Filter Media		
Anthracite Coal		
Depth (L)	in	21
Effective Size (D)	mm	0.85-1.10
Uniformity Coefficient	Dim.	<1.5
Specific Gravity	Dim.	1.6-1.7
L/D Ratio	Dim.	485 - 630

Table 1.2 WFP Design Criteria (continued)

Description	Units	Capacity
Sand		
Depth (L)	in	10
Effective Size (D)	mm	0.43-0.50
Uniformity Coefficient	Dim.	<1.5
Specific Gravity	Dim.	>2.60
L/D Ratio	Dim.	510 - 590
Total L/D Ratio	Dim.	995-1,220
Gravel		
Depth (Total of 5 Layers)	in	18
Filter Backwash		
Underdrain Type: Concrete Teepee		
Design Backwash Rate at 20°C	gpm/ft^2	17.2
	in/min	28
	gpm	22,000
Filter Surface Wash		
Type: Fixed Grid		
Maximum Surface Wash Rate	gpm/ft^2	4.8
	in/min	7.7
	gpm	6,100
Volume to Washwater Basins per Backwash		
Filter Drawdown	gal	27,000
Backwash (17.2 gpm/ sq ft for 7 min)	gal	154,000
Surface Wash (4.8 gpm/sq ft for 4 min)	gal	25,000
Total Surface Water	gal	206,000
Backwash Storage Tank		
Capacity	gal	1,000,000
Diameter	ft	46
Height	ft	80
Washwater Basins		
Type: Reinforced Concrete Lined		
Number	No.	2
Volume per Basin	gal	228,500
Total Volume	gal	457,000

Table 1.2 WFP Design Criteria (continued)

Description	Units	Capacity
Waste Washwater Treatment System		
Type: Actiflo®		
Capacity	mgd	4.0
Coagulation Tank		
Number	No.	2
Volume	gal	2,000
Mixer		
Number	No.	2
Motor Size	Hp	1.0
Injection Tank		
Number	No.	2
Volume	gal	2,700
Mixer		
Number	No.	2
Motor Size	Hp	1.5
Maturation Tank		
Number	No.	2
Volume	gal	7,700
Mixer		
Number	No.	1
Motor Size	Hp	2.0
Settling Tank		
Number	No.	2
Volume	gal	7,800
Sand Pumps		
Type: Centrifugal, Slurry		
Number of Pumps	No.	3
Flow	gpm	55
Total Discharge Head	ft	70
Motor Size	hp	7.5
Hydrocyclones		
Number	No.	2
Capacity	gpm	55

Table 1.2 WFP Design Criteria (continued)

Description	Units	Capacity
Pump Station		
Type: Can Style Vertical Turbine		
Number of Pumps	No.	2
Flow	gpm	2,800
Total Discharge Head	ft	97
Motor Size	hp	100
Coagulant System		
Coagulant Tank		
Number	No.	1
Volume	gal	2,500
Metering Pumps		
Type: Diaphragm		
Number	No.	2
Polymer System		
Type: Dry Polymer		
Aging Tank		
Number	No.	1
Metering Pumps		
Type: Diaphragm		
Number	No.	3
Sludge Thickener		
Type: Circular, Gravity Type		
Diameter	ft	68
Water Depth	ft	11
Surface Area	ft^2	3,630
Capacity	gpm	1,815
Loading Rate	gpm/ft^2	0.5
Treated Water Clearwell		
Type: Buried Reinforced Concrete		
Length	ft	250
Width	ft	330
Height		
Minimum	ft	15
Maximum	ft	24
Volume	gal	13,000,000

Table 1.2 WFP Design Criteria (continued)

Description	Units	Capacity
Sludge Drying Beds		
Type: Concrete Lined, Rectangular, Sloped Sides		
Number	No.	4
Width (approx.)	ft	50
Length (approx.)	ft	200
Bottom Surface Area	ft^2	10,000
Total Surface Area	ft^2	40,000
Chlorine		
One Ton Cylinders	No.	24
Total Weight	lbs.	52,000
Liquid Polyaluminum Chloride (PACL)		
Bulk Tanks	No.	3
Volume per Tank	gal	13,300
Caustic Soda (Sodium Hydroxide)		
Bulk Tanks	No.	2
Volume per Tank	gal	14,000
Aqua Ammonia		
Bulk Tanks	No.	1
Volume per Tank	gal	10,000
Cationic Polymer (Bulk Solution)		
Bulk Tanks	No.	1
Volume per Tank	gal	7,000
Anionic Polymer (Bulk Solution)		
Totes	No.	2
Volume per Tote	gal	250
Chlorine Dioxide		
Number of Generators	No.	1
Capacity	PPD	500
Sodium Chlorite		
Bulk Tanks	No.	1
Volume per Tank	gal	7,000

BASE CASE COST DETERMINATION

In order to provide a benchmark that helps define the value added by each proposed Joint Facility Capital Improvement Project (see Section 8), the JFMP estimated the baseline cost for treating raw water at the WFP under current conditions. Because the cost and quality of the raw water supply (imported vs. local) varies significantly, the cost of treating raw water varies widely depending upon the assumed volume and raw water supply source. In order to establish base costs, and evaluate potential future improvements, the JFMP utilizes the demands projected in the UWMP and the estimated available local water supply volume of 5,700 AF/yr identified in the existing agreement. This percentage of local supply results in a 30/70 ratio, which is similar to long-term historic usage. It is assumed that the percentage of imported treated water used will be minimal. A maximum day demand of 30 mgd was also assumed based upon historic and projected trends. Table 1.3 presents the current supply cost for imported and local raw water supplies.

Table 1.3 FY 2012 Water Supply Cost

Raw Water Supply Option	Supply Cost per Acre Foot ($/AF)
Local Raw Water	$52
Imported Raw Water [1, 2]	$699

Notes
1. Cost includes transportation fee.
2. Cost does not include the imported supply fixed cost of $187/AF.

The quality and consistency of the local raw water supply is lower than imported raw water and is more challenging to treat. However, due to the relatively low supply cost, the overall cost of treated local water has historically been lower than the cost of treated imported raw water. The cost for imported treated water has historically been the highest treated water supply option.

Table 1.4 compares water qualities from local and imported raw water. As shown, imported CWA water is typically lower in alkalinity, TDS, TOC, and manganese, making it “Better” water quality for treatment.

The base case conditions with raw water quality and chemical treatment strategies are shown in Table 1.5. For all conditions except the 2007-2008 and 2009-2010 average conditions, WFP staff assisted in developing the typical chemical dosages for treatment. Chemical dosages for calendar years 2007-2008 and 2009-2010 were calculated by averaging the daily average doses for the given time period.

Treatment costs for base case conditions includes all components associated with operating the treatment plant. Treatment cost categories include water purchase, power, chemicals, labor (including benefits), administration, maintenance, residuals management, and revenue from the hydroelectric facility. Costs for labor, administration, and maintenance were supplied by SFID/SDWD storage. Cost categories are defined in Table 1.6.

Table 1.7 provides a breakdown of the estimated base case raw water treatment cost assuming a 30 percent local raw water supply to 70 percent imported raw water supply blend scenario. Though higher percentages of local water have been utilized in the past 3 years, the 30 percent local assumption is consistent with long-term historic trends and reflects anticipated future demands and local water supply availability as discussed in the following paragraphs. For comparison, Table 1.7 also presents costs assuming treatment of 100 percent imported raw supplies, the cost to purchase 100 percent imported treated supplies, as well as actual cost data from calendar years 2007-08 and 2009-10. All costs are in 2012 dollars.

Table 1.4 Characterization of the Three Source Waters for the WFP[1]

Constituent	Minimum	Maximum	Average
CWA Raw Water			
Alkalinity (mg/L $CaCO_3$)[6]	91	136	-
TDS (mg/L)[6]	405	987	-
TOC (mg/L)[3]	2.0	7.5	2.9
Manganese (mg/L)[4]	0.006	0.20	0.027
pH[4]	7.2	8.5	8.1
Turbidity (NTU)	-	- -	
Temperature (°C)	-	- -	
Dissolved Oxygen[4]	-	- -	
Lake Hodges			
Alkalinity (mg/L $CaCO_3$)[5]	105	234	190
TDS (mg/L)[5]	690	1,011	870
TOC (mg/L)[3]	8.3	22.0	11.9
Manganese (mg/L)[4]	0	5.0	0.21
pH[4]	7.6	8.9	8.3
Turbidity (NTU)[2]	1.2	5.4	3.3
Temperature (°C)[4]	12.8	27.9	19.8
Dissolved Oxygen[4]	0.3	12.9	5.6
San Dieguito Reservoir			
Alkalinity (mg/L $CaCO_3$)[2]	139	200	185
TDS (mg/L)[2]	780	1,038	890
TOC (mg/L)[3]	7.9	19.0	11.0
Manganese (mg/L)[4]	0.045	0.32	0.1
pH[4]	7.5	9.0	8.3
Turbidity (NTU)[2]	0.66	7.4	2.8
Temperature (^oC)[4]	11.7	27.9	20.3
Dissolved Oxygen[4]	7.5	9.0	8.3

Notes

1. Note that the water quality data presented in these tables are from various time periods and years. As such, a direct comparison between these data is not reliable. Raw water quality in Lake Hodges and, subsequently, SDR is heavily influenced by annual and seasonal climatic conditions.
2. June 2009 - December 2010 Data
3. 2002 - 2010 Data
4. March 2008 - February 2011 Data
5. March 2005 - December 2010 Data
6. Values supplied by SFID.

Table 1.5 Raw Water Quality and Chemical Treatment Strategies Used for the Individual Base Case Conditions

		Base Case Conditions Number				
Constituent	Units	5,700 AF/yr of Local Water[1,2]	100% Raw CWA[1]	100% CWA Treated[1]	2007-08 Average	2009-10 Average
Flows						
Local - SDR	mgd	5.1	0.0	0.0	6.4	8.3
Local - Lake Hodges	mgd	0.0	0.0	0.0	1.0	0.8
Imported	mgd	11.8	16.9	0.0	11.4	6.2
CWA Treated	mgd	0.0	0.0	16.9	0.4	0.3
% Influent Local	%	30%	0%	0%	41%	60%
Raw Water Quality						
Turbidity[2]	NTU	3-5	1-2	-	3.6	4.2
TOC[2]	mg/L	5-6	1.5-3.5	-	6.0	7.4
pH[2]	-	8.0-8.3	8.0-8.5	-	7.4	7.5
Temperature[3]	°C	20.4	20.4	-	20.1	20.7
Chemicals						
Chlorine Dioxide						
Plant Influent[4]	0.6	0.5	-	0.6	1.1	1.2
Chlorine						
Plant Influent[4]	7-8	3-4	-	7-8	5.5	6.3
Ammonia						
Plant Influent[4]	6:1	5:1	-	6:1	7:1	8:1
PACL						
Plant Influent[4]	20.4	15.0	-	20.4	42.9	49.8
Cationic Polymer						
Plant Influent[4]	1.0	0.5	-	1.0	1.4	2.0
Caustic						
Filtered Water[5]	8.0	8.0	-	8.0	8.0	8.1

Notes
1. Average annual demand of 19,124 AF/yr was used per the 2010 Urban Water Management Plan.
2. Equates to a 30/70 split of local/imported raw water supply blend.
3. Values provided by SFID Staff
4. All data was provided by SFID Staff except calendar years 2007-08 and 2009-10 Averages.
5. Historical values were used.
6. Assumes annual usage of 5,700 AFYof local water.

Table 1.6 Treatment Cost Category Description

Category	O&M Cost Breakdown Description
Water Purchase	FY 2012 water purchase costs for imported raw, imported treatment and local water sources.
Imported Supply Fixed Cost	Other water charges for FY 2012 based on information supplied by SFID/SDWD.
Power	Power costs estimated for the pump station, backwash pumps, base plant energy costs, plant electrical unit cost (from plant staff's current model), and solids management electrical costs (estimated for Actiflo™ and the centrifuge; these costs are zero since the processes are not being used).
Hydroelectric Revenue	Calculated hydroelectric facility revenue based on the CWA raw water used and an energy purchase rate of $0.10/kWhr.
Chemical	Calculated plant chemical cost based on dosage rates.
Residuals Management	Costs to perform contract solids management (6 times per year) and haul the manageable quantity of solids (based on the 500,000 lb/yr capacity of the sludge drying beds plus an extra 15% due to contract solids management for a total of 575,000 lb/yr) to the landfill. Remaining residuals are assumed discharged to SDR.
Labor	Labor costs tabulated for FY 2012 based on information supplied by SFID/SDWD.
Maintenance	Maintenance costs for the plant tabulated for FY 2012 based on information supplied by SFID/SDWD.
Storage	Costs to construct a 180 MG storage facility. Cost of $135 million is based on information supplied by SFID/SDWD.

CUSTOMIZED WFP PLANT PERFORMANCE AND COST MODEL

To develop base case costs as well as costs for other treatment scenarios, a model was constructed that incorporates various costs incurred at the plant (both fixed and non-fixed). In the model, pump electrical costs are calculated based on pumping rate and current unit electrical rates. Appendix A includes a summary of model assumptions, model inputs, and model outputs for each of the base case conditions. Output of the model provides both tabular and graphical outputs as shown in Table 1.6 and Figure 1.6. A detailed breakdown of the model output is shown in Appendix A.

Base Case Cost Determination Summary

Outputs of the model for each of the base case conditions are presented in Table 1.7. As shown, treatment costs vary widely based on both the source of the water, water quality, and chemical treatment strategies. Model results reveal the following:

1. Local water is the least expensive treated water because of the low raw water costs.

2. Treated imported water is the most expensive treated water.

3. Treatment of local water sources produces more residuals than imported water.

Table 1.7 Base Case Treatment Costs

		Base Case Conditions				
Treatment Cost Category	Units	5,700 AF/yr of Local Water[1,2]	100% Raw CWA[1]	100% CWA Treated[1]	2007-08 Average[3]	2009-10 Average[3]
Percent Local Water	%	30	0	0	39	58
Imported Supply Fixed Cost[4]	$/AF	506	699	924	454	326
Water Administration[4,5]	$/AF	187	187	259	167	205
Power	$/AF	70	43	2	75	93
Hydroelectric Revenue	$/AF	(19)	(27)	-	(16)	(11)
Chemical	$/AF	30	22	-	49	57
Residuals Management[6]	$/AF	12	11	-	10	13
Labor[7]	$/AF	95	95	-	85	104
Maintenance[4,8]	$/AF	72	72	-	64	79
Storage[8]	$/AF	-	-	458	-	-
TOTAL	$/AF	953	1,102	1,643	888	866

Notes
1. Average annual demand of 19,124 AF/yr was used per the 2010 Urban Water Management Plan.
2. Equates to a 30/70 split of local/imported raw water supply blend.
3. Costs based on average flow for the given calendar year range.
4. Cost calculated based on FY 2012 from information provided by SFID/SDWD.
5. 100% CWA Treated option includes Tier 2 treated water cost.
6. Assumes plant staff manages solids with existing drying beds and contract mechanical dewatering. Solids in excess of the drying bed capacity are discharged to SDR.
7. Labor costs for the 100% CWA Treated Option are assumed to be zero.
8. Includes the cost for a 180 million gallon storage facility ($135 million amortized for 30 years at 5%).

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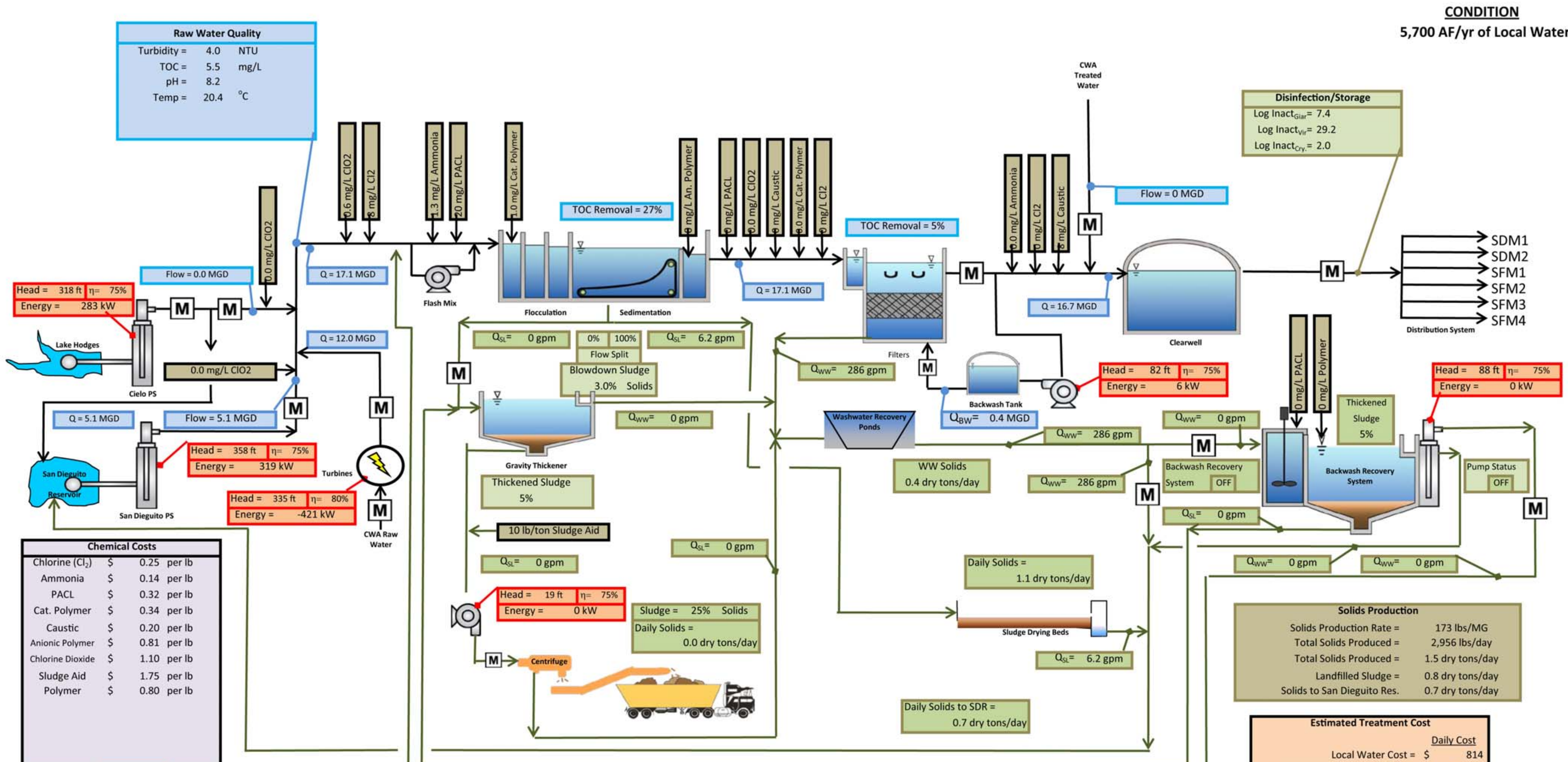

Chemical Feed Dosages - Pretreatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Cielo ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
SDR ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Influent ClO_2	0.6 mg/L	5.0 lbs/MG	$5.48/MG	$ 93.77
Cl_2	7.5 mg/L	62.6 lbs/MG	$15.64/MG	$ 267.40
Ammonia	1.3 mg/L	10.4 lbs/MG	$1.46/MG	$ 24.96
PACL	20.4 mg/L	170.1 lbs/MG	$54.44/MG	$ 930.98
Cat. Polymer	1.0 mg/L	8.3 lbs/MG	$2.84/MG	$ 48.49

Chemical Feed Dosages - Settled Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
PACL	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Caustic	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cat. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
An. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -

Chemical Feed Dosages - Finished Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
Ammonia	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Caustic	8.0 mg/L	67 lbs/MG	$13.34/MG	$ 228.06
Chemical Feed Dosages - Residuals Treatment				
Sludge Aid	10.0 lb/ton	0.0 lbs/MG	$0.00/MG	$ -
PACL	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Polymer	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -

Estimated Treatment Cost

	Daily Cost
Local Water Cost =	$ 814
Imported Raw Water Cost =	$ 35,563
CWA Treated Water Costs =	$ -
Chemical =	$ 1,594
Power =	$ 3,682
Hydroturbines Income =	$ (1,010)
Solids Disposal =	$ 612
Labor Costs =	$ 4,984
MAINT./CIP Costs =	$ 3,779
Total Treatment Cost =	**$ 50,018**
$/ac-ft =	**$ 953**

Figure 1.6 WFP Cost Model for 5,700 AF/yr Alternative (see Appendix A for additional information on the cost model)

As part of the JFMP, water quality challenges facing the WFP were evaluated with water treatment modifications identified that could be implemented at the plant to mitigate these challenges. This section presents the outcome of this evaluation.

OVERVIEW OF THE BADGER WATER FILTRATION PLANT

The WFP treats water from two primary supplies: 1) Imported water from Lake Skinner purchased through the CWA, and 2) local water stored in Lake Hodges and SDR. These two water supplies vary greatly in quality to the extent that their blend ratio tends to dictate the treatment practice at WFP. Specifically, compared to CWA water, the local water supply has three challenging water quality characteristics. The first is the presence of elevated levels of total organic carbon (TOC) resulting in formation of elevated levels of Disinfection By-Products (DBPs). The second is the presence of elevated levels of manganese, which could cause discoloration of drinking water. The third is prevalence of T&O chemicals, primarily Geosmin and 2-methylisoborneol (MIB), which impart an objectionable T&O in drinking water. These three water quality challenges very much define the treatment needs at the WFP. A more detailed discussion of these challenges is presented later in this section.

WFP is a 40 mgd conventional water treatment plant. Figure 2.1 shows a schematic process flow diagram of the main water treatment processes employed at the plant, as well as the types of treatment chemicals added. Local water is pumped to the plant through the SDPS, which draws water from SDR, or through the CPS, which draws water directly from Lake Hodges. In this mode, chlorine dioxide is added directly to Lake Hodges water before it either goes to SDR or is treated at WFP. After water from SDR blends with CWA water, SFID/SDWD adds chlorine dioxide (ClO_2), to the raw water as a preoxidant. The primary purpose of ClO_2 addition is to oxidize dissolved manganese to form manganese dioxide ($MnO_{2(s)}$), which is removed through sedimentation and filtration. The plant also adds PACL to meet its TOC removal requirements. SFID/SDWD relies on multiple disinfectants and short chlorine contact time to control formation of DBPs, primarily trihalomethanes (THMs) and haloacetic acids (HAAs).

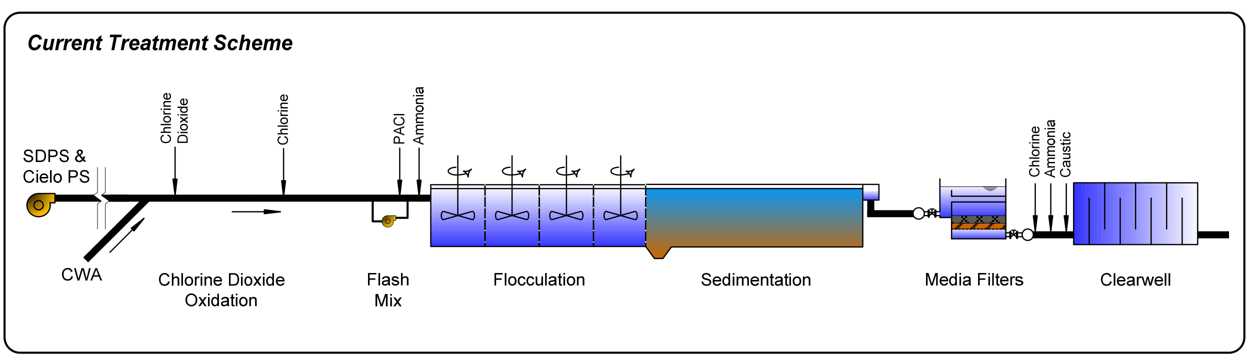

Figure 2.1 Current Treatment Scheme at the WFP

WATER USE PATTERN

Figure 2.2 shows a profile of the maximum and average daily flows for each month of the year between January 2007 and November 2010. The data show that the maximum daily demand has decreased over the last four years. In 2007 and 2008, the maximum daily flow was recorded at 32 mgd. However, in 2009, the maximum daily demand decreased to 27 mgd, and then to 24 mgd in 2010. This is predominantly due to water conservation measures implemented by SFID/SDWD during the last several years. With the wet 2011 winter and spring seasons, the maximum day demand in 2011 is expected to be even lower than 24 mgd.

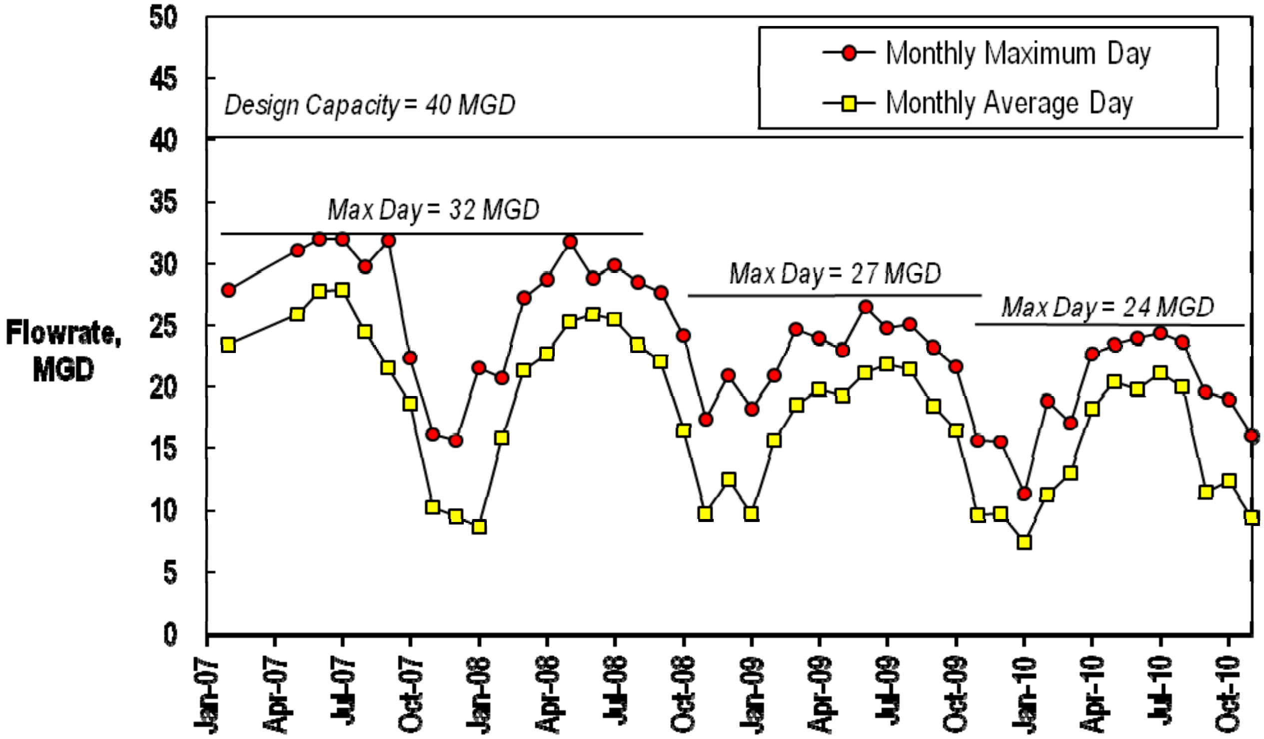

Figure 2.2 Monthly Average and Maximum Daily Flow thru the WFP (2007 – 2010)

Daily flow variation is common at the WFP because of the lack of storage in the distribution system. As a result, the distribution system depends on the clearwell for storage. This requires plant staff to frequently change plant flows to react to the distribution system diurnal patterns. The change in plant flow rate can be as large as 14 mgd from morning until evening.

With the increase in the cost of imported water supply (i.e., CWA water), SFID/SDWD has made a concerted effort to maximize the use of its local water supply. Figure 2.3 shows a profile of the percent local water supply (i.e., SDR and Lake Hodges) treated through the WFP from 2007 through 2010. In 2007, the local water supply represented approximately one third of the water treated through the plant. By 2010, this proportion doubled to approximately 2/3rd of the water treated. It is also noted that the vast majority of the local supply used is drawn from SDR and not Lake Hodges. During the last three years, Lake Hodges water represented only a small fraction of the local supply used with the exception of February 2008. SFID/SDWD desires to continue maximizing the use of its local water supply to the extent possible. This decision has a significant impact on future planning for treatment modifications at the WFP because of the water quality challenges experienced when treating SDR or Lake Hodges water.

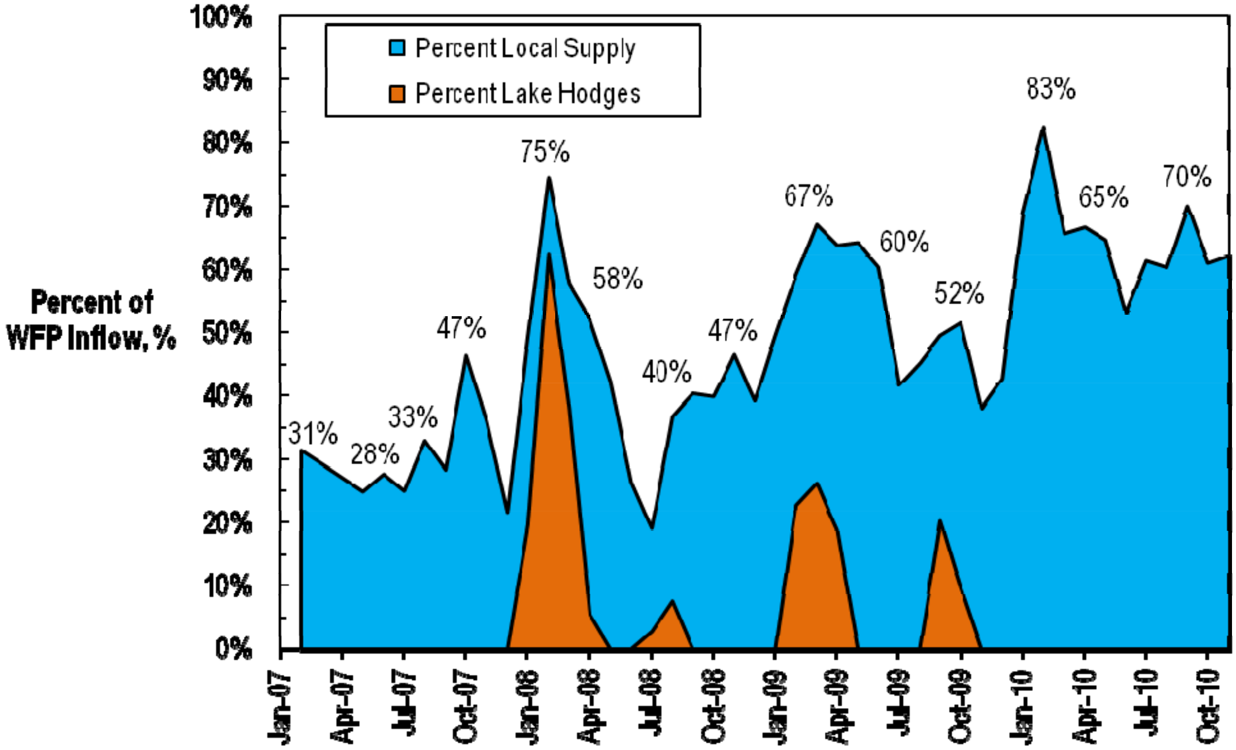

Figure 2.3 Percent Local Water Supply in WFP Influent (2007 – 2010)

CURRENT WATER QUALITY CHALLENGES

Primary and secondary regulatory limits as well as customer acceptance of the treated water encompass the water quality challenges facing SFID/SDWD. All are discussed in the following sections.

Challenging Water Quality Parameters with Primary Regulatory Limits

The operation of the WFP must meet a number of rules and regulations, and must produce water that complies with a number of water quality standards. Of most importance are the parameters that have primary regulatory limits because their purpose is the protection of public health. The WFP currently complies with all existing drinking water quality standards. The purpose of the analysis presented herein is to identify regulatory requirements that pose a challenge to SFID/SDWD as it looks into the future. The two primary regulatory requirements that stand out are those for disinfection and DBPs. The discussion will begin with disinfection requirements, specifically how the WFP is currently meeting these requirements, and whether compliance could be more challenged as the plant makes any modifications to comply with the DBP regulatory requirements. The discussion will then shift to the current status of compliance with the DBP regulations and the projected compliance with the upcoming modification to these regulations.

Disinfection

As a conventional filtration plant, the pretreatment and filtration processes are credited with 2.5 log *Giardia* removal. The remaining disinfection credit is achieved by chemical disinfection. At the WFP, SFID/SDWD utilizes the disinfection credit achieved with chlorine in the plant raw water line, as short as that may be, and with chloramine through the entire treatment plant and clearwell. For most surface water plants, the total *Giardia* inactivation requirement is 3.0 logs. However, for the WFP, the requirement is increased to 4.0 logs due to the poor bacterial quality of the local water supply. Figure 2.4 shows a plot of the coliform bacterial counts in all three water sources. While the coliform levels in CWA water seldom exceed 1,000 counts/100mL, the coliform counts in Lake Hodges water or SDR water are almost always above 1,000 counts/100mL, and many times above 10,000 counts/100mL. Figure 2.5 shows a frequency distribution plot of the coliform counts in the three water sources measured over the last four years. The plot shows that 80 percent to 90 percent of water samples collected from SDR and Lake Hodges contained more than 1,000 coliform bacteria per 100 mL of water, and approximately 20 percent of the samples contained more than 10,000 coliforms/100mL. Due to these elevated coliform levels, CDPH set a high 4.0-log *Giardia* removal/inactivation goal for the WFP. With 2.5-log credit given to physical removal through the treatment plant, the disinfection process must still achieve 1.5-log inactivation of *Giardia* cysts. The *Giardia* and virus inactivation requirements are currently met with a combination of the short chlorine contact time in the raw water pipeline, and chloramine through the entire plant from the flash mix through the clearwell and a section of the 54-inch distribution piping. In addition, SFID/SDWD is currently installing baffles in the clearwell to improve its hydraulic efficiency and increase its T_{10}/HRT ratio. This will provide for a higher inactivation credit through the clearwell.

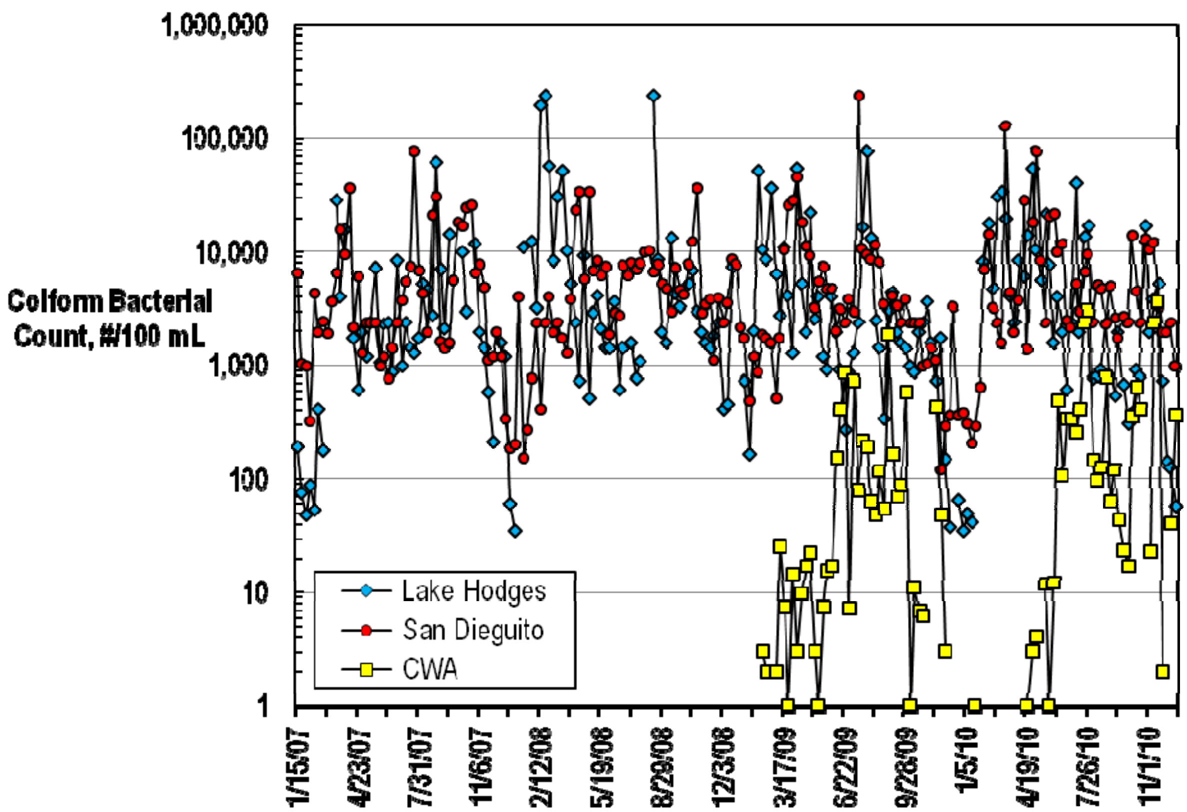

Figure 2.4 Coliform Bacterial Counts in SDR, Lake Hodges, and CWA Waters (2007 – 2010)

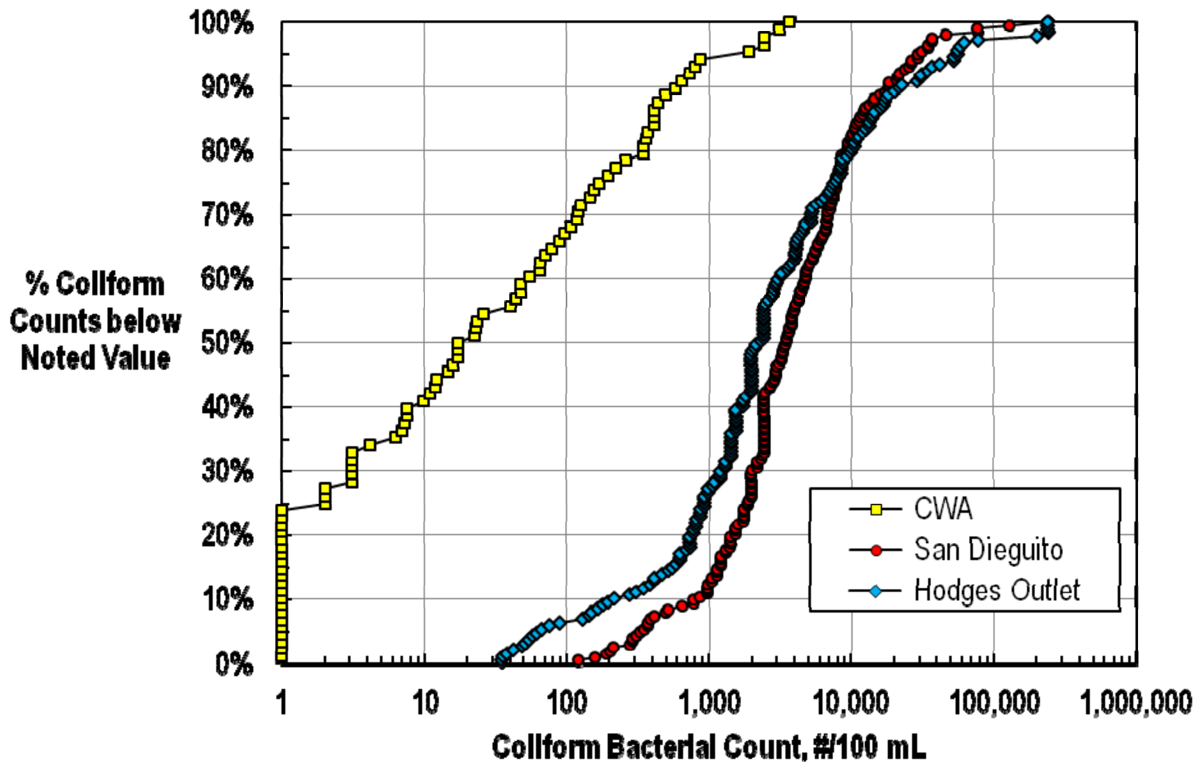

Figure 2.5 Frequency Distribution of Coliform Bacterial Counts in SDR, Lake Hodges, and CWA Waters (2007 – 2010)

Disinfection By-Products

The DBPs of concern are those resulting from the reaction of chlorine with the natural organic matter (NOM) present in the WFP water sources. These are primarily total trihalomethanes (TTHMs) and HAAs. Figure 2.6 presents a plot of the SFID system-wide Running Annual Average (RAA) of TTHMs and HAA5 levels measured under the Stage 1 Disinfectants/Disinfection By-Product (D/DBP) Rule between 2006 and 2010. Similar results are reported for the SDWD s ystem. The HAA5 lev els formed in the dis tribution system have been quite low. Compared to the m aximum contaminant level (MCL) of 6 0 micrograms per liter (µg/L), HAA5 levels ranged from 14 to 26 µg/L. TTHM levels have also been below the TTHM MCL of 80 µg/L. However, the TTHM level has been increasing over the last five years such that the compliance level during the last quarter of 2010 was as high as 69 µg/L. Figure 2.7 shows a profile of the Locational Running Annual Average (LRAA) at each of the SFID Stage 1 D/DBP Rule monitoring site over the same period of 2006 to 2010. The plots also show that the levels of THMs in all the distribution system sites increased. Similar results are reported for the SDWD system.

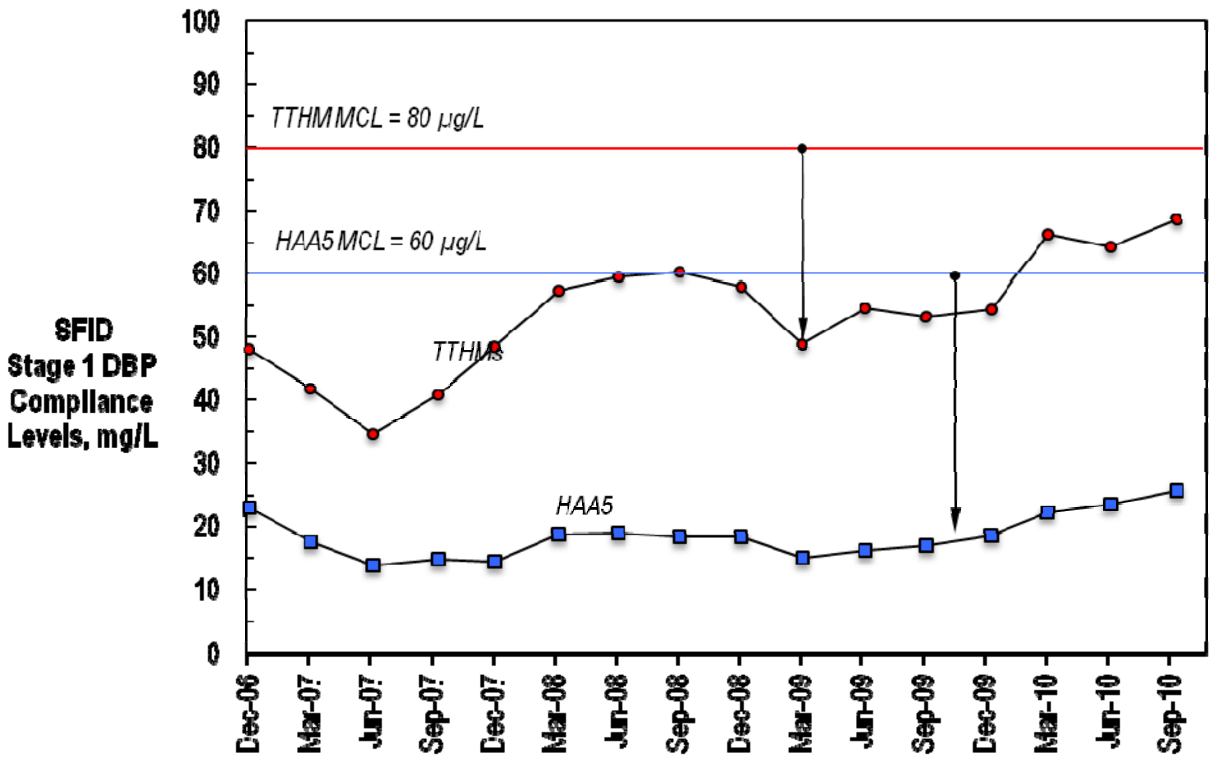

Figure 2.6 SFID System-wide Running Annual Average of TTHM and HAA5 Levels Measured at Stage 1 D/DBP Monitoring Sites Between 2006 to 2010 (Results for SDWD are reported to be similar)

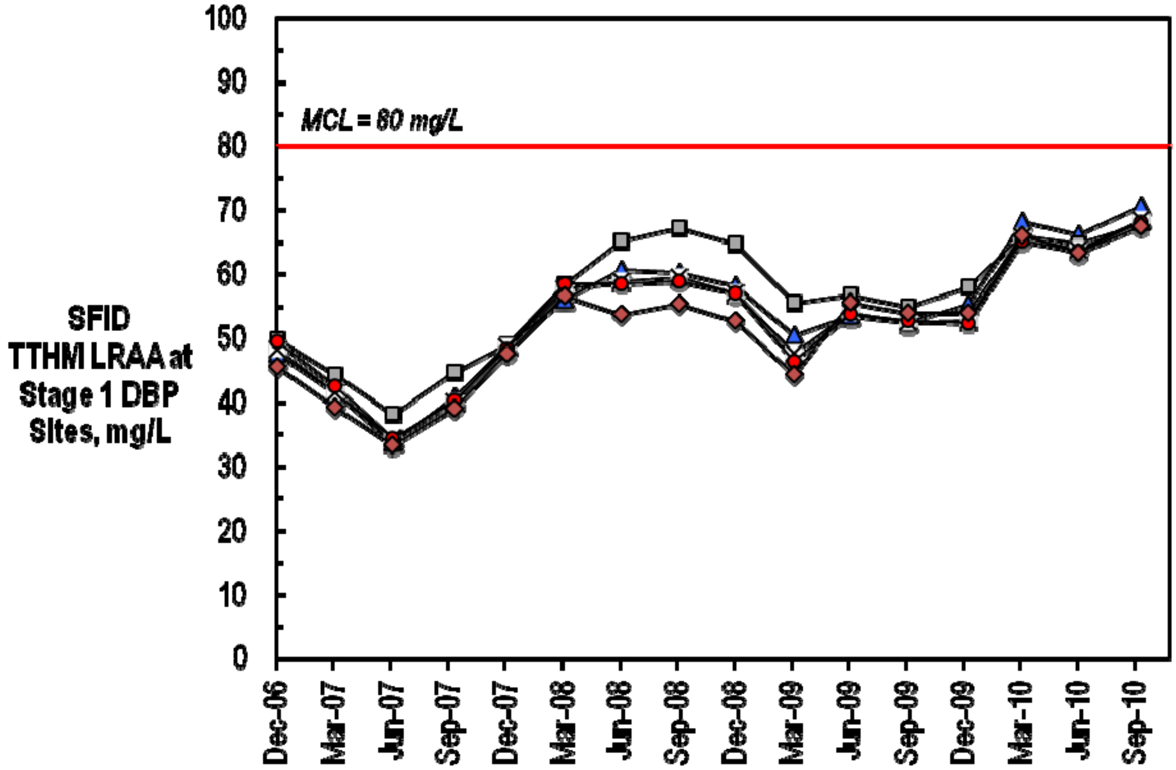

Figure 2.7 SFID Locational Running Annual Average of THM Levels Measured at Stage 1 D/DBP Monitoring Sites between 2006 to 2010 (Results for SDWD are reported to be similar)

A comparison of the water use pattern in Figure 2.3 and the TTHM levels depicted in Figures 2.6 and 2.7 shows that the increase in THM formation paralleled the increase in local water use at the plant. Figure 2.8 shows a plot of the TOC levels in the WFP's three water sources and the influent blend water between January 2006 and December 2010. While the TOC levels in SDR water and Lake Hodges water ranged from 8.8 to 15 milligrams per liter (mg/L), the TOC level in CWA water was substantially lower, ranging only from 2.0 to 3.5 mg/L. In general, TOC in SDR is about 9 percent lower than Lake Hodges. However, as the use of local water increased, the influent water to the treatment plant increased from a low of 5 mg/L in 2006 to approximately 7.5 mg/L in 2010. This 50 percent increase in TOC concentration entering the treatment plant explains the rise in TTHM levels measured during the same period.

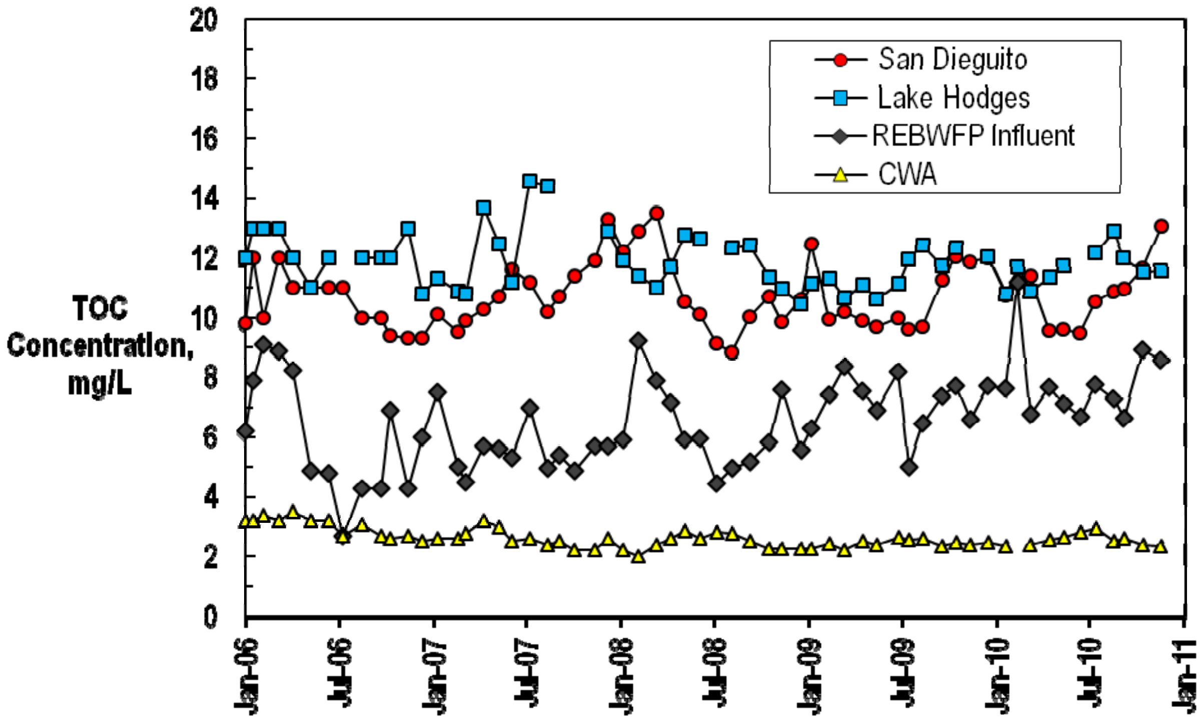

Figure 2.8 TOC Levels in SDR, Lake Hodges, CWA, and WFP Influent (2006 – 2010)

With the promulgation of the Stage 2 D/DBP Rule on April 1, 2012, SFID/SDWD will need to comply with the 80 µg/L THM MCL as an LRAA at predetermined sites, which will only have THM levels that are equal to or higher than the highest THM levels measured at the current Stage 1 D/DBP Rule monitoring sites. Using the IDSE data collected by SFID in 2008 and 2009, a comparison was made between the THM level at the Stage 1 maximum-THM monitoring site and the THM level at the Stage 2 maximum-THM site. The results, which are presented in Figure 2.9, show that the LRAA value under the Stage 2 D/DBP Rule may be 15 percent higher than that measured at the highest THM location under the current Stage 1 D/DBP Rule. A similar analysis was conducted on the THM levels measured by SDWD during the IDSE period of 2008 and 2009. The results showed that the Stage 2 D/DBP levels are also about 15 percent higher than the SDWD Stage 1 D/DBP levels.

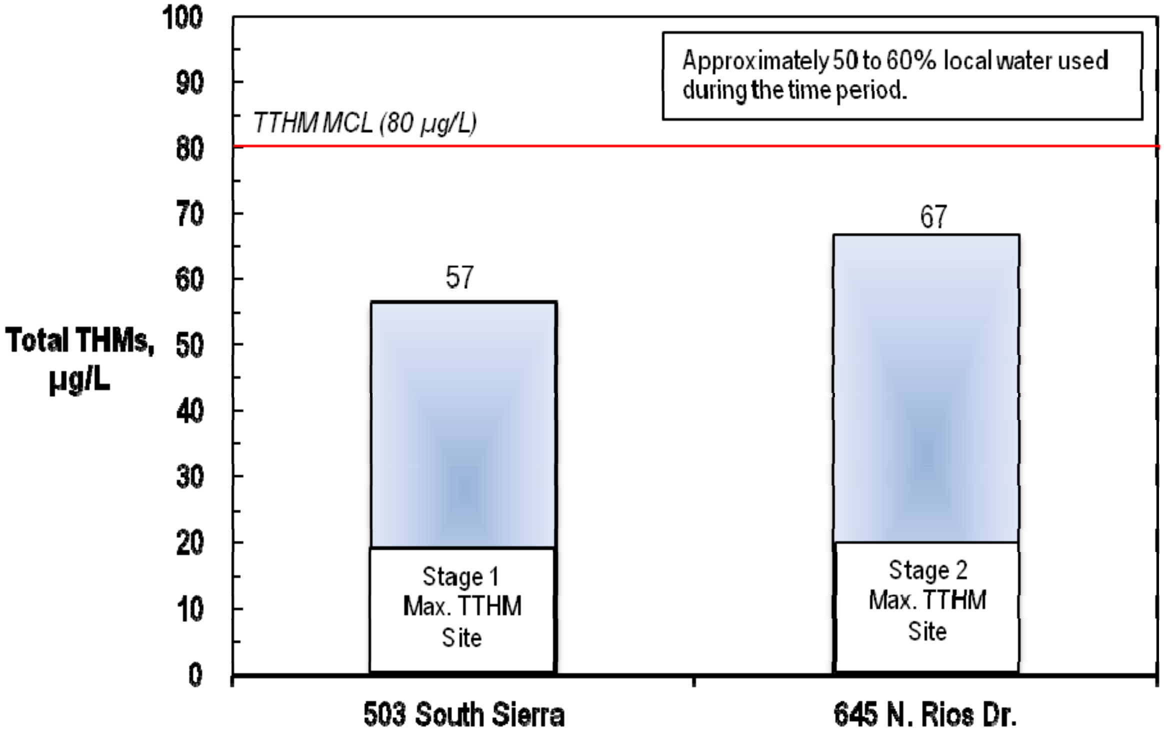

Figure 2.9 Comparison of TTHM Levels between Maximum Stage 1 D/DBP Location and Maximum Stage 2 D/DBP Location for SFID between December 2008 through June 2009 (Similar results experienced by SDWD)

Diligence and creativity by plant staff with their treatment approaches coupled with the ability to blend local and imported raw water supplies have resulted in r egulatory compliance. The a bove analysis suggests that SFID/SDWD is set to experience an increase in its THM compliance levels due to the promulgation of the Stage 2 D/DBP Rule and increased use of local water supplies. SFID/SDWD needs to implement countermeasures aimed at reducing the formation of DBPs, primarily TTHMs, in their distribution systems.

Challenging Water Quality Parameters with Secondary Regulatory Limits

While the earlier discussion focused on the health-based regulatory requirements, there are numerous aesthetic water quality challenges facing the WFP. The three parameters discussed herein are manganese, T&O, and total dissolved solids (TDS).

Manganese

The secondary MCL for m anganese is 0. 05 mg/L. Manganese precipitation causes strong discoloration of surfaces in contact with water including fixtures, sinks, and others. In fact, experience shows that manganese levels should be below 0.03 mg/L to prevent the formation of noticeable discoloration of household fixtures.

Figure 2.10 shows a profile of manganese levels in SFID/SDWD's three water sources between 2008 and 2010. Figure 2.11 shows a frequency distribution plot of the data to statistical distribution of the values. These two figures show that the manganese levels in both Lake Hodges and SDR are well above the secondary MCL, with some values higher than 10 times the MCL (0.5 mg/L). On the other hand, the manganese levels in CWA water are predominantly below the desired maximum of 0.03 mg/L.

With increased reliance on local water supplies, it will be imperative that WFP includes treatment processes that reliably achieve high removals of manganese. This is currently achieved with the addition of chlorine dioxide to the raw water.

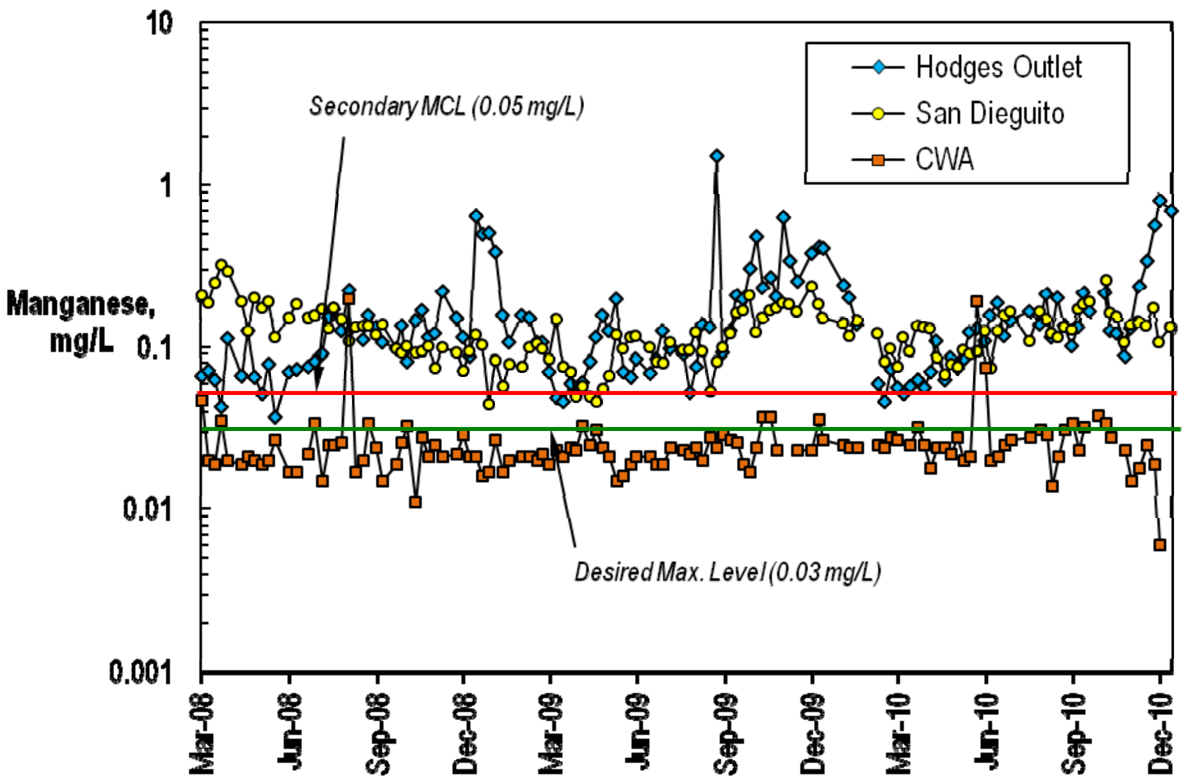

Figure 2.10 Manganese Levels in SDR, Lake Hodges, and CWA Waters (2008 – 2010)

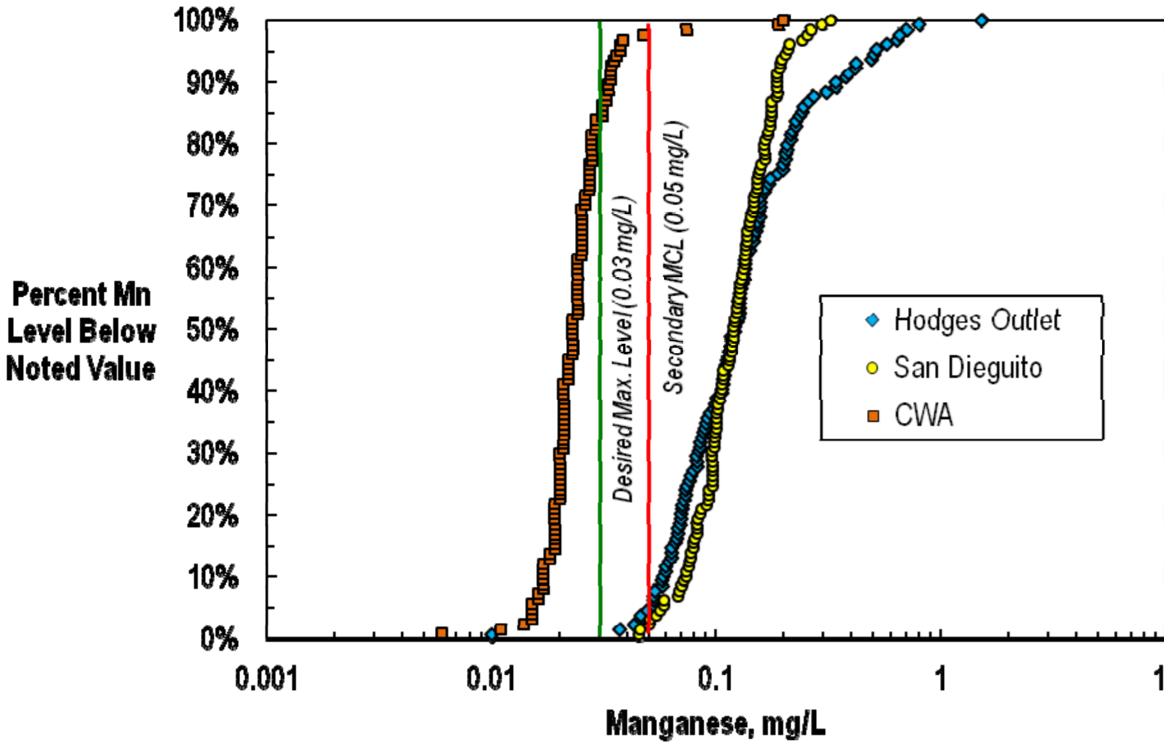

Figure 2.11 Frequency Distribution of Manganese Levels in SDR, Lake Hodges, and CWA Waters (2008 – 2010)

Taste-and-Odor

Many naturally occurring chemicals impart objectionable T&O into drinking water supplies. The two most prominent chemicals are Geosmin and MIB, which are produced by certain types of algae. Depending on an individual person's palate, Geosmin and MIB are noticeable at levels between 5 and 10 nano-grams per liter (ng/L). Both MIB and Geosmin are commonly present in WFP's water supplies. However, the analysis presented in this section focuses on MIB because it is more prevalent than Geosmin in the three sources, and because it is more difficult to remove from water than Geosmin.

Figure 2.12 shows a timeline profile of MIB levels in the three water sources from 2006 through 2010. A large spike in MIB levels was measured in the local water supplies during the summer and fall of 2008 with MIB levels reaching 750 ng/L in mid July. Figure 2.13 shows a frequency distribution plot of the MIB levels in all three source waters during the last five years. If the desired maximum treated water MIB level is set at 10 ng/L, the plots show that only 10 percent of the samples collected from CWA water were above the target level, while 25 percent of the samples collected from both Lake Hodges and SDR were above the target level. It is interesting to note that there appears to be no difference in MIB levels between SDR and Lake Hodges.

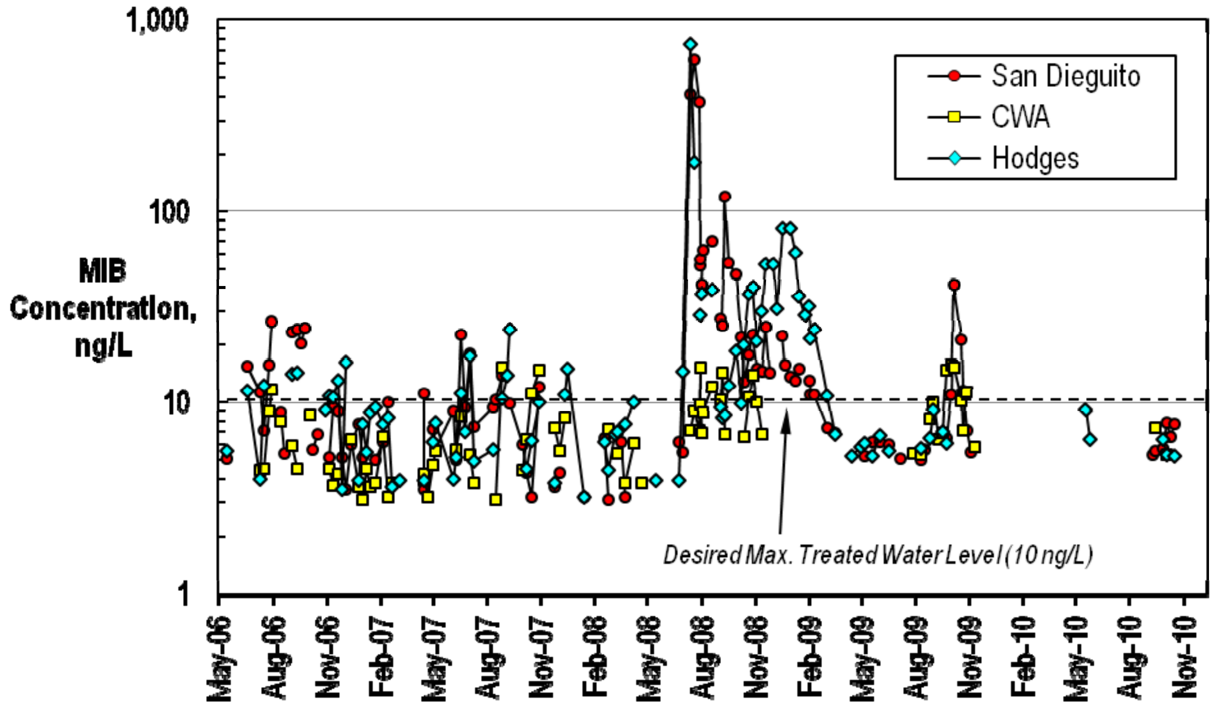

Figure 2.12 MIB Levels in SDR, Lake Hodges, and CWA Waters (2006 – 2010)

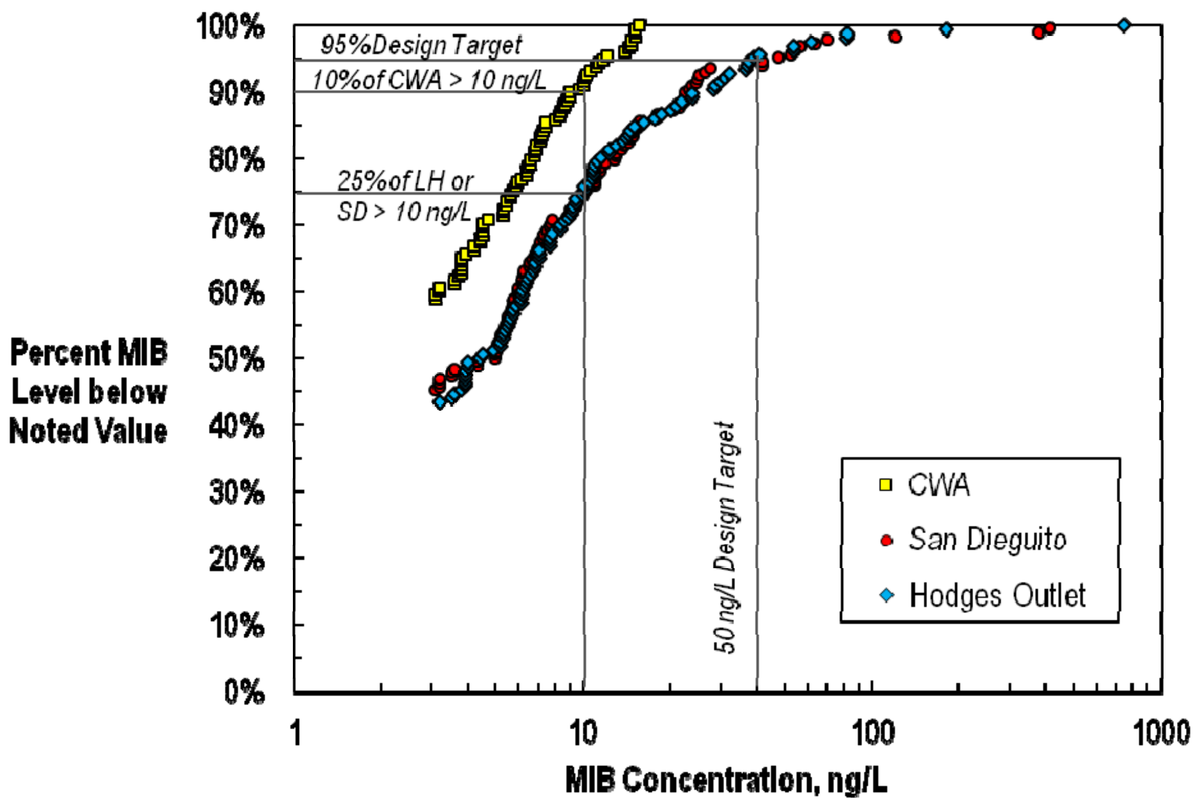

Figure 2.13 Occurrence Frequency of MIB in SDR, Lake Hodges, and CWA Waters (2006 – 2010)

Unfortunately, it is impossible to predict the timing or severity of T&O events in a water source. This makes it virtually impossible to develop a design strategy that completely protects against all possible scenarios. A common approach is to use a certain percentile level of historical occurrence data to set the MIB design target levels. For example, Figure 2.13 shows that the 95th percentile MIB level in the local water supplies during the last five years was 50 ng/L. If SFID/SDWD desires to achieve target MIB treatment 95 percent of the time, then the treatment systems at the plant should be designed and operated to reduce MIB from 50 ng/L to below the maximum desired treated water level of 10 ng/L. This represents an 80 percent reduction in MIB levels. Currently, there is not a treatment unit process at the WFP capable of achieving this performance goal.

Salinity

In addition to elevated levels of manganese and T&O chemicals, the water supplies are quite high in TDS. California has a tiered secondary MCL for TDS. The recommended MCL is 500 mg/L, with an upper MCL of 1,000 mg/L. Elevated TDS, or salinity, levels in drinking water cause numerous aesthetic problems including objectionable taste (by some consumers), as well as staining of glassware and fixtures, and clogging of irrigation lines.

Figure 2.14 shows a timeline profile of TDS in SDR, Lake Hodges, and Lake Skinner water (representing CWA water) between 2004 and 2010. Figure 2.15 shows a frequency distribution plot of the same values. For the period evaluated, the TDS level in CWA water hovered around the recommended MCL of 500 mg/L. However, the TDS level in the local water supplies was always above the recommended MCL of 500 mg/L, and even exceeded the upper MCL of 1,000 mg/L in SDR during one month. The plot presented in Figure 2.15 essentially shows that there is no difference in TDS levels between SDR and Lake Hodges. For the WFP, any blend of the three water sources will contain TDS levels above the recommended secondary MCL of 500 mg/L, and increased reliance on local water supplies will only increase the TDS levels in the treated water from the plant.

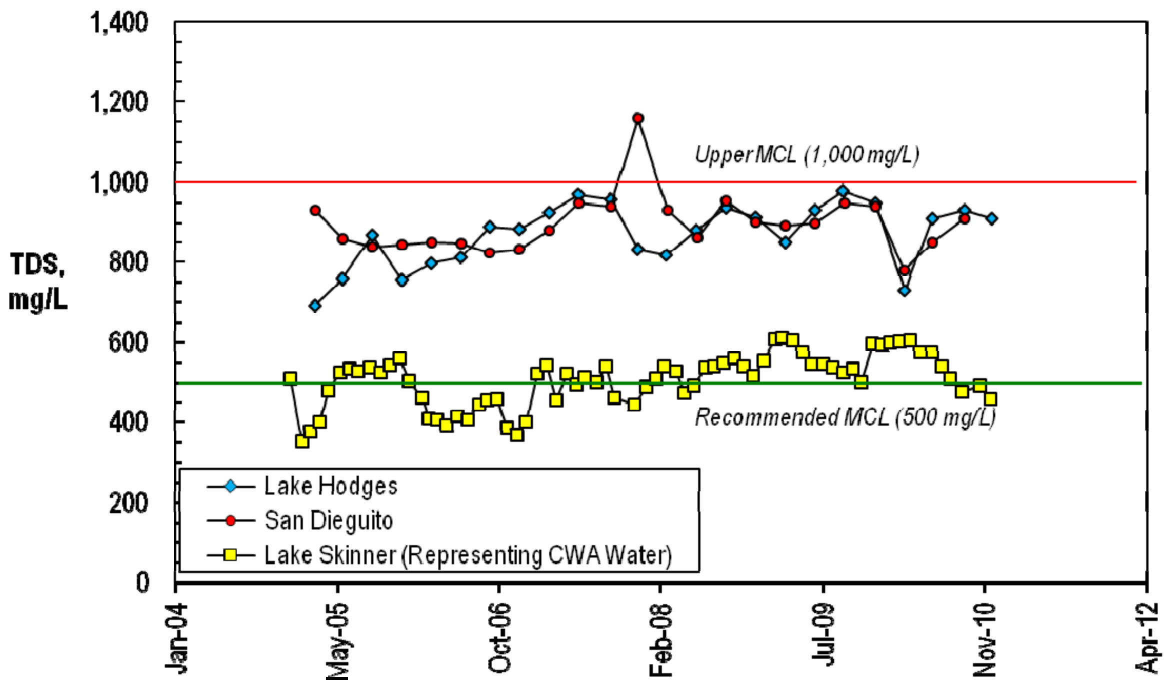

Figure 2.14 TDS Levels in SDR, Lake Hodges, and CWA Waters (2005 – 2010)

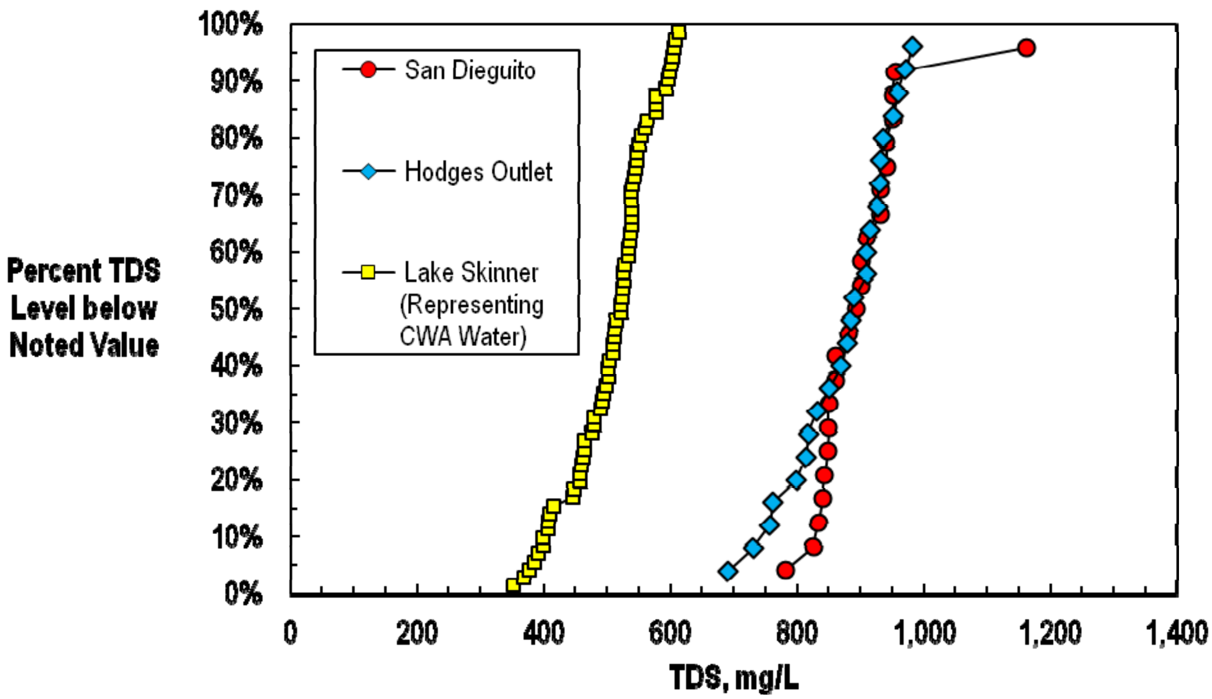

Figure 2.15 Occurrence Frequency of TDS in SDR, Lake Hodges, and CWA Waters (2006 – 2010)

Other Nuisance Constituents in Lake Hodges Water

Low dissolved oxygen (DO) and hydrogen sulfide are sometimes prevalent in Lake Hodges water. Plant staff currently manages these problematic parameters with the best available tools at their disposal - aeration within SDR, oxidation with chlorine dioxide, and dilution with imported water. These two challenging constituents illustrate the difficulty in treating Lake Hodges water directly at WFP during periods of poor water quality.

POTENTIAL CHANGES IN RAW WATER QUALITY

Other than its operation of SDR, SFID/SDWD has little to no control over the operation of its raw water sources. Raw CWA water is drawn from Lake Skinner, which is controlled by the Metropolitan Water District of Southern California. Operation of Lake Hodges is controlled by San Diego County Water Authority and the City of San Diego. This section evaluates potential changes in the operation of Lake Skinner and Lake Hodges that may impact the qualities of CWA and Lake Hodges waters received at the WFP.

Lake Skinner receives a blend of Colorado River Water (CRW) and State Water Project (SWP) water. The two water sources have very different qualities. SWP water typically contains higher TOC and bromide levels compared to CRW. However, CRW contains higher levels of TDS compared to SWP water. Therefore, depending on the blend ratio between SWP water and CRW in Lake Skinner, the quality of CWA may change significantly. Figure 2.16 shows a profile of the SWP water proportion in Lake Skinner over the last 10 years. Metropolitan manages the blends in its various lakes primarily based on relative availabilities of its two sources. During 2008 and 2009 when water withdrawal from the Sacramento-San Joaquin Delta was reduced due to legal challenges, as well as reduction in SWP allocations by the California Department of Water Resources (DWR), the proportion of SWP water in Lake Skinner gradually declined until it reached less than 5 percent by January 2010. However, with the wet 2010 and 2011 seasons, DWR has increased the SWP allocations to 80 percent and Metropolitan has been importing a significant amount of SWP water into all of its reservoirs, including Lake Skinner. As of April 2011, SWP water represented 40 percent of the water inflow into Lake Skinner.

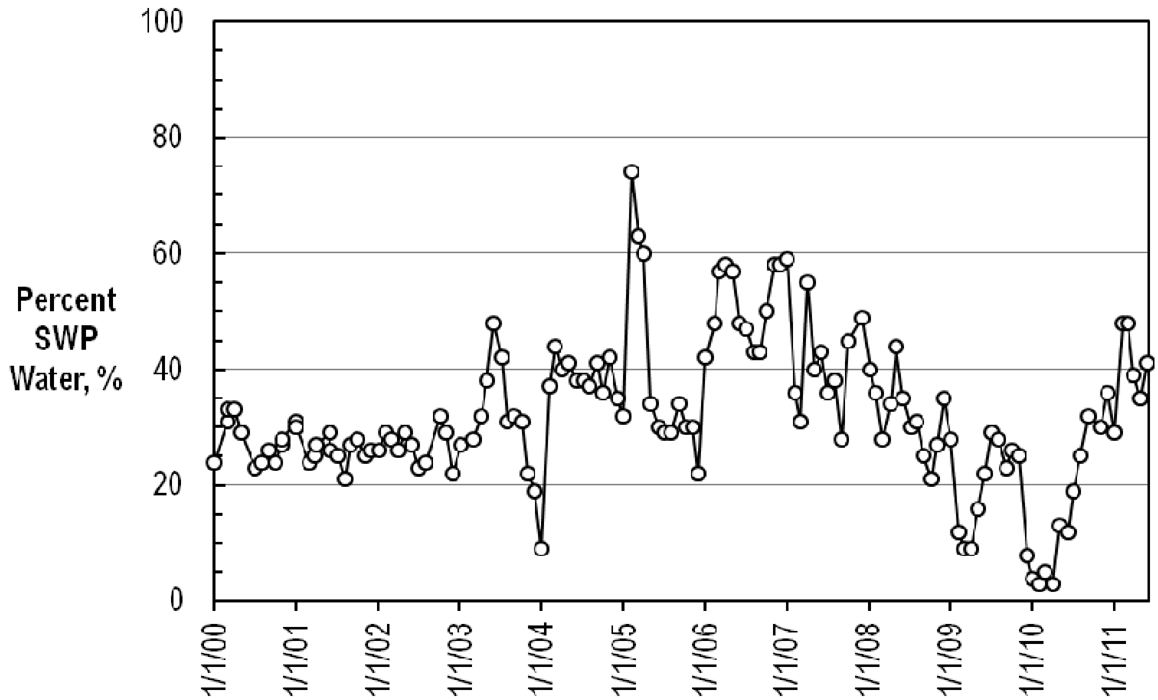

Figure 2.16 Percent Blend of State Water Project (SWP) Water into Lake Skinner (2000 – 2011)

The most significant change to the operation of Lake Hodges is the upcoming power generation project in which about 900 AF of water per day will be pumped from Lake Hodges to Olivenhain Reservoir during off-peak hours, and then released from Olivenhain Reservoir back into Lake Hodges through a power plant during peak power demands. The quality of water in Olivenhain Reservoir is similar to that of CWA water. Therefore, the water transfer project will essentially blend Lake Hodges water with CWA water. This action could have advantages with respect to treatment of the local water supply.

Plant staff has historically utilized blending of CWA and local water sources as an effective treatment tool. DBP compliance and management of naturally occurring problematic parameters (low dissolved oxygen, hydrogen sulfide, manganese) are partially addressed by blending with the imported supply. Potential positive impacts of the water transfer project on the treatment challenges previously discussed in this section are summarized in Table 2.1.

Table 2.1 Potential Positive Impacts of the Water Transfer Project on Treatment Challenges at the WFP

Treatment Challenges	Positives	Comments
Disinfection	Lower coliform bacterial counts in CWA water	Current blending strategy has not been enough to eliminate additional 1-log *Giardia* disinfection requirement
Disinfection By-product Formation	Lower TOC in CWA water; water transfer could lower raw water TOC levels to the 4 to 6 mg/L range; reduced levels of DBPs may occur; current blending strategy at the plant has been a component of an effective compliance tool.	Reduced raw water TOC does not always translate to significantly lower coagulant dosages and DBPs; increased percentage of SWP water could increase brominated DBPs (and overall DBPs)
Total Dissolved Solids	Imported water TDS levels about 50 percent lower than local supplies; in wet years, more SWP water could reduce imported TDS levels even lower	Anticipated TDS level to continue to hover around and/or exceed recommended secondary limit of 500 mg/L
Taste and Odor	CWA has historically lower MIB levels than local waters	Blending not usually a reliable treatment tool for T&O control; SWP water can have elevated MIB episodes
Manganese	CWA has historically lower manganese levels than local waters; blending an effective tool in reducing manganese levels (as demonstrated by plant staff)	Manganese in Lake Hodges an order of magnitude higher than CWA water; blending alone will not alleviate need for a reliable unit treatment process for manganese removal at WFP

POTENTIAL CHANGES IN REGULATORY REQUIREMENTS

The most immediate change in water quality regulations is the implementation of the Stage 2 D/DBP Rule on April 1, 2012. The potential impact of this regulation on the operation and performance of the WFP was discussed earlier. One important potential regulatory development is the possibility for a new future MCL for nitrosamines. These are a class of chemicals with significant public health concerns, and one of them, nitroso-di-methyl amine (NDMA), has been shown to be a by-product of chloramine use in water treatment.

There is a California action level (AL) of 10 ng/L for NDMA in drinking water. There is no information on the levels of nitrosamines in WFP effluent or SFID/SDWD's distribution system. However, the high organic content of Lake Hodges and SDR, as well as the current treatment practice at WFP suggests that there could be significant formation of NDMA – and possibly other nitrosamines – at the WFP. Specifically, NDMA has been shown to form when chloramine is contacted with significant levels of polyDADMAC cationic polymers. The majority of the cationic polymer added for proper coagulation and flocculation is typically removed through sedimentation and filtration. For those plants that form chloramine downstream of filtration, there is a strong separation between the cationic polymer and the formed chloramine. However, chloramine is formed at the flash mix of the WFP, and it is contacted with the cationic polymer through flocculation, sedimentation, and filtration. Plants utilizing chloramine contact through flocculation and sedimentation have reported NDMA formation above the AL of 10 ng/L. It is likely that the WFP may experience the same formation.

The USEPA is currently considering regulating NDMA and other nitrosamines in drinking water. It is completely uncertain at this time what the MCLs will be. However, there is a good possibility that they may be set below the NDMA AL of 10 ng/L because the 10^{-6} cancer risk level of NDMA is 0.7 ng/L. It would be important for SFID/SDWD to evaluate the formation of NDMA and other nitrosamines at the WFP and identify mitigation measures that could be implemented to reduce it.

A profile of NDMA and other nitrosamine levels through the treatment plant should be performed to understand the severity of this issue. Plant staff has already undertaken measures at the plant to address this potential future regulatory hurdle. These measures include future relocation of the ammonia injection point downstream of sedimentation as well as baffling the clearwell to improve its hydraulic efficiency.

CURRENT PERFORMANCE OF WFP

This section analyzes how the WFP meets its regulatory requirements and water quality goals with the objective of identifying potential areas for improvements.

Disinfection By-Products Control

Figure 2.17 shows a timeline profile of TOC removal with enhanced coagulation and filtration at the WFP. Using PACL at an average dose of 46 mg/L, approximately 30 to 35 percent TOC removal is achieved. These removals are driven by the Enhanced Coagulation (EC) requirements of the Stage 1 D/DBP Rule.

TOC removal is also believed to help reduce the formation of DBPs in the plant effluent and distribution system. However, a close evaluation of special data collected by SFID/SDWD shows that DBP formation at the WFP is virtually un-influenced by TOC removal with enhanced coagulation. These data, which were collected in 2009, are presented in Figures 2.18 and 2.19. Figure 2.18 shows the TOC levels in the plant influent and filtered water measured each month. The data show that enhanced coagulation removed between 27 percent and 39 percent of the TOC present in the water. However, Figure 2.19 shows the THM levels measured at the plant influent (i.e., flash mix) and the plant effluent (clearwell). These data show that, for all practical purposes, the entire amount of THMs measured at the plant effluent had formed during the short free chlorine contact time upstream of ammonia addition at the flash mix. These data suggest that the current chlorination/chloramination practice at the WFP is not taking advantage of the TOC removal achieved with enhanced coagulation and that the THM levels are formed under the highest-formation potential levels – i.e., those of the raw water quality. Unfortunately, the free chlorine contact time at the plant influent is critical to meeting the *Giardia* disinfection requirements, and any changes to the free chlorine contact time jeopardize the ability to meet these requirements.

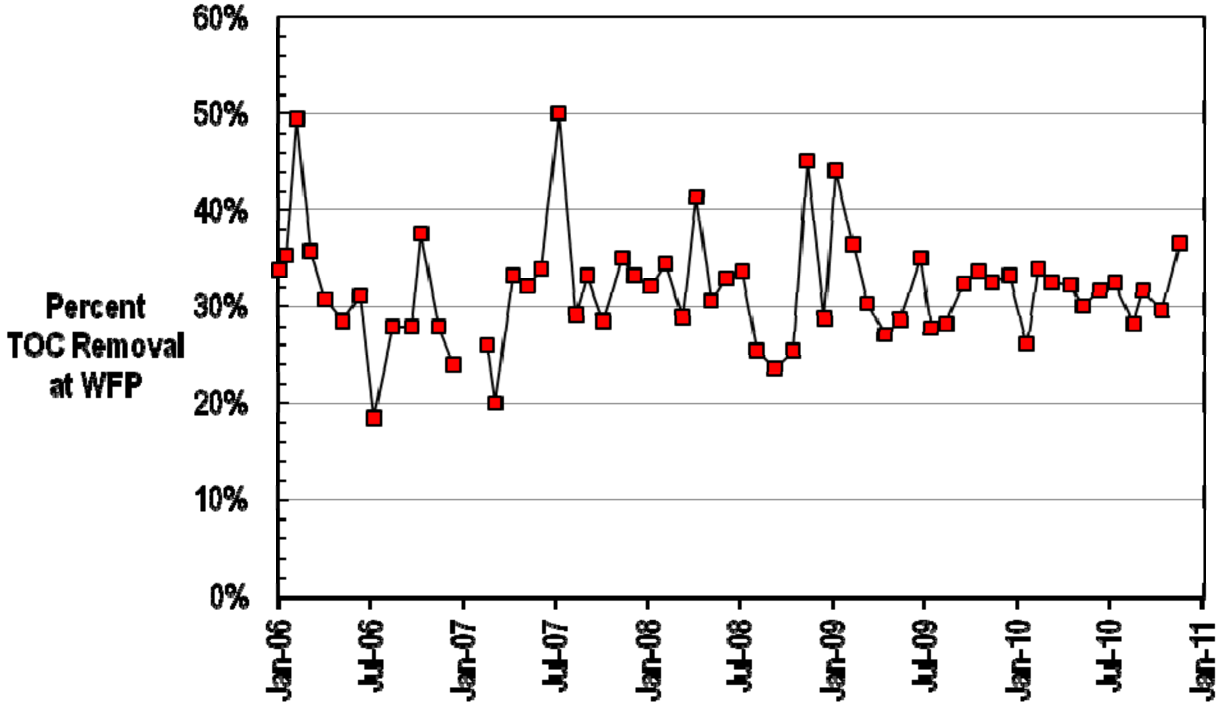

Figure 2.17 TOC Removal through the WFP (2006 – 2010)

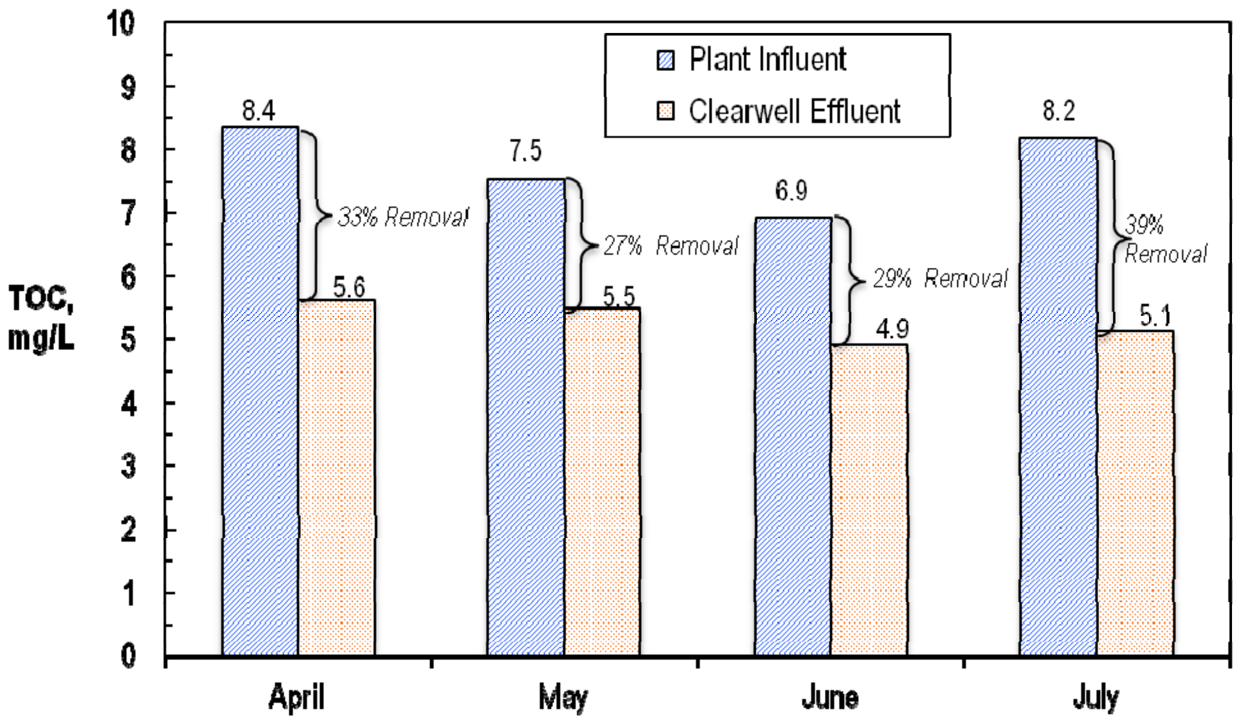

Figure 2.18 TOC Removal through the WFP during Four Months in 2009

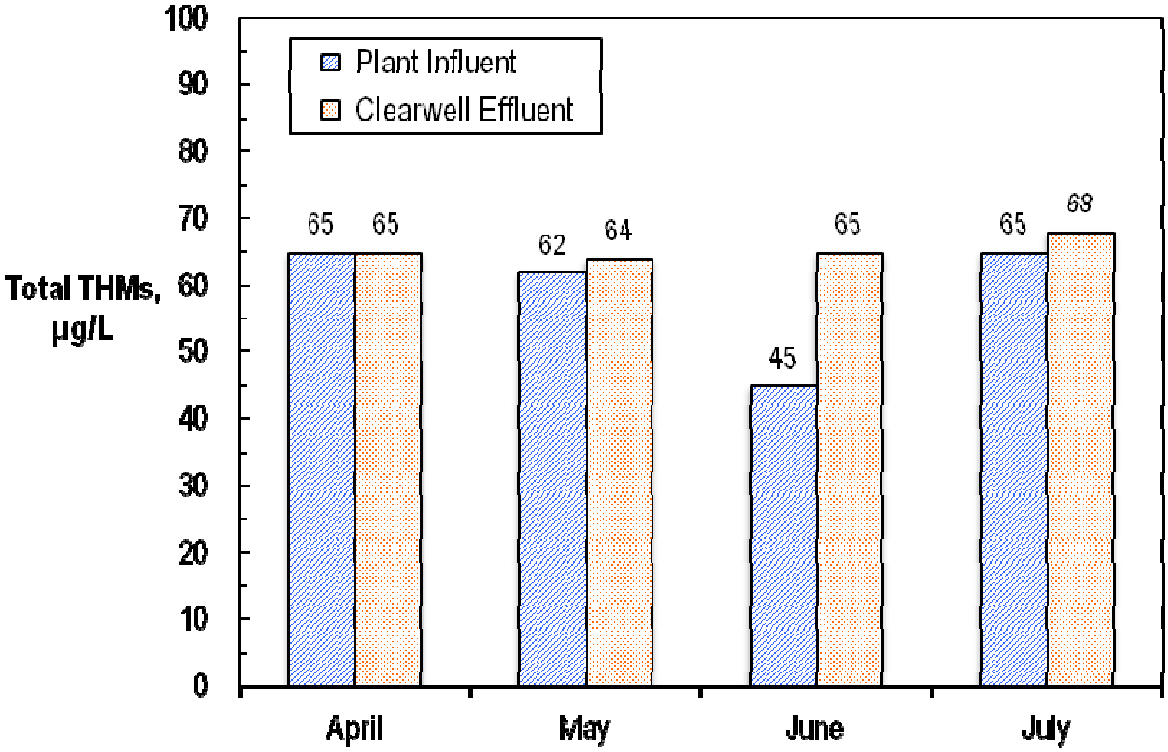

Figure 2.19 THM Levels Measured at Plant Influent and Effluent during the same Four-Month period in 2009 Presented in Figure 2.18

T&O Control

Figure 2.20 shows a plot of the MIB levels in the influent and effluent of the WFP. While the effluent values were measured, the influent values were calculated based on source water MIB levels and blend ratio into the treatment plant. The plot shows that the effluent MIB levels are virtually the same as the estimated influent MIB levels. This is expected since the WFP includes no treatment process capable of removing MIB or Geosmin. During the high MIB event of 2008, the MIB concentration in the effluent of the WFP reached as high as 200 ng/L, which is 20 times the desired maximum level of 10 ng/L.

As these data show, this issue is exacerbated by the use of local water supplies. The frequency and intensity of T&O events would be expected to increase with an increase of local water supplies. The current treatment scheme does not incorporate a reliable and effective unit process for T&O control. As discussed previously, if SFID/SDWD decided to establish a treatment goal for T&O, a unit process, such as ozonation, will be required.

Manganese

The WFP relies on the use of ClO_2 and free chlorine addition to the raw water to achieve oxidation of manganese upstream of clarification and filtration. Data collected by SFID/SDWD show that this strategy is achieving good removal of manganese by the WFP. However, it is noted that the ClO_2 dose is limited to no more than 1.0 mg/L. Higher doses could result in the formation of chlorite, ClO_2^-, at levels exceeding its MCL of 1.0 mg/L.

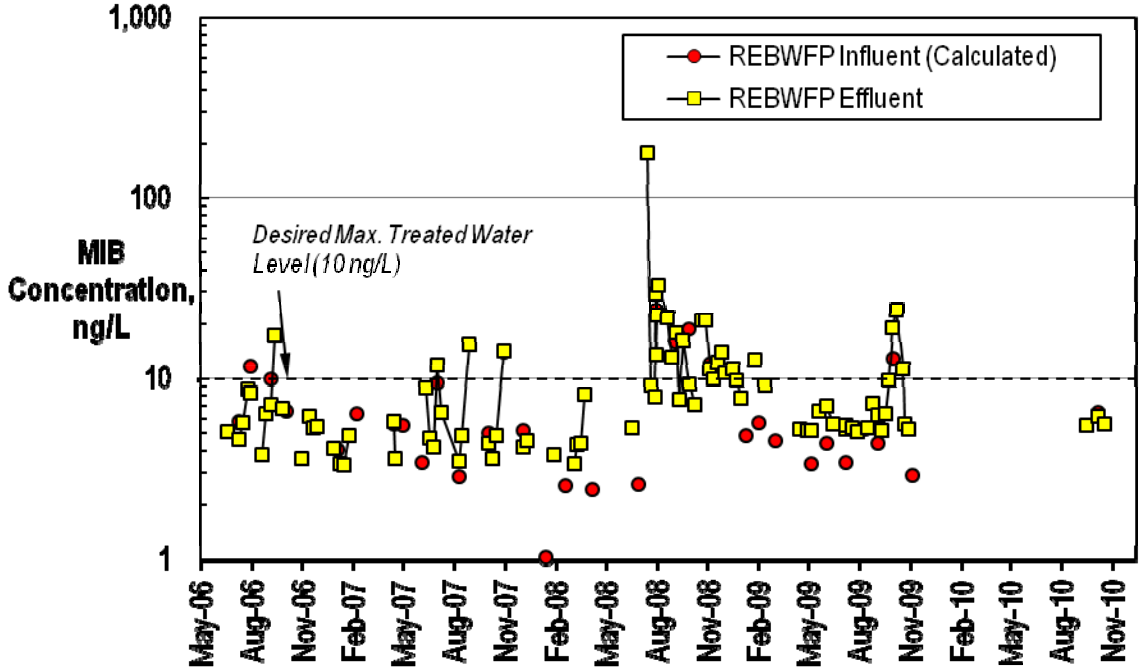

Figure 2.20 MIB Concentrations in the Influent and Effluent of the WFP (2006 – 2010)

Salinity

The WFP does not utilize any treatment technologies capable of reducing TDS levels. In fact, the high chemical doses applied at the plant could increase the TDS level through the treatment train by approximately 50 mg/L. Reducing TDS levels requires the installation of either nanofiltration (NF) or reverse osmosis (RO) membranes on a part of the treated water flow. These processes are quite expensive (about $10 million per mgd of treatment capacity) to construct and operate. In addition, they generate a high-TDS brine stream that requires proper disposal.

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Section 3 PLANT PROCESS AND HYDRAULIC EVALUATION

BACKGROUND

The WFP treats local Lake Hodges water diverted directly to the plant or through San Dieguito Reservoir and imported new water provided by CWA. Local water is of lesser quality compared to imported CWA water and exhibits the following treatment challenges:

- Higher turbidity
- Higher TOC
- Manganese
- Algae
- T&O compounds
- Additional disinfection requirements
- High coagulant dosages and sludge production
- Low dissolved oxygen levels
- Hydrogen sulfide

Plant staff prefers treating water from SDR rather than directly from Lake Hodges because of the lake management program implemented at SDR. The result of this lake management program is higher dissolved oxygen and lower sulfur (corrosive) compounds in SDR. Although treating local water is difficult, plant staff has done a great job operating the plant with the tools that are available. For the past several years, most of the plant's water production (up to 70 percent) has been obtained from the local raw water supply.

The purpose of this analysis is to identify process deficiencies in the plant that hinder water treatment and to develop solutions, improvements, and capital costs for treating the raw water sources while meeting regulatory requirements.

PLANT PROCESS EVALUATION

Site inspections and desk-top evaluations of the existing WFP were conducted to assess capacity, performance, and physical condition of the plant process facilities. The following processes and equipment were evaluated:

- Coagulation (flash mix)
- Flocculation
- Sedimentation
- Filtration
- Disinfection
- Solids handling
- Utility water
- Chemical handling

COAGULATION (FLASH MIX)

The purpose of coagulation is to quickly and completely disperse the chemical coagulant to the raw water, thus allowing formation of a flocculated particle that can be removed via sedimentation and filtration. (PACL is the primary coagulant used at the WFP to accomplish enhanced coagulation (EC) as part of the D/DBP Rule for removal of TOC. Typical dosages range from 15 mg/L when treating 100 percent imported water to 70 mg/L when treating 100 percent local water.

The WFP uses pumped jet diffusion, which is an effective means for coagulant mixing. It is comprised of a pump and a specially tapered nozzle to create a high velocity jet of water to impart flash mixing energy to the process flow. The flash mix pump was designed to provide a mixing intensity (G-value) of 750 sec^{-1}, which is consistent with recommended values.

The current system injects chemical coagulant into the flash mix piping upstream of the high-energy discharge nozzle. Because of their precipitative properties, chemical coagulants react quickly with water and can scale on pipe walls and orifices. It is common to find significant scale and precipitate buildup clogging of the flash mix nozzles. Common practice is to apply coagulant at the nozzle discharge rather then in the flash mix piping to mitigate chemical scale and potential clogging. It is recommended that the next time the influent channel is drained plant staff inspect the flash mix injection nozzle to verify it is clear of scale from chemical addition. If it does exhibit severe scaling, it is recommended that the chemical injection points be moved to the raw water line upstream of the injection nozzle.

Recommendations - Coagulation

The following items represent conclusions and recommendations in defining CIP related to coagulation at the WFP:

1. Have a spare flash mix pump onsite.

2. Routinely inspect the flash mix nozzle to verify it is clear of scale from chemical addition.

FLOCCULATION

Flocculation basins provide gentle agitation to coagulated particles increasing the rate of particle collision and subsequently aiding the agglomeration of particles into larger settleable floc. The flocculation basins are designed with multiple compartments to promote plug flow through the system. Gentle mixing is provided in each compartment.

The WFP contains two parallel flocculation basins oriented in a serpentine arrangement to promote plug flow. Each basin contains four mixing zones, each with two compartments, and each compartment containing a vertical shaft flocculator with hydrofoil blades. These flocculators are used to impart mixing energy to the water to promote particle collision. Flocculators at the WFP are operated in a tapered mode where rotational speed of the flocculator blades are decreased as water flows through flocculation basins with the first flocculator operating at 100 percent speed and each subsequent flocculator decreasing speed by 25 percent from the previous stage (100/75/50/25 percent). Both vertical shaft flocculators and tapered flocculation have been proven to be a good means for producing settleable particles.

Parameters used to assess the operation of flocculation basins are flocculation time through the basins and mixing energy gradient (G-value). The recommended flocculation time for local and CWA waters is 30 minutes or greater at colder water temperatures. Typical mixing intensities for tapered flocculation should range from 70 down to 10 sec^{-1}. Table 3.1 compares these operating parameters at typical plant flow rates (15 to 30 mgd) and the listed plant design flow rate of 40 mgd. As shown, at rates at or below 30 mgd, flocculation time is in the range of 30 minutes, and produces settleable floc as demonstrated by settled water turbidity discussed below.

Table 3.1 Operational Parameters of the WFP Flocculation Basins

Parameter	Typical Range (15 – 30 mgd)	Design Flow (40 mgd)	Recommended Range
Detention Time (min)	24.1 to 48.3	18.1	25+
G-value (sec^{-1}), tapered	60 to 10	60 to 10	70 to 10

If the desire for the plant is have a design capacity of 40 mgd, the flocculation basins will need to expanded. However, based on typical plant flows rates over the last few years, the flocculation basins and operations performance appears adequate.

There are sixteen vertical shaft flocculators at the flocculation basins. Each of these was installed as part of the 1993 plant improvements. The flocculators are approaching a 20-year lifetime and should be considered for replacement. Plant staff has indicated that the flocculators are not currently wired to emergency power. Because flocculation is a critical part of treatment, the flocculators should be connected to emergency power to ensure continuous operation during power outages. The project cost for replacing the flocculators and wiring them to emergency power is $1,000,000.

Recommendations - Flocculation

The following items represent conclusions and recommendations in defining capital improvement projects related to flocculation at the WFP:

1. Budget for routine maintenance and phased replacement of existing flocculators.

2. Wire the flocculators for emergency power.

SEDIMENTATION

Sedimentation is the process of gravity clarification for removal of agglomerated particles formed during flocculation. Effective sedimentation relies on proper configuration and operation of upstream coagulation and flocculation processes. Conventional sedimentation at the WFP is accomplished using long rectangular-shaped basins that take advantage of the relative density and settling velocities of the flocculated particles as water flows through the basin.

The WFP contains two parallel sedimentation basins. Each basin contains a traveling bridge solids collector system. Settled water is collected at the end of the basin by finger launders over a v-notch weir. Operational parameters that govern conventional sedimentation basins are shown in Table 3.2. Hydraulic and clarification objectives are to decrease turbulence in a basin to maximize settling efficiency. Table 3.2 describes the range of sedimentation basin operational parameters typically experienced at the plant at flow rates between 15 and 30 mgd. At these rates, the hydraulic surface loading, detention time, and other parameters fall within or near recommended design values. At plant design flow, 40 mgd, basin parameters fall out of the desired or accepted range. As long as daily plant flows are 30 mgd or less, the existing floc/sed processes should perform reasonably well. Higher flows would challenge the current pre-treatment processes and lead to higher solids carryover and increased settled water turbidity. At some point, the additional solids loading would overwhelm downstream filtration resulting in shorter filter runs (less production) and eventually turbidity breakthrough due to ineffective pretreatment.

Basin performance is normally acceptable with settled water turbidities less than 2 Nephelometric Turbiidty Units (NTU) 95 percent of the time (reference Figure 3.1). Higher turbidity in the range of 3 to 4 NTU can occur based upon water temperature, coagulant dose, flocculation time, and basin surface loading rates. No single parameter such as time of year, flow rate, or operating criteria seen to dominate and dictate performance. Settled water turbidity data in Figure 3.2 clearly demonstrates the range of values independent of time of year and corresponding temperature and flows. Settled water turbidity can trend upward with high raw water turbidity events, but not always; especially over the past two years of operation.

Table 3.2 Operational Parameters of the WFP Sedimentation Basins

Parameter	Typical Range (15 to 30 mgd)	Design Flow (40 mgd)	Recommended Range
Surface Loading Rate (gpm/ft^2)	0.6 to 1.2	1.6	0.75 to 1.0
Detention Time (hrs)	1.1 to 2.2	0.8	1.5 to 3.0
Horizontal Velocity (ft/min)	1.7 to 3.3	4.4	1.0 to 3.5
Weir Loading Rate (gpm/ft)	12 to 23	31	5 to 20
Reynolds Number	13,500 to 27,000	36,000	<18,000
Froude Number	3.4×10^{-6} to 1.4×10^{-5}	2.4×10^{-5}	$>10^{-5}$

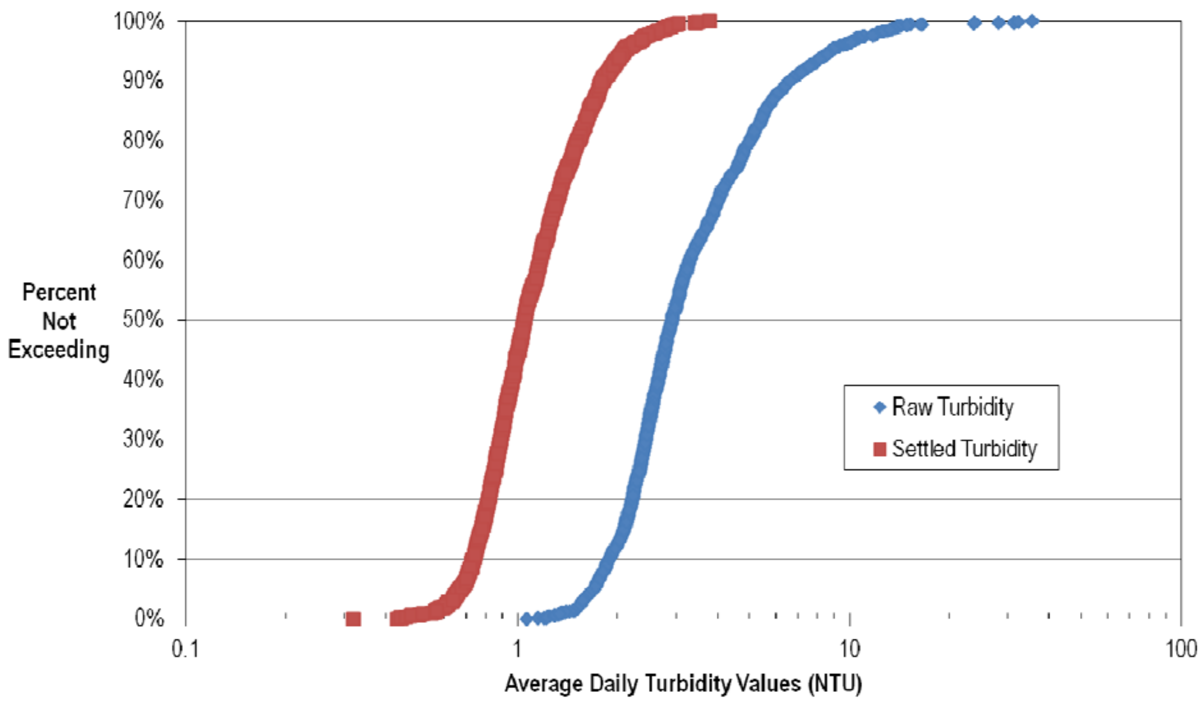

Figure 3.1 Raw and Settled Water Turbidity Data Frequency Curves (2007 to 2010)

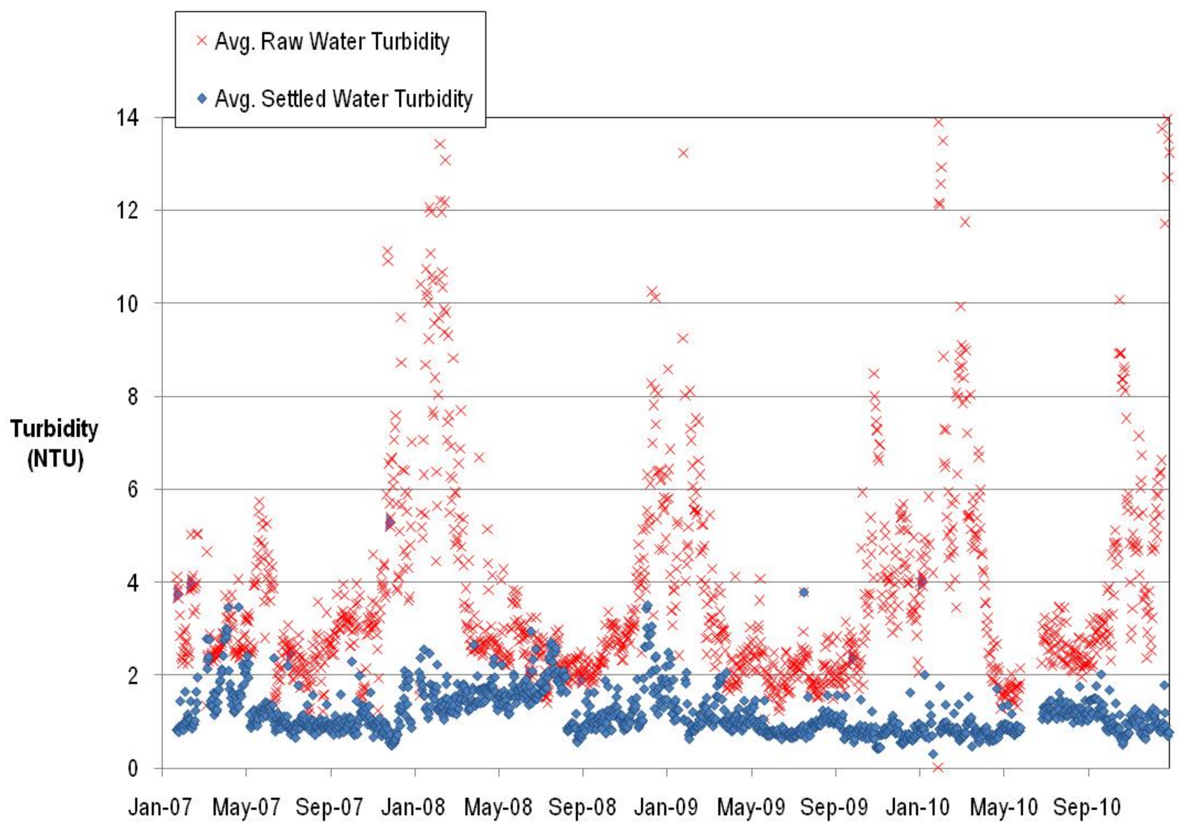

Figure 3.2 Raw and Settled Water Turbidity Profiles from 2007 to 2010

Basin Improvements

Based on performance over the last several years, the sedimentation basins produce acceptable quality a majority of the time. However, when flows exceed 30 mgd and approach the 40 mgd design capacity, then improvements would be recommended and warranted. Upgrade options include a new third floc/sed basin or installation of tube or plate settlers in the existing sedimentation basins.

Construct New Flocculation/Sedimentation Basin

The WFP was originally designed to include a third flocculation/sedimentation basin in the future and space has been preserved for such an expansion south of the existing basins. Project costs to construct a third flocculation/sedimentation basin are estimated at $6.2 million as detailed in Table 3.3.

Table 3.3 Project Cost Estimate for a New Flocculation/Sedimentation Basin

Description	Estimate
General Conditions	$490,000
Site Work and Excavation	$230,000
Yard Piping	$300,000
Reinforced Concrete	$2,100,000
Miscellaneous Structural	$450,000
Flocculators	$430,000
Solids Collector	$750,000
Miscellaneous Mechanical	$630,000
Electrical/Instrumentation	$820,000
Estimated Project Cost	$6,200,000

Install Tube Settlers in Existing Basins

Tube settler units are used for increasing settling capacity and performance of conventional sedimentation basins. Installation requires a 10 to 12 feet water depth depending upon the profile of sludge removal equipment used in a basin. Given depth of a tube, it is anticipated that acceptable surface loading rates across installed tube area would be 2 gallons per minute per square feet (gpm/ft^2). If 75 percent of a basin area could be retrofitted with tubes, the resultant capacity would be 20 mgd (capacity = 20 mgd = 0.75 x 8,800 ft^2 x 2 gpm/ft^2 / 695 gpm/mgd). The estimated project cost to install tube settler units in both existing sedimentation basins is $3 million. This estimate assumes continued use of the traveling bridge sludge collectors.

Tube installation as presented may improve turbidity removal in the sedimentation basins at 40 mgd (20 mgd per basin) but doesn't increase overall nameplate design capacity. It is also recognized that tube settler performance is dependent upon proper coagulation and flocculation so without improving flocculation, the use of tubes would not benefit capacity or quality. Installation of tube settlers in the existing basins is not beneficial given the potential project costs and minimal improvement in performance and capacity.

Other Recommended Improvements

The traveling bridge sludge collection assemblies in the sedimentation basins are original equipment and have been in service for over 40 years. Plant staff have maintained the equipment and recently refurbished the cross collectors. The bridges are in need of refurbishing. Because of the equipment age, the equipment requires significant maintenance and has reached the end of its useful life. The cost to replace each traveling bridge with new sludge collection equipment is $750,000.

Recommendations - Sedimentation

The following items represent conclusions and recommendations in defining CIPs related to sedimentation at the WFP:

1. Budget for replacement of the traveling bridge equipment at $750,000 each basin.
2. Maintain and operate existing flocculation and sedimentation basins. A new third pretreatment train is recommended when plant flows increase consistently over 30 mgd.
3. Installation of tube settler or other high-rate devices in existing sedimentation basins is not cost effective and not recommended.

FILTRATION

Granular media filtration is employed at the WFP for final turbidity removal to meet safe drinking water regulations. The plant has six dual media filters. Four constructed in 1968 with the original plant construction and two constructed as part of the 1993 plant modification and rehabilitation project.

Table 3.4 summarizes key design and operational criteria of the existing filters. The filters have a 40 mgd nameplate capacity that yields conservative nominal and maximum filtration rates of 3.6 and 4.3 gpm/ft^2, respectively. Regulatory design requirements will allow filtration rates up to 6 gpm/ft^2 for dual medias. Regardless, the existing filters seldom operate higher than 3.5 gpm/ft^2 because maximum day plant production has been in the range of 30 mgd for the past several years (see Section 1).

Filter media depths and sizes listed in Table 3.4 are from the original media design with 21 inches of anthracite coal over 10 inches of sand. The calculated L/d ratio is just over 1,000 based upon an average effective size for both media types. The L/d value is a ratio of media depth to its effective size and is a measure of the media's ability to capture and remove filterable particles. Higher L/d ratios yield higher filtrate quality. There is no regulated value for L/d. Most filters designed before 1980 have media configurations with L/d ratios of 1,000. Since that time, typical L/d values have ranged from 1,200 to 1,600. It is recommended that L/d ratios of 1,200 or higher be employed to meet today's more stringent filtration requirements.

Other key criteria listed in the table is described below along with discussions and evaluations of filter performance, backwash operations, hydraulic capacity, physical features and potential filter improvements.

Table 3.4 Existing Filter Design and Operating Criteria at the WFP

Description	Units	Value	Comments
Plant Flow Rate	mgd	40	Normal max day is 30 mgd
Type: Dual media, constant level- constant rate			
Number	No.	6	
Filter area, each	ft^2	1,280	
Total filter area	ft^2	7,680	
Filtration rate (at 40 mgd)			
All in service	gpm/ft^2	3.6	
One out of service	gpm/ft^2	4.3	6 gpm/ft^2 is regulatory limit
Filter media			
Anthracite Coal			
Depth	in.	21	
Effective size	mm	0.98	average per media spec
Sand			
Depth	in.	10	
Effective size	mm	0.47	average per media spec
Total depth	in.	31	
Total L/d Ratio	-	1,080	media combined
Filter Backwash			
Type: Elevated tank, fixed-grid surface wash			
Backwash rate	gpm/ft^2	17.5	
	gpm	22,400	
Surface wash rate	gpm/ft^2	4.8	
	gpm	6,100	
Backwash tank volume	gal	900,000	Four backwash volumes
Filter Waste Washwater Volume			
Filter drawdown to launder	gal	27,000	zero if drawdown to filtrate
Surface wash (4 min)	gal	25,000	
Backwash (7 min)	gal	157,000	
Total per wash	gal	209,000	
Unit backwash volume (UBWV)	gal/ft^2/wash	163	
Type: Lined, trapezodal shaped			
Number	No.	2	
Capacity, each	gal	228,500	
Combined capacity	gal	457,000	
Number backwash volumes	No.	2	one volume each pond

Physical Features of Existing Filters

Figure 3.3 has been prepared to illustrate physical dimensions of the existing filter box that define the features and layout of the filters. The filter box depth is 15.50 feet from the filter floor to the structure walkway deck. Key dimensions within the box are listed and described below:

- Media depth – total of 31 inches consisting of 10 inches sand and 21 inches coal.
- Underdrain depth – 18 inches of graded gravel. Purpose is to support the media to keep it in the box. The 'tee-pee shaped" concrete laterals collect the filtrate and distributes backwash water.
- Launder (backwash trough) height – 21 inches.
- Water depth above launder – approximately 33 inches. Inlet water enters the filters from the upper gullet through the launders.
- Distance between top of media and launder bottom – approximately 30 inches. This depth is important during fluidized backwash. If the distance is too small excessive media loss during backwash can occur. The recommended distance is between 50 and 100 percent of total media depth. Extreme distances between media and launder are also not desirable because then a longer backwash duration is required to transport solids from the bed.
- Water depth above media – 84 inches (7 feet). This depth is important because it represents the positive driving head that can be exhausted during filtration without concern for developing negative head and air binding conditions within the media bed. A minimum of 6 feet of positive driving head is recommended. The 7 feet depth above the media will go along way in support of current and future filter operations.
- Available head for filtration – 8 feet. The total available head for filtration is the 10 feet elevation difference between the water surface in the filter (El 531.50) and the downstream weir (El 521.40) in the filter control structure. Depending upon plant flow, filtration rate, and resultant clean-bed headloss, available head for solids accumulation within the media is 6 feet. Weir elevations and hydraulic conditions of the existing filters would support up to 8 feet of total head for filter operations, i.e., operate the filter until 8 feet of differential head is measured across filter media, underdrain, and piping.

The distance between the filter floor and underdrain defines the depth of media that can be installed in the box for a given underdrain profile. The current configuration would support up to six more inches of filter media before imposing upon distance to bottom of launder.

The surface wash distribution laterals should be located within three inches of the media to realize proper scouring of the media surface. Surface wash performance suffers as a result of media loss because of increased distance between fixed-grid laterals and top of media. Media depths for both sand and coal layers should be measured and inspected annually. Filter media should be added to the bed when losses exceed 3 inches.

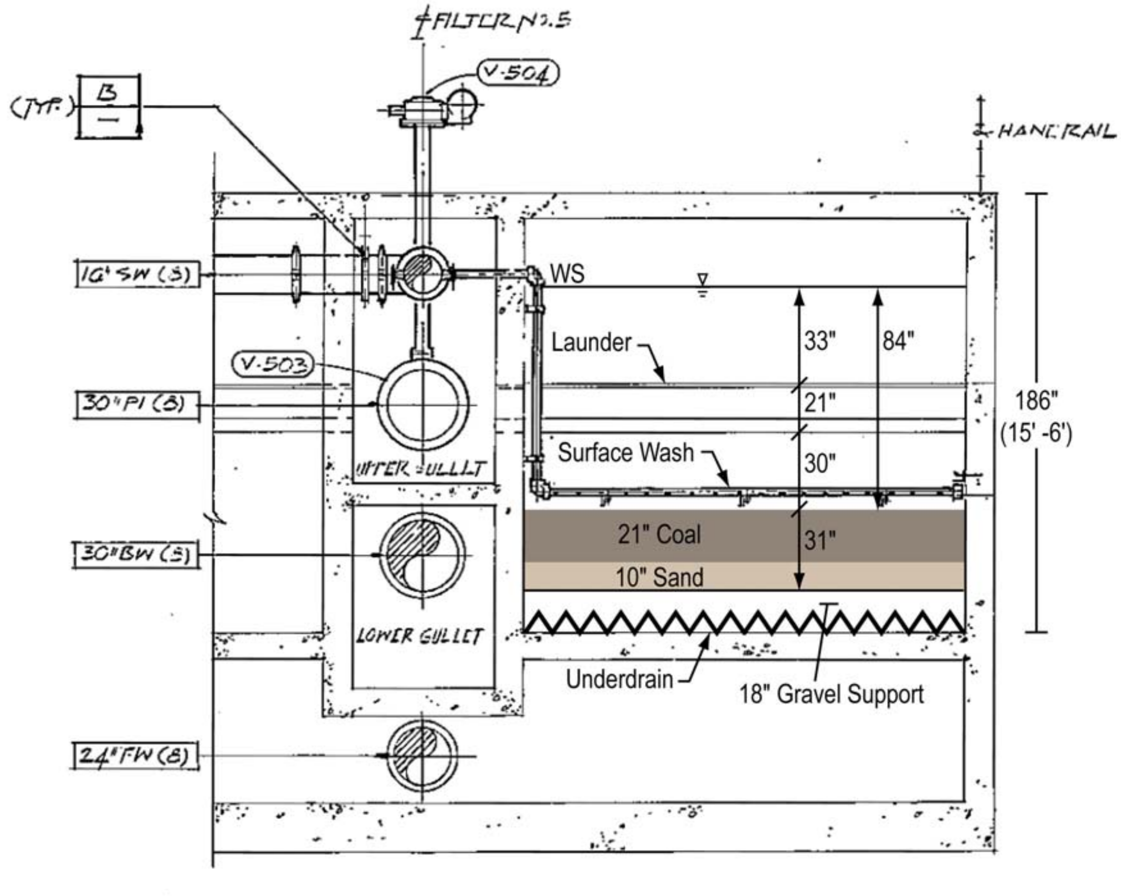

Figure 3.3 Physical Features and Dimensions of Existing Filter Box

In general, the physical features of the existing filter box are of sufficient dimension to support proper filter operations, especially at historical and anticipated future filtration rates at this plant. Noted highlights are the 7 feet water depth above the media and the overall box depth. A limiting feature is the modest distance between trough and filter floor that may constrain media depth and height profiles of potential replacement underdrains. These constraints are further discussed in the filter improvements section below.

Filter Performance

Successful performance can be defined as filter operations that produce desired filtrate quality and quantity to meet drinking safe drinking water regulations and system-wide water demands. The existing filters have historically accomplished these objectives as discussed below.

Filtrate Quality

Turbidity is the primary water quality parameter that defines regulatory compliance and filtrate quality. The Surface Water Treatment Rule (SWTR)requires that filtered water turbidity be less than 0.3 NTU in 95 percent of the samples taken with a maximum of 1 NTU. Individual filter turbidity should be monitored every four hours. Filters at the WFP produce excellent quality water. Figure 3.4 contains turbidity profiles of the daily values for settled and filtered water. These data consist of average daily values during the time period of 2007 through 2010. Although settled turbidity ranged from below 1 to almost 4 NTU, filtrate turbidity was well below 0.10 NTU and consistently 0.05 NTU or less. The frequency curves of Figure 3.5 clearly demonstrate that filtrate turbidity is less than 0.30 NTU 95 percent of the time with the 95 percent value of 0.07 NTU. Correspondingly, the settled water turbidity is less than 2 NTU 95 percent of the time. The existing filters have produced excellent quality water.

Filtrate quality can be compromised during media maturation at filter startup following backwash. Experience with granular media filtration has determined that as much as 90 percent of the particles that pass through a filter do so at the beginning of a run while media is maturating or re-ripening. Figure 3.6 presents a profile of turbidity values from Filter No. 5 collected at 15-minute intervals. Data was extracted from filter water quality records during a filter run conducted January 10-11, 2010. The curve of Figure 3.6 illustrates the typical profile and pattern with an initial turbidity spike at the beginning of a run with elevated values 7 to 10 times greater than the filtrate turbidity achieved after maturation. The curve exhibits no turbidity breakthrough at the end of the run. There was an excursion of about two hours near the middle of the run where the turbidity increased from 0.02 to 0.04 NTU (still very low) that most likely were caused by changes to flow rate or chemical dosages or possibly due to a disruption of sample flow to the analyzer. The filters do not have provisions for filter-to-waste (FTW) or other media-maturation measures; yet the plant staff does a great job of managing backwash and other methods for bringing filters into and out of service. Options for implementing FTW and other maturation tools are discussed below.

Filter Production

In addition to filtrate quality, the other success metric is filter production or the ability to produce the quantity of treated water when it is needed. Of equal importance is the efficiency at which that production is obtained. The Unit Filter Run Volume (UFRV, gpm/ft^2/run) is a filter operating parameter used to assess filter production efficiency. The UFRV is the volume of water filtered through one square foot of media area each filter run or cycle and is calculated as the product of average filtration rate (gpm/ft^2) and the filter run time (minutes). The Unit Backwash Volume (UBWV, gpm/ft^2/run) is the amount of water used to backwash and clean the filter and includes both surface wash and water backwash volumes. Filter efficiency can be calculated from the UFRV and UBWV values using the following equation:

$$\text{Filter Efficiency} = (\text{UFRV} - \text{UBWV}) / \text{UFRV} * 100\%$$

Figure 3.7 contains a filter efficiency plot over a range of UFRVs. The curve is for a UBWV of 163 gal/ft^2/run and is representative of current backwash operations. Also indicated in the figure is the calculated average filter UFRV of 6,200 gal/ft^2/run with an average filter efficiency of 97 percent. If the total filter production was 30 mgd the net daily filter or plant production would be 29 million gallons; 97 percent of the total. Note the slope of the curve of Figure 3.7 and how the efficiency drops sharply once the UFRV value decreases to below 5,000 gal/ft^2/run. Also, filter production efficiency increases with higher UFRV values but the incremental change becomes less dramatic with increasing UFRV. Successful filter production is normally accomplished when the calculated UFRV value is 5,000 to 10,000 gal/ft^2/run and higher.

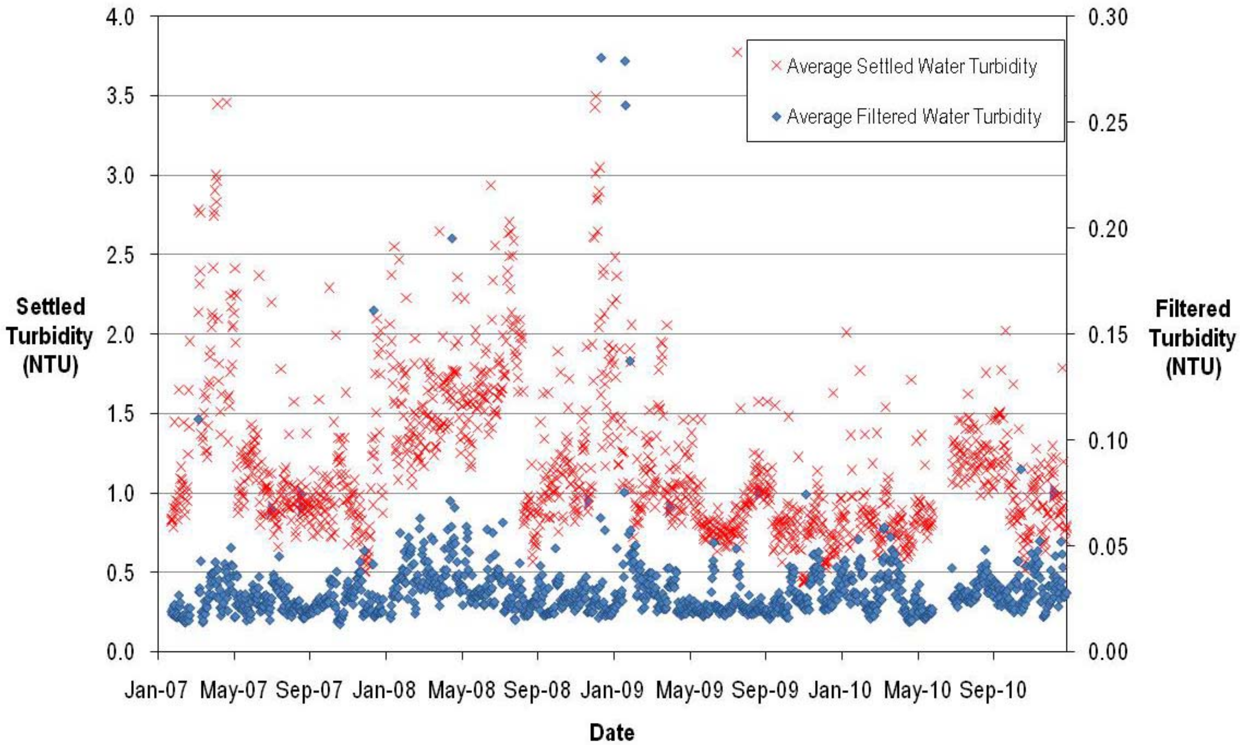

Figure 3.4 Turbidity Profiles for Settled and Filtered Water (2007 – 2010 Daily Values)

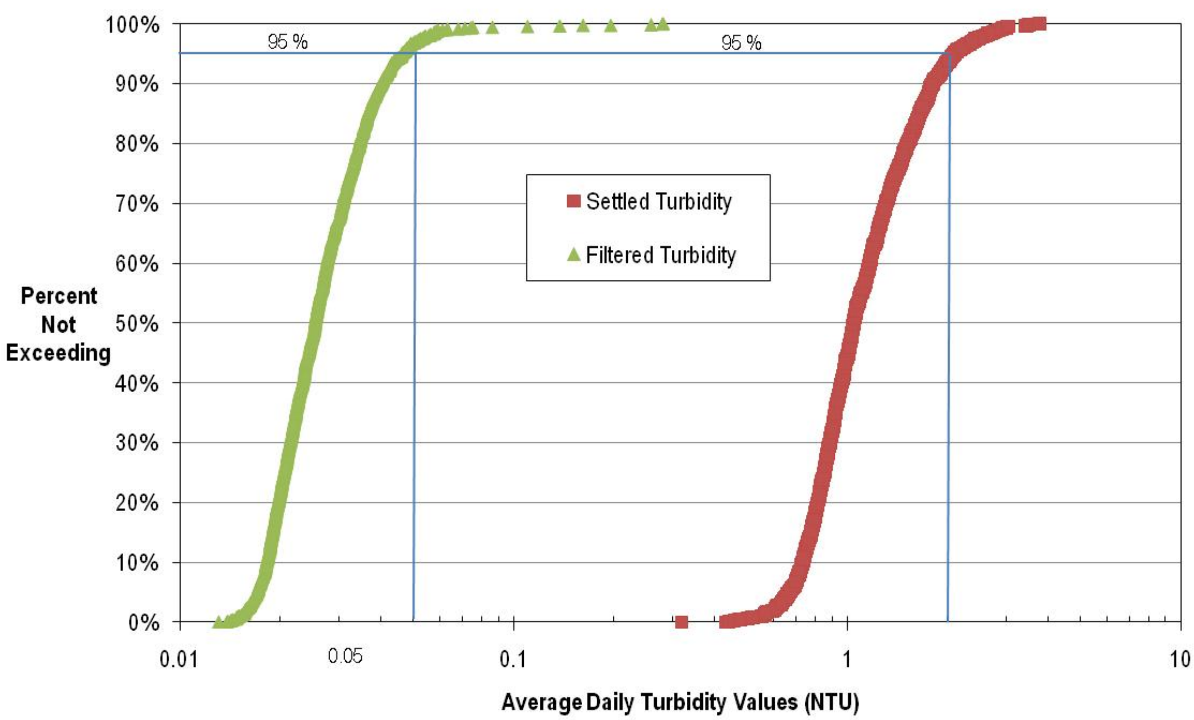

Figure 3.5 Turbidity Frequency Curves for Filtration (Filter No. 5) and Settled Water

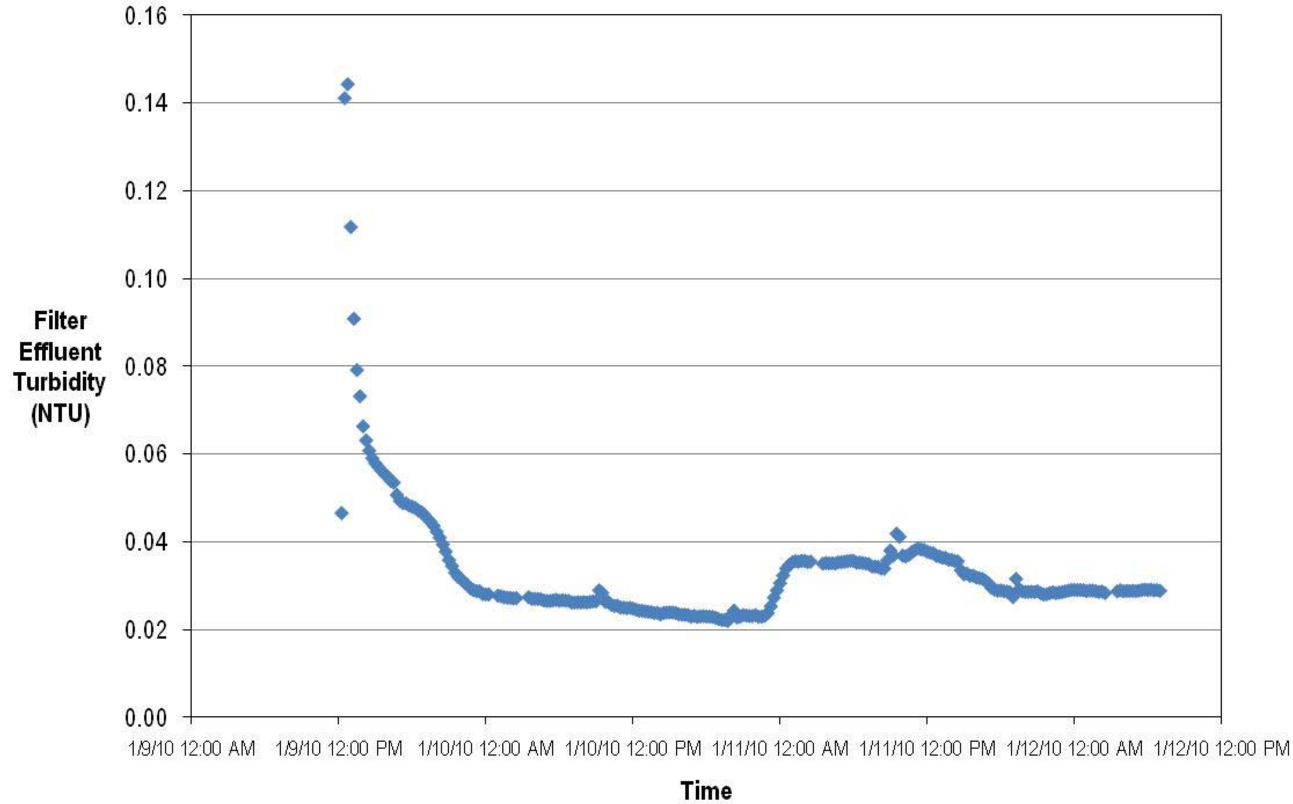

Figure 3.6 Filtrate Turbidity Profile for Filter No. 5 (Jan 10-11, 2010)

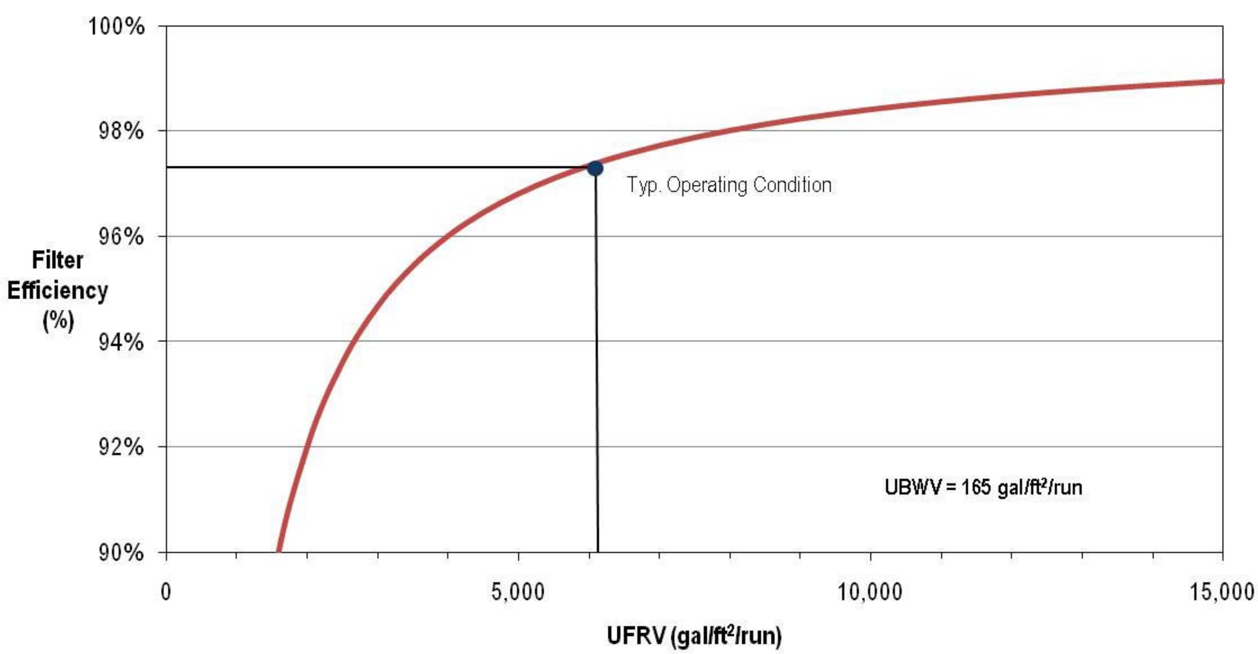

Figure 3.7 Filter Efficiency vs. UFRV at WFP

Figure 3.8 contains a series of frequency curves of calculated UFRV values from Filter No. 5 over the past four years (2007 to 2010). It is peculiar that 90 percent of the UFRV values fall within a rather narrow range between 6,000 and 6,500 gal/ft^2/run. The UFRV is primarily impacted by solids loading and resultant bed exhaustion at terminal headloss. Consequently, most filter facilities exhibit a broad range of UFRV values. The calculated UFRV's of Figure 3.8 show very little variance because filter runs at the plant are terminated based upon a fixed volume, not terminal headloss. So when the filter has produced approximately 8 milligals (Mgal) of water, the filter is taken offline and backwashed. As a result, the filter's available headloss may have only partially been utilized depending upon solids and hydraulic loading rates. The filter run time under this operating scenario would vary entirely upon rate and would be calculated as the fixed volume divided by the filtration rate. For example, at a 3 gpm/ft^2 rate of filtration (5.5 mgd per filter), the run time to produce 8 Mgals of filtrate would be approximately 35 hours (8 Mgal / 5.5 mgd * 24 hours per day (hrs/day) = 34.9 hours).

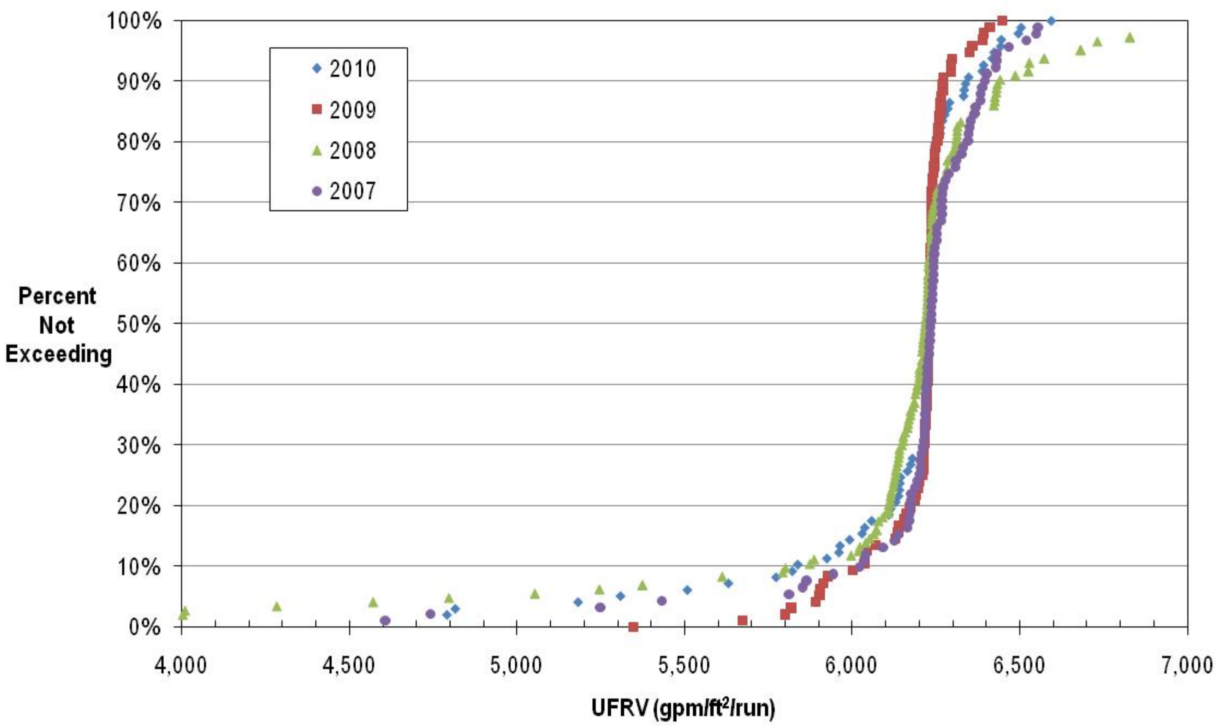

Figure 3.8 Frequency Curves of UFRV Values for Filter No. 5 (2007 – 2010)

Most filter plants terminate filter runs based upon one of three operating parameters: terminal headloss, filtrate turbidity, or run time. Termination based upon headloss is a natural result when a filter is heavily loaded with influent solids and/or high filtration rates. At low rates and low solids, a maximum run time may be used to terminate the run. For the WFP filters, filtration is terminated based upon accumulated filtrate volume and not headloss. A review of the WFP filter operations headloss data determined that the accumulated headloss upon termination for backwash was less than 2 feet in 90 percent of the filter runs. This suggests that the filters have additional capacity in terms of operating time, headloss, and overall filter production. It also illustrates the success of the operations staff in operating the plant and the combined performance of the pretreatment and filtration processes.

Potential Filter Improvements

As discussed above, current filter operations and performance meet and exceed plant production and filtrate quality needs. Consequently, major filter improvements are not currently warranted in the near term. However, given the age and the existing filter facility, this master plan update includes several future filter improvements that should be included in the filter upgrades CIP. Recently, new handrail has been installed on the filter deck to improve safety for plant operations staff when walking around the filters. Other improvements are presented and discussed below.

Filter Box Improvements

Potential filter box improvements include replacement of the filter underdrains, auxiliary surface wash, and media replacement. Figure 3.9 illustrates the potential filter improvements for underdrain and media replacement for two different underdrain types: block lateral or nozzle with monolithic concrete floor. Preliminary evaluations indicate that either underdrain type could be installed and either type would support water backwash preceded by surface wash and/or air scour.

As depicted in the figure, a total media depth of 42 inches could be configured within the existing filter box for either underdrain type. Larger media depths would be constrained without replacing and raising the launders to facilitate proper distances within the box. A 42-inch dual media design should be more than sufficient to upgrade the filters with 30 inches of anthracite coal over 12 inches of sand resulting in an L/d ratio exceeding 1,200. The upgraded media configuration would maintain high filtrate quality and increase filter production and overall operations.

Filter Production Improvements

In addition to the media improvements described above, filter production efficiency and quality can also be improved with minor changes to filter operational strategies and methods that take advantage of the existing filter head and operational capacity. For example, by changing filter operations to terminate filter run based upon headloss, time, or a higher fixed filtrate volume, the overall filter efficiency and production capacity would be increased. The changes for this approach and potential results are shown graphically in Figure 3.10. Historical filter operations place the UFRV at 6,200 and production efficiency at 97.2 percent. If changed filter operations could yield a UFRV of 12,000, the resultant efficiency would be 98.6 percent. Although relatively minor, the increased efficiency would increase the net plant production by 400,000 gallons per day (gal/day) for a 30 mgd plant flow rate. These calculations and graphic are based upon a UBWV of 163 gallons per square feet per run (gal/ft^2/run). Increased production could be realized with a lower UBWV; however, this current value may already be near optimum for backwashing and cleaning the media.

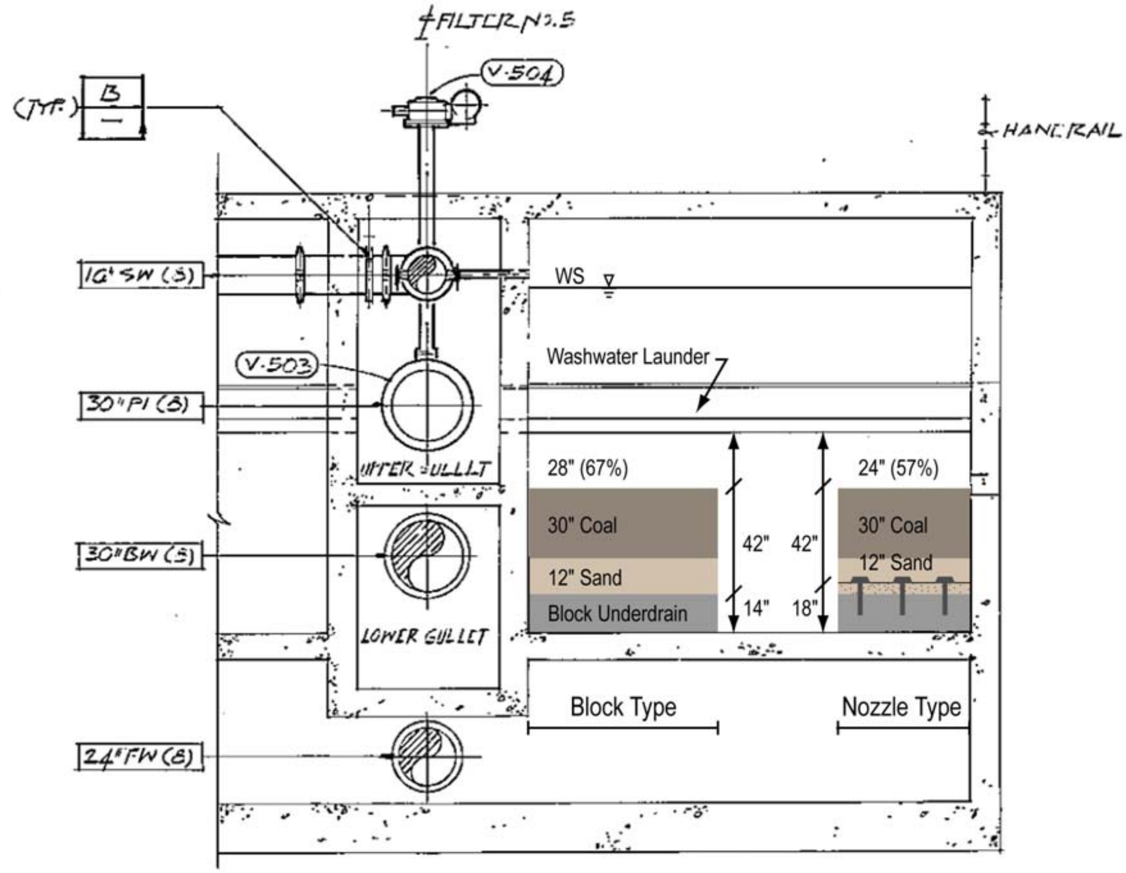

Figure 3.9 Potential Filter Box Improvements

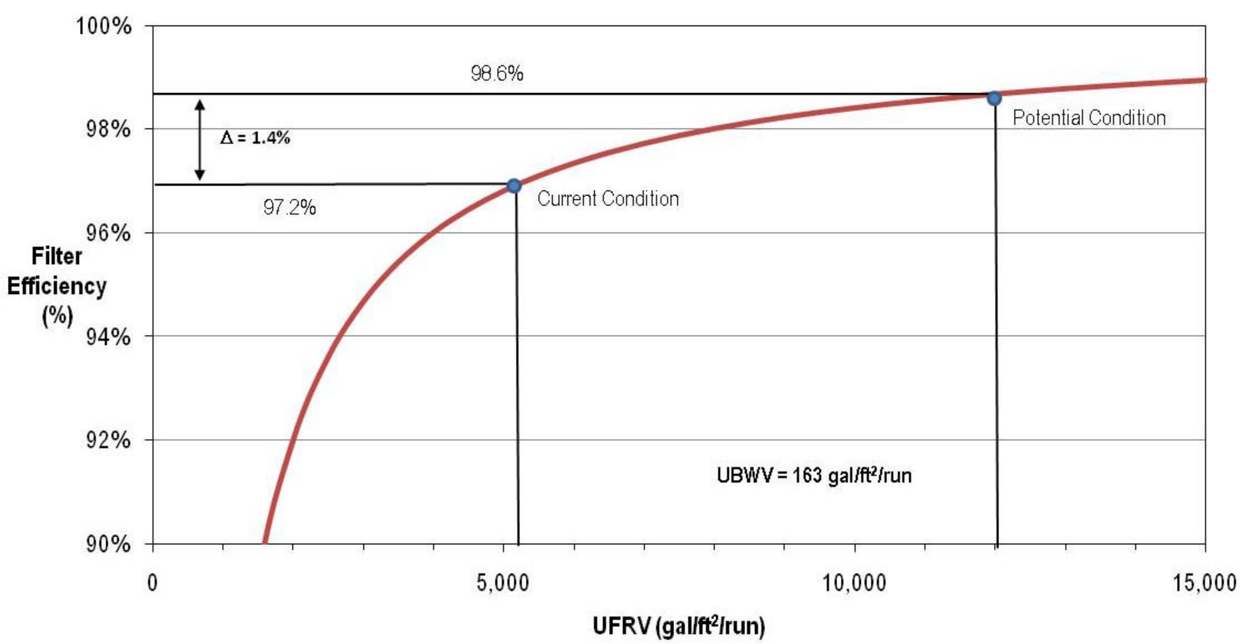

Figure 3.10 Filter UFRV and Production Efficiency Potential

Another potential filter improvement includes installation of FTW to eli minate turbidity spikes during media ripening upon startup following backwash. Provisions for FTW would include common FTW control valve and piping (with an air-gap) to divert filtered water away from the clearwell until the media is maturated. Wasted water would gravity flow to the washwater equalization ponds and be processed with the filter waste washwater. Implementation and operation of FTW would generate an additional waste stream and volume that impacts overall filter and plant efficiency. It is estimated that FTW will increase the total UBWV, or water used to clean and maturate the media, by 150,000 gal each FTW cycle. The resultant UBWV would then increase from the 163 gpm/ft^2/run base case conditions to 285 gpm/ft^2/run, thereby changing the overall efficiency as a function of UFRV. The advantage of FTW is improved filtrate quality delivered to the clearwell.

Table 3.5 summarizes conditions and operational differences as a result of implementing these potential filter production improvements. The base case condition highlights filter results as currently experienced at the plant. At 30 mgd plant flow rate and with five filters in service, the resultant filtration rate would be 3.3 gpm/ft^2. The net plant production would be 29.2 mgd with 836,000 gal/day of water consumed for filter backwashing operations. Changes to filter operations that double the UFRV would increase the net daily production rate to 29.6 mgd and reduces backwash from 4 to 2 backwashes per day as shown in the table.

The UFRV and FTW condition of the table illustrates the impact of operating FTW at the plant. Because more water is used and wasted to accomplish FTW, the net pr oduction capacity becomes 29.3 mgd similar to the base case condition. The increased UBWV negates the higher UFRV resulting in less water being produced and lower overall efficiency but for the sake of improved water quality. This analysis demonstrates that with minor changes filter operations can be initiated to overcome production lost as a result of FTW and other media maturation strategies to improve finished water quality

Table 3.5 Summary Results for Potential Filter Operational Changes

Filter Parameter	Units	Operational Results per Condition		
		Base Case	Increase UFRV	UFRV & FTW
Plant Flow Rate	mgd	30	30	30
Number Filters	No.	5	5	5
Filtration Rate	gpm/ft^2	3.3	3.3	3.3
UFRV	gal/ft^2/run	6,200	12,000	12,000
UBWV	gal/ft^2/run	163	163	285
Filter Efficiency	%	97.2	98.6	97.6
Filter Run Time	hrs	32	60	60
Net Production Rate	mgd	29.2	29.6	29.3
No. BW per Day	No.	4	2	2
Total Volume	gal/wash	209,000	209,000	359,000
Total Daily Backwash Volume	gal	836,000	417,000	718,000

Rinse-to-waste (RTW) is another media maturation technique to reduce or eliminate the initial turbidity spike following backwash. RTW can be accomplished as follows:

- Conduct normal backwashing procedures.
- At the end of the backwash, lower the rate to sub-fluidization conditions.
- Rinse the media at the reduced rate until the water volume between the top of the underdrain and top of launder has been displaced.
- Return filter to service.

The purpose of RTW is to remove remnant turbidity and particles from the bed that were created from colliding media grains during fluidized backwash. This method can be successful at reducing or eliminating the turbidity spike upon filter start-up following backwash. If effective, RTW normally uses less water than FTW. And, RTW can usually be implemented and practiced with no capital expenditures.

Estimated Project Cost of Filter Improvements

Estimated project costs to implement the potential future filter improvements are summarized in Table 3.6. All cost elements are for improvements inside the filter box including underdrain and media replacement. The table lists a common cost to incorporate air scour or to replace the surface wash valves and piping as these budget-level estimates are similar. The costs do not include replacement of filter gallery piping and major valves as it is anticipated that this items would be replaced overtime as part of normal O&M.

Table 3.6 Estimated Project Costs to Implement Potential Filter Improvements

Improvement Description	Estimate
General Demolition and Repairs	\$120,000
Replace Underdrains	\$2,250,000
Media Replacement	\$1,350,000
Surface Wash or Air Scour	\$750,000
Filter-to-Waste	\$525,000
Rinse-to-Waste	\$0
Electrical and Instrumentation & Control	\$300,000
Replace Launders	\$450,000
Estimated Project Cost	\$5,745,000

Notes
1. Estimate for all six filters. Total area of 7,680 ft^2.
2. Underdrain costs similar for block lateral or nozzle options.
3. Air scour cost includes duty and standby blowers.
4. Media consists of 12" sand, 30 " coal. No gravels.
5. Filter box improvements only. No gallery or valve replacement.
6. Assume common FTW configuration with master FTW valve control.

Recommendations - Filtration

The six granular, dual media filters at the WFP currently serve SFID/SDWA well in meeting filtered water quality and production requirements. Based upon available head across the filter and operating filtration rates, there appears to be plenty of filter area and treatment capacity to meet current maximum day (30 mgd) and plant design maximum day (40 mgd) production rates. Filtrate quality is excellent; normally less than 0.05 NTU which exceeds safe drinking water regulations established at less than 0.30 NTU 95 percent of the time.

There are no immediate major filter improvements needed to realize treatment objectives. However, given the age of the filter facilities (initial construction in the late 1960s), a number of potential filter improvements have been identified and evaluated for inclusion as part the filter improvement CIP. These include provisions for underdrain and media replacement, installation of new surface wash or an air scour cleaning system, and provisions for FTW. Additionally, a number of filter operational improvements were discussed as part of the overall plan to further optimize filtrate quality and production efficiency.

Filter Box Improvements

The dimensions and configuration of the existing filter box will support an increase in total media depth to 42 inches. Traditional filter underdrain types consisting of media retaining block laterals and nozzle system could be installed employed for underdrain replacement. A listing of potential filter improvements and associated costs are listed in Table 3.6 above. Total project costs to implement all of the listed improvements amounts to $5.8 million.

Filter Operational Changes

The filter operational changes relate to filter rates, terminal headloss and filter run times in support of higher UFRVs and more efficient filter operations. These improvements can be implemented with little or no cost of capital investment. Suggested operational changes include:

- Operating at filtration rates from 2.5 to 3.5 gpm/ft^2 of the online filters.
- Terminate filters based upon headloss, time, or fixed volume.
- A UFRV goal is 12,000 gal/ft^2/run may be possible based upon available filter head.
- Evaluate efficiency of RTW to manage turbidity spikes during media maturation.

DISINFECTION

Three disinfectants are used at the WFP: chlorine, chloramines, and chlorine dioxide. Chlorine can be used as a disinfectant from its injection point in the 54-inch raw water line until flash mix where ammonia is added. A chloramine residual is carried through the entire plant. Although chlorine dioxide is injected upstream of the plant, it cannot be accounted for in disinfection credits because no residual is carried.

The Surface Water Treatment Rule (SWTR) requires that disinfection be continuously applied so that the overall water treatment process achieves at least 3-log (99.9 percent) removal/inactivation of *Giardia* cysts and at least 4-log (99.99 percent) removal/inactivation of viruses. Due to elevated levels of coliform in the local raw water source, the State requires the WFP to achieve an additional 1-log removal for both *Giardia* cysts and viruses. In addition, based on LT2ESWTR, the WFP must meet a 2.0-log removal for *Cryptosporidium*. Because the WFP is a Bin 1 classification, no additional log removal is required for *Cryptosporidium.* The SWTR Guidance Manual allows for treatment facilities utilizing flocculation, sedimentation, and filtration processes to get credit for 2.5-log removal of *Giardia* cysts and 2.0-log removal of viruses. The LT2ESWTR allows conventional filtration plants credit for 2.0-log removal of *Cryptosporidium.* Thus, for the WFP, disinfection must achieve the remaining 1.5-log inactivation for *Giardia* cysts and 2.0-log inactivation for viruses.

For disinfection with free chlorine and chloramines, the contact time (CT) required for *Giardia* exceeds that for viruses, thus *Giardia* CT governs compliance. The CT product is calculated by multiplying the chlorine disinfectant concentration (C, mg/L) by the basin detention time (T, minutes) for a true plug flow reactor. To account for short-circuiting, an efficiency factor (T_{10}/T) is used. Typical values for this factor is 0.1 for unbaffled structures, 0.3 for poorly baffled structures, 0.5 for baffled structures and structures with high length to width ratios, 0.7 for serpentine style structures, and 1.0 for pipeline flow. This factor can appropriately be obtained through tracer studies.

Required CT values to meet log removal requirements vary with temperature. For free chlorine, CT values also vary with pH measured residual. CT values can be obtained from published EPA CT tables. There have been mathematical equations derived to approximate required CT values.

The total CT through the WFP can be calculated for all treatment process for which there is a measured disinfectant residual. Tables 3.7 and 3.8 below show CT calculations for the plant. In these tables, a CT ratio for each disinfectant (CT-achieved/CT-required) is calculated. A summation of the individual CT-ratios greater than 1.0 meets compliance. For the analysis presented in Tables 3.7 and 3.8, two cases were considered. The first was a maximum flow condition (40 mgd) which would happen in the summer time when the water temperature is greater than 20°C. The second was a maximum flow during the winter (20 mgd) when the water temperature is colder at 10°C. These conditions were selected to be conservative (higher than normal flows and lower than normal temperatures). As shown in the tables, disinfection as practiced at the plant complies with current state and EPA disinfection regulations.

The CT calculations assumed a T_{10}/T factor of 0.1 for the reservoir. Currently, the reservoir is undergoing modifications to add baffles to promote plug flow and improved hydraulic efficiency. Upon completion of this project, it is expected that the T_{10}/T factor will be 0.7 which will greatly enhance disinfection CT for this facility. A T_{10}/T factor of 0.70 increases the disinfection capacity of the existing clearwell sufficient to satisfy all CT credit with chloramines for both summer and winter conditions as defined in the tables.

Table 3.7 *Giardia* Disinfection (1.5 log removal) CT Evaluation for Summer Condition (Flow = 40 mgd; Water Temperature = 20°C; pH = 7.5)

Location	Unit Volume (MG)	Units in Service	Detention Time (min)	T_{10}/T	Free Chlorine Residual (mg/L)	Free Chlorine CT Achieved (mg-min/L)	Free Chlorine CT Required[1] (mg-min/L)	Free Chlorine CT Ratio	Chloramine Residual (mg/L)	Chloramine CT Achieved (mg-min/L)	Chloramine CT Required[1] (mg-min/L)	Chloramine CT Ratio
Influent 54" Line	0.021	1	0.8	1.0	4.5	3.4	53	0.06	0	0	559	0
Flocculation Basins	0.252	2	18	0.7	0	0	33	0.00	4.2	53	559	0.095
Sedimentation Basins	0.692	3	75	0.5	0	0	33	0.00	4.1	153	559	0.274
48" Line to Filters	0.021	1	0.8	1.0	0	0	33	0.00	3.8	2.9	559	0.005
Filters	0.067	5	12	0.7	0	0	33	0.00	3.7	31	559	0.056
Clearwell[2]	9.7	1	349	0.1	0	0	33	0.00	3.5	122	559	0.219
54" Outlet (old+new)	2.252	1	81	1.0	0	0	33	0.00	3.3	268	559	0.479
Total								0.06				1.13

Total CT Ratio 1.19

Notes:
1. Calculated from regression equations of the EPA CT tables
2. Clearwell volume assumes an operational storage of 3.3 MG as outlined in the 2009 Asset Management Master Plan

Table 3.8 *Giardia* Disinfection (1.5 log removal) CT Evaluation for Winter Condition (Flow = 40 mgd; Water Temperature = 20°C; pH = 7.5)

Location	Unit Volume (MG)	Units in Service	Detention Time (min)	T_{10}/T	Free Chlorine Residual (mg/L)	Free Chlorine CT Achieved (mg-min/L)	Free Chlorine CT Required[1] (mg-min/L)	Free Chlorine CT Ratio	Chloramine Residual (mg/L)	Chloramine CT Achieved (mg-min/L)	Chloramine CT Required[1] (mg-min/L)	Chloramine CT Ratio
Influent 54" Line	0.021	1	1.5	1.0	4.5	6.8	106	0.06	0	0	923	0
Flocculation Basins	0.252	2	36	0.7	0	0	63	0.00	4.2	107	923	0.116
Sedimentation Basins	0.692	3	149	0.5	0	0	63	0.00	4.1	306	923	0.332
48" Line to Filters	0.021	1	1.5	1.0	0	0	63	0.00	3.8	5.7	923	0.006
Filters	0.067	5	24	0.7	0	0	63	0.00	3.7	62	923	0.068
Clearwell[2]	9.7	1	698	0.1	0	0	63	0.00	3.5	244	923	0.265
54" Outlet (old+new)	2.252	1	162	1.0	0	0	63	0.00	3.3	535	923	0.580
Total								0.06				1.37

Total CT Ratio 1.43

Notes:
1. Calculated from regression equations of the EPA CT tables
2. Clearwell volume assumes an operational storage of 3.3 MG as outlined in the 2009 Asset Management Master Plan

Future Disinfection Considerations

Ozone is being considered as a potential pre-oxidation process and CIP improvement at the plant (see later discussion in this section). If and when pre-ozonation is implemented, ozone may be used as a primary or additional disinfectant to meet disinfection requirements. Ozone is a powerful biocide for *Giardia* and viruses. *Cryptosporidium* is also inactivated with ozone but only effectively at warmer water temperature. In cold, low temperature waters (< 10°C), ozone *Cryptosporidium* activation requires higher residuals and contact times that are not cost effective compared to ultraviolet light (UV) disinfection.

If additional removal/inactivation of *Cryptosporidium* is required in the future, UV disinfection would be the recommended method of disinfection. Construction and operational costs for UV are a fraction of the costs for ozonation facilities. Project costs to install UV treatment at the WFP are estimated at $5.3 million. The facility would be positioned in the process flow between filtration and the finished water clearwell to take advantage of filtered water clarity for efficient and cost effective dispersion of UV light through the water. UV would require 3 to 4 feet of hydraulic head between the filters and clearwell. Because UV could provide primary disinfection for *Giardia* as well as *Cryptosporidium*, it is envisioned that several feet of clearwell water depth could be used to operate UV and still allow most of the clearwell volume to be converted to operational and system shortage. UV disinfection offers the following advantages:

- Disinfection for future *Cryptosporidium* activation
- Provide primary disinfection for *Giardia*
- Eliminate need for chlorination CT credit. Chloramine would still be used for distribution system disinfection residual.
- Finished water clearwell/reservoir volume available for operational and system storage.

Because UV does not inactivate viruses, the use of free chlorine or chloramine (or ozone if installed) would be needed to meet CT for virus.

Recommendations - Disinfection

The following items present conclusions and recommendations in defining CIPs related to disinfection at WFP.

1. UV disinfection is the most cost effective process to achieve future enhanced disinfection requirements.
2. A project cost of $5.3 million was estimated to install UV disinfection between the filters and clearwell.

SOLIDS HANDLING

Plant residuals or solids are generated through the coagulation and flocculation processes and removed in the sedimentation basins and downstream filtration facilities. The bulk of the solids are removed by gravity clarification within the sedimentation basins. Flocculated, particulate matter that carries over from the clarification process is be removed by the filters.

Plant residuals consist of solids already in the raw water plus those added through chemical addition. The amount of solids generated can be estimated by summing all solids removed from the plant. The unit solids production rate (USPR) is the amount of dry solid material produced per million gallons of water treated and can be calculated based upon the following relationship:

$$USPR=8.34*(f * C + SS + P + TOC + O)$$

Where:

USPR = Unit Solids Production Rate, dry lbs/Mgal
C = Coagulant Dosage, mg/L
f = Coagulant Factor
SS = Raw Water Suspended Solids, mg/L
P = Polymer Dosage, mg/L
TOC = Total Organic Carbon Removed, mg/L
O = Other Solids Production Chemicals, mg/L

The coagulant factor of the above equation relates the quantity of precipitated metal coagulant with respect to the coagulant dosage. This factor has been developed from empirical relationships and calculated to be approximately 0.33 to 0.44 for aluminum solids and 0.46 to 0.66 for ferric chloride usage. A coagulant factor ranging from 0.5 to 0.65 is proposed for PACL. The suspended solids value is a direct measurement of solids in the raw water. Often, suspended solids concentration is not known and turbidity data is used. When using turbidity, it is common to apply a 1:1 to 2:1 suspended solids to turbidity factor (TSS:NTU).

Tables 3.9 and 3.10 contain solids production estimates for the years 2009 and 2010. The estimated annual sludge production for 2009 amounted to 2 million dry pounds. In 2010, the solids production was estimated at 1.7 million pounds. The monthly USPR estimates listed in the tables were calculated using the above equation and actual turbidity, coagulant, polymer, and TOC removal data. The average monthly USPR for both years was in the range of 330 to 340 dry pounds of solids generated for every million gallons of water treated (lbs/Mgal). Higher USPR values occur during spring and early summer months associated with higher coagulant dosages. The tables list monthly production estimates and cumulative totals. Also shown are the projected filter waste washwater (FWW) solids and sedimentation basin solids removed from the sedimentation and filtration processes. These later estimates were calculated assuming that overall on a monthly basis 75 percent of the total solids were removed through gravity clarification in the sedimentation basins and the remaining 25 percent were captured by the granular media filters. The 25 percent estimate was based upon the general performance of the existing sed basins.

Average monthly production estimates are useful for sizing and operating sludge drying beds and sludge lagoons because these facilities have significant solids equalization and storage capacities. Daily production estimates are more appropriate for sizing and operating mechanical thickening and dewatering facilities where equalization is not provided. The maximum day production is estimated at 12,000 lbs/day based upon a 30 mgd plant flow rate in conjunction with a 400 lbs/Mgal USPR (12,000 lbs/day = 30 mgd x 400 lbs/Mgal). Of this maximum daily value, it is estimated that 9,000 lbs/day would be removed through the sedimentation basins and the remaining 3,000 lbs/day via the filters.

Table 3.9 2009 Monthly Historical Solids Production Estimates

			Average WQ and Dosages				Total Solids Production			FWW Solids Production*		SB Solids Production	
Month	Ave Daily Flow (mgd)	Monthly Flow (MG)	Turbidity (NTU)	PACl (mg/L)	TOC (mg/L)	Polymer (mg/L)	USPR (lbs/MG)	Monthly (lbs/mo)	Acc Totals (lbs)	Monthly (lbs)	Acc Totals (lbs)	Monthly (lbs)	Acc Totals (lbs)
Jan	9.8	304	5.4	39	1.6	1.3	287	87,160	87,160	21,790	21,790	65,370	65,370
Feb	9.4	263	6.1	48	2.8	1.6	353	92,970	180,130	23,250	45,040	69,720	135,090
Mar	15.4	477	3.3	59	2.7	2	376	179,370	359,500	44,850	89,890	134,520	269,610
April	18.4	552	2.2	72	2.8	2.3	430	237,550	597,050	59,390	149,280	178,160	447,770
May	19.6	608	2.5	68	2.1	2.2	407	247,550	844,600	61,890	211,170	185,660	633,430
June	19.1	573	2.3	68	2.0	2.2	404	231,540	1,076,140	57,890	269,060	173,650	807,080
July	21.0	651	2.3	65	2.9	2.2	397	258,170	1,334,310	64,550	333,610	193,620	1,000,700
Aug	21.5	667	2.0	39	1.4	1.5	244	162,870	1,497,180	40,720	374,330	122,150	1,122,850
Sept	21.1	633	2.2	38	1.8	1.5	245	155,210	1,652,390	38,810	413,140	116,400	1,239,250
Oct	17.9	555	3.3	43	2.4	1.7	291	161,290	1,813,680	40,330	453,470	120,960	1,360,210
Nov	14.0	420	5.1	53	2.6	2.3	370	155,350	1,969,030	38,840	492,310	116,510	1,476,720
Dec	9.5	295	4.4	32	2.2	1.3	244	71,970	2,041,000	18,000	510,310	53,970	1,530,690
Ave/Tot	16.4	5,997					340						

USPR: Unit Solids Production Rate

TSS:NTU=	1.50
Coagulant Factor=	0.60
*FWW Solids Distribution Factor=	25%

Data Input Cells

Table 3.10 2010 Monthly Historical Solids Production Estimates

			Average WQ and Dosages				Total Solids Production			FWW Solids Production*		SB Solids Production	
Month	Ave Daily Flow (mgd)	Monthly Flow (MG)	Turbidity (NTU)	PACl (mg/L)	TOC (mg/L)	Polymer (mg/L)	USPR (lbs/MG)	Monthly (lbs/mo)	Acc Totals (lbs)	Monthly (lbs)	Acc Totals (lbs)	Monthly (lbs)	Acc Totals (lbs)
Jan	7.8	242	8.2	29	2.6	1.3	280	67,760	67,760	16,940	16,940	50,820	50,820
Feb	7.1	199	7.3	52	2.0	2.4	388	77,180	144,940	19,300	36,240	57,880	108,700
Mar	11.4	353	7.0	67	3.8	3.0	480	169,480	314,420	42,370	78,610	127,110	235,810
April	13.2	396	3.3	55	2.2	2.3	354	140,200	454,620	35,050	113,660	105,150	340,960
May	18.9	586	1.6	58	2.5	2.3	350	205,230	659,850	51,310	164,970	153,920	494,880
June	19.2	576	3.1	50	2.1	2.1	324	186,630	846,480	46,660	211,630	139,970	634,850
July	19.8	614	2.8	36	2.1	1.9	249	152,550	999,030	38,140	249,770	114,410	749,260
Aug	21.1	654	2.4	42	2.5	2.1	279	182,210	1,181,240	45,560	295,330	136,650	885,910
Sept	20.0	600	2.8	41	2.1	2.1	275	165,140	1,346,380	41,290	336,620	123,850	1,009,760
Oct	11.5	357	5.6	50	2.1	2.6	359	128,150	1,474,530	32,040	368,660	96,110	1,105,870
Nov	12.5	375	4.6	44	2.6	2.3	319	119,480	1,594,010	29,870	398,530	89,610	1,195,480
Dec	9.5	295	9.4	46	3.1	2.4	394	115,930	1,709,940	28,990	427,520	86,940	1,282,420
Ave/Tot	14.4	5,246					326						

USPR: Unit Solids Production Rate

TSS:NTU=	1.50
Coagulant Factor=	0.60
*FWW Solids Distribution Factor=	25%

Data Input Cells

Current Facilities and Operations

A site plan identifying the existing washwater and solids handling facilities is presented as Figure 3.11. The handling facilities and current operations are discussed below.

FWW Handling

Existing washwater handling facilities at the plant site consist of the following:

- Two FWW equalization ponds
- A two-train Actiflo™ process facility
- FWW recycle pump station

The original intent for the Actiflo™ equipment, constructed in 2002, was for treatment and clarification of FWW. Clarified washwater would be pumped and recycled to the head of the plant. Settled solids and sludge from the Actiflo™ process would be pumped to the circular thickener and then dewatered via centrifugation. Currently, FWW flows by gravity from the filters to the equalization ponds where the washwater is equalized. From the ponds, FWW is transported by gravity at a reduced rate to SDR. The existing Actiflo™ facility has been abandoned and is no longer operated for FWW clarification. Hence, washwater and solids from the equalization ponds bypasses the Actiflo™ process and flow directly to SDR. Plant staff terminated use of Actiflo™ treatment for a number of reasons as listed below:

- Difficult and challenging to operate
- Batch treatment with frequent start/stop operation
- Actiflo™ treated and recycled washwater disrupts main plant treatment process performance
- Actiflo™ requires use of coagulant plus bridging polymer plus sand; all O&M intensive

The Actiflo™ sludge also contains a significant amount of sand that escapes the sand separation process. The sand can erode and abrade mechanical dewatering equipment.

Solids Handling

Existing sludge handling and dewatering facilities at the site include:

- Four sludge drying beds (10,000 ft^2 each)
- One circular solids thickener and sludge pumps
- One centrifuge
- Dewatering building (houses centrifuge and polymer feed system)

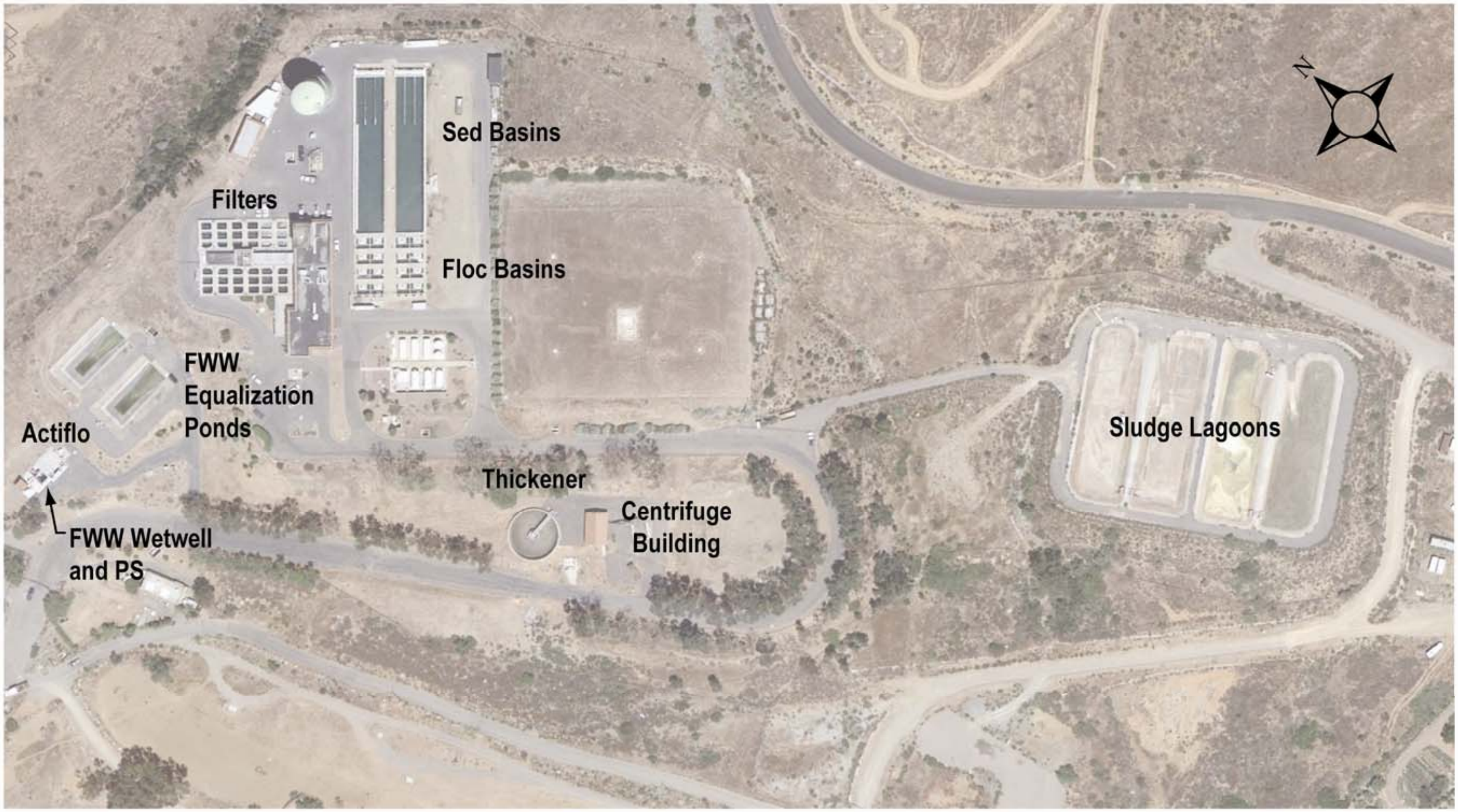

Figure 3.11 Identification and Location of Existing Solids Handling Facilities

The original plant construction enlisted two small sludge lagoons located adjacent to the equalization ponds. These lagoons were used for dewatering and drying solids but have long since been replaced and abandoned. Four larger sludge drying beds were later constructed to receive and dry settled sludge from the sedimentation basins. In 2002, the mechanical dewatering facilities consisting of the circular thickener and centrifuge building were designed and installed to process the increasing quantity of residuals produced at the plant.

Operation of the mechanical dewatering equipment was short lived. The manganese and sulfides concentrated in the aged and anoxic sludge created significant corrosion problems for the centrifuge. Due to erosion and corrosion of the equipment, lack of standby units (only one thickener and one centrifuge were constructed and installed at the plant), coupled with manpower and cost requirements to operate the mechanical systems, the mechanical dewatering facilities became in-operable. The circular sludge thickener and its companion centrifuge are not in use nor functional.

Currently, settled solids are diverted from the sedimentation basins directly to the sludge drying beds for processing. Plant operations personnel have experimented with numerous methods to enhance the dewatering capability of the drying beds but these facilities are just not of sufficient size and capacity to handle and dewater all the solids generated at the plant. As a result, the drying beds process as much sludge as possible but a major portion is sent to SDR along with the FWW. For the past several years, it is estimated that approximately half of the plant residuals have been diverted to SDR because of insufficient and ineffective dewatering capabilities at the treatment site. Diverted solids settle to the bottom of SDR consuming storage volume of this raw water reservoir. Recent studies determined that the operating volume of SDR has decreased at a rate of 10 AF/yr for the past 13 years. This volume closely relates to the amount of solids likely diverted into the reservoir over the same time period.

Capital Improvement Options

A number of options for replacing and increasing solids dewatering capacity at the WFP are presented. These options are focused at methods for clarifying FWW and for increasing dewatering facilities to meet the solids handling objectives defined herein. Options for discussion include:

- Use of sludge drying beds
- FWW clarification using existing Actiflo™ or sludge lagoons
- Mechanical dewatering

From these alternatives, SFID/SDWD can move forward in developing and implementing CIPs to resolve the solids handling needs.

Sludge Drying Beds

The use of engineered lagoons, or sludge drying beds as currently configured onsite, is a proven and simple method for handling and dewatering water plant residuals. The key success factor is sufficient surface area for drying sludge. Settled solids are blown down from the sed basins as a dilute suspension and transferred to the lagoons where the liquid stream is clarified and decanted and the solids are gravity thickened, stored, and ultimately dewatered; primarily via solar evaporation with some percolation depending upon the porosity of the bed. Dewatering or sludge drying works best in dry climates with hot summer months. Drying time is largely dependent upon the solids loading rate and resultant depth of sludge zone after all the free standing water has been decanted from the sludge.

Beds are operated in multiple cycles with sludge loading rates of 4 to 5 lbs/ft^2 per cycle. This results in a relative shallow sludge layer that can be dewatered and removed in a reasonable amount of time. In this region, two to three cycles per year can be realized yielding a total annual loading rate of 10 to 12 dry pounds per square feet (lbs/ft^2) of drying bed area. Based upon these values, the annual dewatering capacity of the four existing drying beds is estimated at approximately 500,000 pounds of dry sludge per year (480,000 lbs/yr = 40,000 ft^2 x 12 $lbs/ft^2/yr$). Estimated sludge production for the past several years has been in the range of 1,700,000 to 2,000,000 lbs per year. This amount exceeds the estimated drying bed capacity by three to four times. To adequately dewater solids currently generated at the plant, 10 to 12 additional drying beds of the same size as existing would need to be constructed.

Given the available land areas and existing site topography, it may be possible to configure four lagoons in the unused area south and off the hill from the existing beds and another two lagoons between the drying beds and the horseshoe bend of the access road. Capacity of six new lagoons is only half of what is needed. There is simply not enough available, useable area on the existing site to establish sufficient drying bed capacity. Given these conditions, the necessity of mechanical dewatering to process solids remains in effect.

Actiflo™ for FWW Treatment

To take advantage of previously expended capital, SFID/SDWD desires to reinstate and utilize the Actiflo™ facility for clarifying FWW and eliminating discharge of washwater solids to SDR. This option has been developed to meet that objective in conjunction with mechanical dewatering upgrades and expansion capacity. The approach for mechanical dewatering is presented and discussed later on.

Description. This option uses the Actiflo™ process for treatment and clarification of FWW generated by filter backwash operations. As depicted in the solids handling diagram of Figure 3.12, FWW flows to the existing equalization ponds. From the ponds, FWW would be metered at a reduced rate to the Actiflo™ basins for treatment. Clarified washwater (RWW) would then flow by gravity to SDR to be blended with raw water and eventually returned to the plant. Alternatively, RWW could be pumped directly to the head of the plant via the existing FWW pumps located in the Actiflo™ settled water wetwell. However, past experience indicates poor plant performance when Actiflo™ treated RWW is directly recycled.

Solids removed via the Actiflo™ process would be pumped through the 4-inch and 8-inch diameter sludge piping to the sludge drying lagoons for processing. Decant or clarified water from the drying beds would be collected and flow by gravity through the 8-inch decant line and onto SDR. For this option, it is imperative that Actiflo™ sludge be dewatered using the drying beds as the sand laden sludge would adversely impact mechanical dewatering equipment. Therefore, all Actiflo™ sludge would be transferred to the lagoons. From Tables 3.9 and 3.10, the estimated solids generated from backwash amount to approximately 500,000 dry lbs/yr, which matches the dewatering and drying capacity of the four drying beds.

The Actiflo™ process would treat a maximum capacity of 1,800 gpm, which corresponds to the flow rate to treat one backwash volume in a two-hour time period. This rate would allow plant operations staff to backwash one filter every two hours, which should be more than adequate to maintain filter production needs. Based upon these requirements, only one of the two Actiflo™ process trains would be needed to clarify FWW and satisfy filter backwashing operations.

As part of this option, mechanical dewatering facilities would be updated and expanded as illustrated in Figure 3.12 to provide sufficient capacity to process and dewater solids generated from the pretreatment and sedimentation basins. Mechanical dewatering is discussed below.

Improvement Elements. The following modifications, equipment, and updates would be needed to implement the Actiflo™ Option for FWW handling:

- Update and re-activate the Actiflo™ basins and equipment to for use and operations.
- Minor yard piping to connect the 4-inch and 8-inch sludge piping to deliver Actiflo™ sludge to the existing drying beds.

Costs. Project costs to implement the Actiflo™ Option are relatively minimum. It is estimated that $50,000 would be sufficient to update the Actiflo™ facility by cleaning out the basins and maintaining mixers, pumps, valves, feeders, motors and electrical gear. This assumes that the existing equipment can be reused and does not require replacement or major modifications. Another $50,000 would be needed to install a short length of 4-inch piping from the thickener up the hill and connect to the 8-inch sludge pipeline that connects to the drying beds. Total project costs for this option is estimated at $100,000 (exclusive of mechanical dewatering). Annual operating costs are estimated at $30,000 per year for electric power and chemicals but exclusive of manpower for operations and maintenance.

Lagoons for FWW Treatment

Description. This approach employs the existing sludge drying beds to serve as lagoons for treating FWW to provide both clarification and solids dewatering functions as illustrated in the solids handling diagram of Figure 3.13. FWW would flow from the filters to the washwater equalization ponds as currently practiced. The existing Actiflo™ inlet valve would be modified to modulate and maintain water level in the FWW pump station wetwell. FWW would be pumped from the wetwell at a controlled rate to the drying beds. The drying beds are large enough to serve as washwater recover lagoons and provide clarification at the 1,800 flow rate. And, the lagoons have sufficient area and volume to properly thicken, store and dewater the FWW solids. From Tables 3.9 and 3.10, the estimated solids generated from backwash amount to approximately 500,000 dry lbs/yr, which matches the dewatering and drying capacity of the four drying beds.

All FWW and solids would be pumped to the lagoons via a new 14-inch diameter pipeline. A new pipeline is necessary because the existing 4-inch and 8-inch sludge lines are too small to convey the 1,800-gpm FWW rate of flow. Clarified washwater (RWW) would flow by gravity from the lagoons to SDR where it is blended with raw water and eventually returned to the plant. A new, larger diameter RWW pipeline will be needed between the lagoons and the emergency bypass connection to support gravity flow at the higher rates.

As part of th is option, mechanical dewatering facilities would also be updated and expanded as illustrated in Figure 3.13 to provide sufficient capacity to process and dewater solids generated from the pretreatment and sedimentation basins. Mechanical dewatering is discussed below.

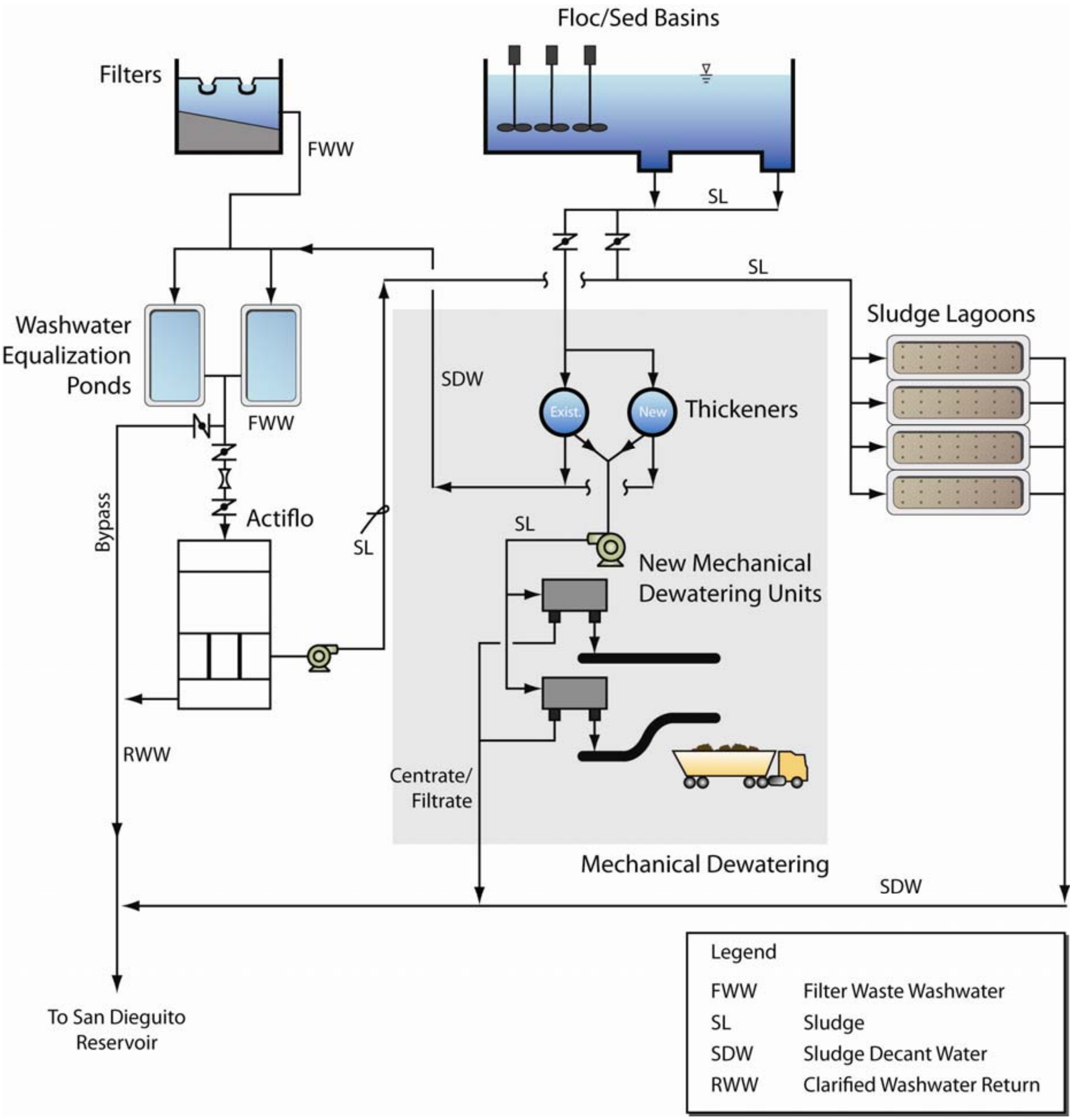

Figure 3.12 Solids Handling Diagram Using Actiflo™ Option for FWW Clarification

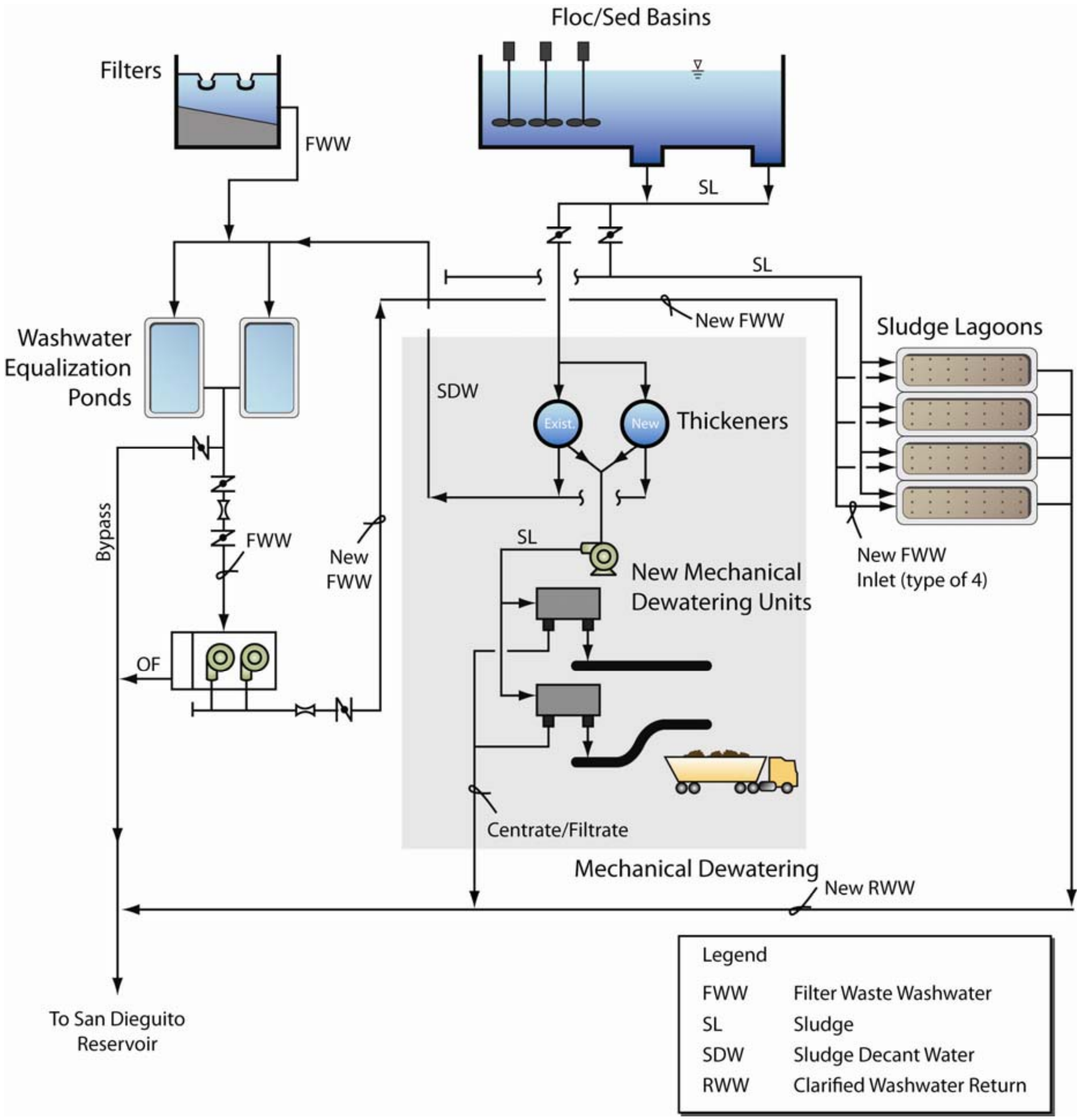

Figure 3.13 Solids Handling Diagram Using Lagoon Option for FWW Clarification

Improvement Elements. The following piping, equipment, and modifications would be needed to implement the Lagoon Option:

- Modification/renovation to FWW pump station and wetwell.
- Minor yard piping between FWW equalization ponds and pump station wetwell.
- New 14-inch force main between FWW pump station and drying beds (lagoons).
- New 14-inch gravity pipeline between lagoons and connection to 15-inch overflow pipeline to SDR.
- New FWW inlet connections to existing sludge lagoons.

Costs. Project costs to implement the Lagoon Option are summarized in Table 3.11. The major cost elements include the new force main and gravity pipelines to convey the higher FWW flows to and from the lagoons. The total project or estimate for implementing the Lagoon Option for FWW clarification using the existing drying beds amounts to $960,000.

Table 3.11 Estimated Project Cost for Lagoon Option

Description	Estimate
FWW PS and wetwell modifications	$45,000
Minor yard piping	$30,000
New 14-inch force main (2500 ft)	$420,000
New 14-inch gravity piping (2500 ft)	$420,000
FWW inlet connections/valves	$45,000
Estimated Project Cost	$960,000

Annual electric power costs to operate the pumps are estimated at $30,000 per year. This assumes an annual daily flow of 0.60 mgd resulting from three filter backwashes per day. Labor for O&M are not included in the estimate.

Mechanical Dewatering

Figures 3.12 and 3.13 depict components and solids handling diagram for the sludge thickener and mechanical dewatering processes needed to accomplish solids handling at the treatment facility. These would be common for either the Actiflo™ or Lagoon Options. A brief description and operation of the mechanical dewatering component are provided below.

Description. Settled solids from the sed basins would be diverted to one of two sludge thickeners. Thickened sludge would be pumped to the mechanical dewatering equipment. Dewatered sludge would be conveyed to a truck or dumpster for solids transport. Decant from the sludge thickeners would gravity flow to the washwater equalization ponds. Centrate or filtrate from the mechanical dewatering units would be collected and diverted with the clarified RWW flow to SDR. To preserve capital, the existing thickener would be cleaned, re-furbished, and reused in conjunction with a second new thickener. The type of mechanical dewatering equipment would be determined in subsequent phases of the CIP with consideration for a belt press or centrifuge. Rehabilitation and reuse of the existing centrifuge should be considered.

Capacity of the expanded mechanical dewatering facilities should be based upon maximum day sludge production. Currently maximum day estimates are 12,000 lbs/day with the major portion (9,000 lbs/day) being removed via sedimentation for delivery to the mechanical system. Both FWW handling options take advantage of the existing drying beds for processing washwater solids and reducing required operating capacity of the mechanical system. The solids handling schematics depict minor piping improvements that would allow diversion of sed basin sludge to either the thickeners or the sludge lagoons allowing for flexibility in solids handling operations.

Improvement Elements. The following piping, equipment, and modifications are proposed to implement the mechanical dewatering elements for solids handling at the site:

- Rehab existing thickener/clarifier
- Construct one new thickener
- Sludge pumping station complete with structure, valves, piping, etc.
- New mechanical dewatering equipment
- Modifications and expansion to dewatering building and out-loading equipment and facilities
- Minor yard piping and connections
- Electrical and instrumentation/control improvements

Costs. Project costs to implement the mechanical dewatering elements of the solids handling facilities are summarized in Table 3.12. The total estimated project cost for upgrading and expanding the mechanical dewatering facilities amounts to $5.4 million.

Table 3.12 Estimated Project Cost for Mechanical Dewatering Improvements

Description	Estimate
Rehab existing thickener	$120,000
Construct new thickener	$750,000
Sludge pumping station	$225,000
Dewatering Equipment	$2,550,000
Building/out-loading expansion	$480,000
Minor yard piping improvements	$150,000
Electrical and I&C	$795,000
Estimated Project Cost	$5,370,000

Annual operating costs have been estimated for mechanical dewatering of sludges generated at the plant. These costs are listed in Table 3.13 and include pumping costs to transfer FWW solids to the sludge lagoons. Annual estimates consist of labor, power, chemicals, transporting, and disposal of dewatered solids to a landfill. Assumptions used in developing the annual costs are also noted in the table. The total estimates for processing and dewatering settled sludges and FWW solids amounts to $680,000 per year. Unit costs are calculated based upon handling 2 million dry lbs/yr (1,000 tons) and yield $680 per dry ton, $0.34 per lbs processed and $36 per acre-ft of an nual water treated. The $/acre-ft unit cost is based upon an annual production of 19,000 acre-ft.

Table 3.13 Estimated Annual Operating Cost for WFP Solids Handling

Description	Estimate
Labor	$220,000
Electrical Power	$190,000
Chemicals	$20,000
Sludge Transport/Hauling	$50,000
Landfill Disposal	$170,000
FWW Pumping	$30,000
Total	$680,000
Cost per dry ton	$680
Cost per lb	$0.34
Cost per acre-ft production	$36

Notes
1. Assumes1.5 additional full-time employees.
2. Based on 2 million dry lbs/yr; 1,000 tons.
3. Water production at 19,000 acre-ft/yr.

Summary - Solids Handling

Solids generated at the WFP have overrun the site. The existing drying beds do not have sufficient capacity to handle the solids loading and the m echanical dewatering equipment and facilities have failed and are not useable. As a result, approximately half of all sludge from the sedimentation basins ends up in the San Dieguito Reservoir. The Actiflo™ unit that was constructed to treat and clarify FWW has been abandoned resulting in FWW being diverted directly into SDR without treatment. Master planning objectives for the solids handling CIP call for elimination of solids disposal in SDR and upgrade and expansion capacity to the dewatering facilities to meet production requirements. A com bination of F WW clarification and implementation of m echanical dewatering is required to meet project objectives.

FWW Handling

Two options for clarifying washwater were developed and evaluated. The Actiflo™ Option would re-instate the abandoned Actiflo™ facility. The Lagoon Option involves pumping of FWW through a new force main to the existing sludge lagoons. Both utilize the drying beds for processing and dewatering FWW solids, which represents approximately 25 percent capacity of the total estimated annual sludge production of 2 million dry lbs/yr.

The estimated project cost to implement the Actiflo™ Option is $100,000 less expensive than the $960,000 capital cost for the Lagoon Option. Annual operating costs for these FWW treatment options are similar, estimated at $30,000, excluding labor.

Operation of the Actiflo™ process for washwater clarification is much more challenging that operating the pumping station required for the Lagoon Option. Previous experience at the plant in treating FWW with the high-rate Actiflo™ process yielded unacceptable results by the operations staff as measured by water quality and equipment O&M issues.

Solids Handling and Dewatering

Mechanical dewatering is required to process and dewater the amount of solids generated at the plant. The existing equipment and facilities need to be rehabilitated and expanded to provide an operable system. In addition, the upgraded mechanical dewatering facility must be designed and configured with redundant process and equipment for a reliable and functional system. The facility should be sized to handle maximum day sludge production from the sedimentation basins. The existing drying beds would be used to process and dewater solids generated from the granular media filters. Combined, the system must handle up to 12,000 dry lbs/day and 2 million dry lbs/yr.

Estimated project costs to update, expand, and replace elements of the mechanical dewatering facilities amount to $5.4 million. The type of dewatering equipment selected, whether belt press or centrifuge, will be determined in subsequent preliminary design phases.

Recommendations - Solids Handling

The following items present conclusions and recommendations in defining CIPs related to solids handling at the WFP:

1. Weighing the capital costs and operational issues associated with the Actiflo™ versus the Lagoon Options for clarifying FWW, it is recommended that the CIP be configured for implementation of the Lagoon Option. The cost for this element of the CIP is $960,000.

2. Mechanical dewatering is required at the site. This element of the solids handling CIP amounts to $5.4 million.

3. The total budget of $6,330,000 is required to implement the complete solids handling CIP.

4. SFID/SDWD should move forward with predesign, final design and construction of the solids handling CIP. Predesign and design activities should give consideration for and resolution of the following design and operational details:

   a. Verify size of mechanical dewatering system.

   b. Determine and select type of dewatering equipment.

   c. Investigate potential to refurbish and use the existing centrifuge.

   d. Provide flexibility for delivery of settled sludges to the thickeners and sludge lagoons.

   e. Provide redundant, standby equipment for reliable operations.

   f. Provide means of managing sludge age and to control and minimize anoxic conditions and release of manganese and sulfides within the sludges.

   g. Properly size dewatering units, thickeners, pumps, etc. to satisfy range of operating requirements at the site.

OTHER POTENTIAL PROCESS MODIFICATIONS TO IMPROVE PERFORMANCE AND TREATED WATER QUALITY

Based on discussion presented earlier in this section as well as in Section 2, the WFP has the following water quality limitations:

1. THM formation, while still below the MCL of 80 µg/L, is projected to further increase when SFID/SDWD begins monitoring under the requirements of the Stage 2 D/DBP Rule. The plant can greatly benefit from measures to reduce THM formation.

2. While no data were available on NDMA formation, experience at other plants suggests that the current practice of maintaining elevated levels of chloramine through flocculation and sedimentation in the presence of poly-DADMAC cationic polymers is likely to form unacceptable levels of NDMA.

3. The WFP relies on the combination of chlorine and chloramine through the entire treatment plant to meet its disinfection requirements. With the desire to reduce THM and NDMA formation, the plant should rely less on chlorine addition to the raw water, and should evaluate delaying chloramine addition until after sedimentation or filtration.

4. While the local water supplies contain very high levels of T&O chemicals at times, the WFP has no treatment processes capable of removing these chemicals from water. The plant can use a treatment process that can either remove or destroy T&O chemicals from the water.

Figure 3.14 contains a revised treatment scheme that will help resolve the first three deficiencies. The revised treatment scheme will be implemented after the current clearwell modification project (i.e., baffles) is completed.

To address all the above deficiencies with a different approach, the WFP can benefit from a strong alternative oxidation process that is capable of oxidizing manganese and T&O chemicals, and a modified disinfection strategy that reduces THM formation and eliminates the potential for NDMA formation without compromising the plant's ability to meet its disinfection requirements.

One alternative oxidant worthy of consideration is ozone. Ozone is a powerful oxidant capable of destroying MIB, Geosmin, and other T&O chemicals. Ozone is also a strong oxidant of manganese as well as iron, sulfide, and color that may be present in local water supplies. Ozone's greatest challenge when treating SFID/SDWD's water sources is the potential formation of bromate, BrO_3^-, which is a regulated disinfection by-product with an MCL of 10 µg/L in drinking water. Bromate is formed from the reaction of ozone with bromide ions, Br^-. Bromide is present in CWA water and well as SFID/SDWD's local water supply. Over the last 10 years, the bromide level in SDR water ranged from a low of 0.4 mg/L to a high of 0.75 mg/L with an average of 0.57 mg/L. This is considered to be a high bromide level requiring the implementation of a bromate formation mitigation strategy. However, it is believed that the benefits of ozone could very well outweigh the concerns over bromate formation, especially because bromate formation could be effectively controlled.

Ozone application for the treatment of Lake Hodges water was evaluated by the Olivenhain Municipal Water District (OMWD). Bench-scale testing showed that an ozone dose of 8.5 mg/L is capable of achieving greater than 80 percent destruction of MIB and Geosmin, and greater than 90 percent oxidation of manganese. The water used for testing contained 0.4 mg/L bromide. At an ozone dose of 8.5 mg/L, the bromate level formed was only 1.8 µg/L, which is well below the MCL of 10 µg/L. This performance needs to be confirmed with pilot-scale testing to ensure satisfactory performance under seasonal water quality changes and multiple blends of local and imported water supplies.

With ozone as a preoxidant, SFID/SDWD can eliminate the use of chlorine dioxide as a preoxidant, and could eliminate the need to add free chlorine to the raw water and maintain chloramine contact through the flocculation and sedimentation processes. This should reduce the NDMA formation potential at the treatment plant. Delaying chlorine addition until after sedimentation or filtration would also take advantage of the lower TOC levels in the settled water to result in the formation of lower THM levels in the treated water.

Because of the potentially high ozone demand of the water, it is unlikely that ozone can be used to satisfy the plant's *Giardia* disinfection requirements. Therefore, chlorine or an alternative disinfectant would need to be added through or downstream of the filters. One option is to utilize free chlorine contact through the media filters, followed by chloramine contact through the clearwell. If chlorine contact through the filters will generate excessive THM levels, another option is to utilize UV disinfection to meet the *Giardia* inactivation requirements, and then use a short free chlorine contact time to meet the virus inactivation requirements before adding ammonia to form chloramine. This approach will result in minimal THM formation while maintaining compliance with all the disinfection requirements for *Giardia* and virus inactivation.

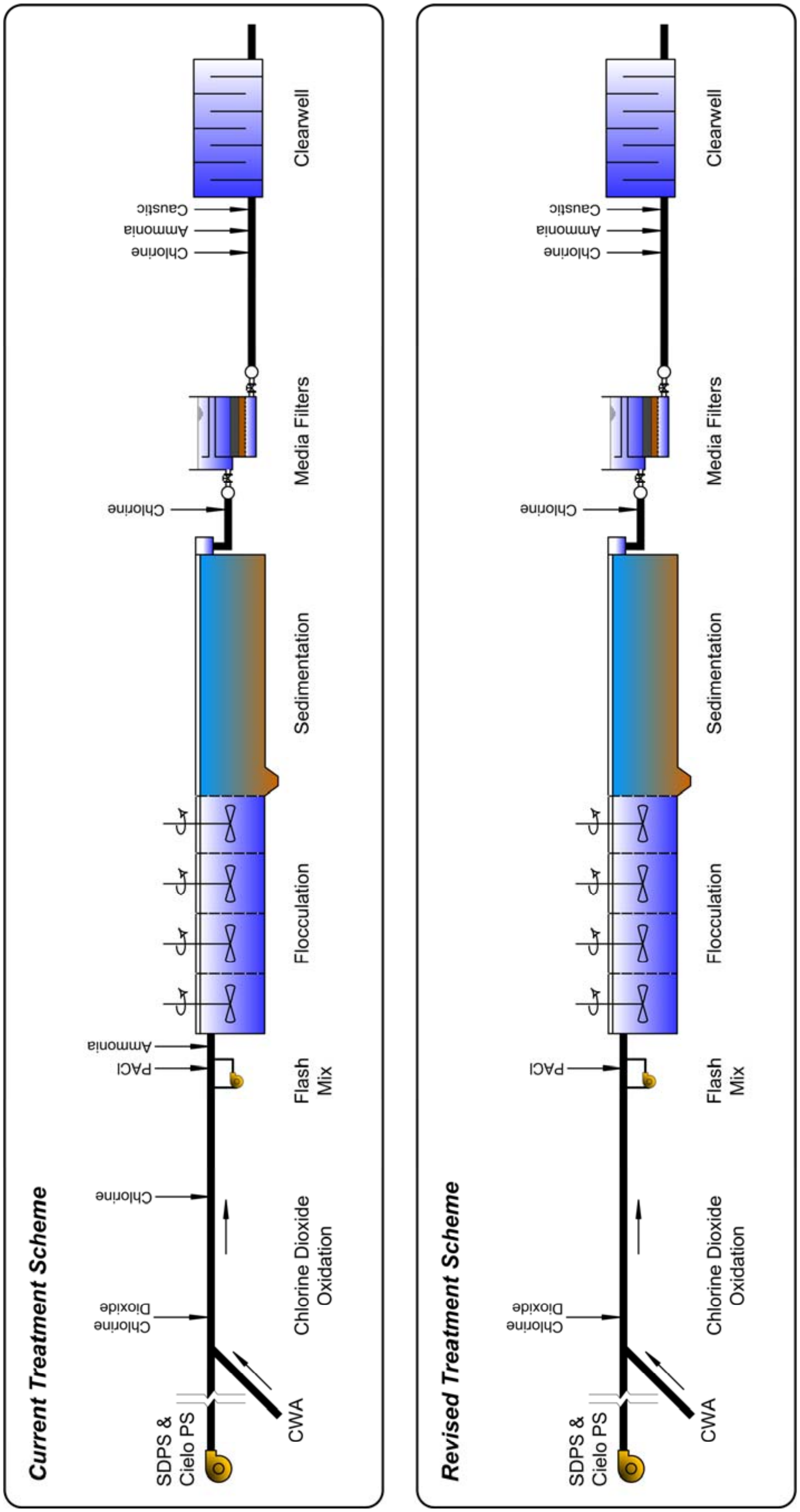

Figure 3.14 Revised Treatment Scheme for the WFP

Another modification that can be implemented at the WFP is slight pH suppression to reduce scaling in the distribution system. Under current treatment conditions, a caustic dose of approximately 8 mg/L is added to the filtered water to raise the pH of the water entering the clearwell and distribution system to a range of 8.0 to 8.2. Under typical water quality conditions, this is a good pH range to protect the distribution system against corrosion, including lead and copper corrosion from in-house plumbing. However, the TDS, hardness, and alkalinity of the WFP effluent are quite high resulting in a relatively high Langelier Saturation Index (LSI). Table 3.14 lists the average and range of the pertinent effluent water quality parameters during 2009 and 2010. The LSI at 25°C (LSI_{25}) ranged from 0.5 to 1.1 with an average of 0.7. This is an unnecessarily high LSI value that may result in excessive scaling of $CaCO_3$ in the distribution system. The LSI value at 60°C (LSI_{60}) is even higher with a range of 0.9 to 1.5 and an average of 1.2. This high-temperature LSI reflects the water precipitation potential in residential water heaters, which are typically maintained at a temperature of 60°C.

Table 3.14 Effluent WFP Water Quality Characteristics (2009 – 2010)

Parameter	Unit	Average	Range
pH	--	8.2	8.1 to 8.5
Alkalinity	mg/L as $CaCO_3$	137	106 to 170
Total-Hardness	mg/L as $CaCO_3$	294	220 to 380
Total Dissolved Solids (TDS)	mg/L	655	488 to 830
LSI @ 25°C (LSI_{25})	--	0.7	0.5 to 1.1
LSI @ 60°C (LSI_{60})	--	1.2	0.9 to 1.5

It is our experience that an LSI_{25} value between –0.2 and +0.5 is sufficiently protective of a distribution system. Lowering the LSI can be achieved by reducing the caustic dose added at the plant and thus lowering the pH of the water entering the distribution system. Figure 3.15 shows a profile of the water pH in the effluent of the WFP between June 2009 and February 2010 and the pH of saturation at 25°C calculated based on the general effluent water quality (i.e., pH, alkalinity, calcium hardness, and TDS). The plot shows that the current pH is approximately 0.8 pH units above the saturation pH value. If the effluent pH is lowered to a range of 7.6 to 7.8, it should still maintain a slightly positive LSI_{25}.

If SFID/SDWD considers lowering the pH of the water in the distribution system to reduce $CaCO_3$ scaling, it is imperative that significant monitoring be implemented in the distribution system and in-house plumbing to ensure that this action does not result in unintended consequences in the distribution system.

In order to accommodate potential process modifications, the chemical feed system will need some upgrades to provide dedicated chemical injection points. Currently, chemicals can feed to different locations, but do so through a common system making simultaneous injection to multiply points difficult. One additional injection point desired by plant staff is the capability to add chlorine or chlorine dioxide to the backwash line. It is estimated that chemical feed system improvements will cost approximately $75,000.

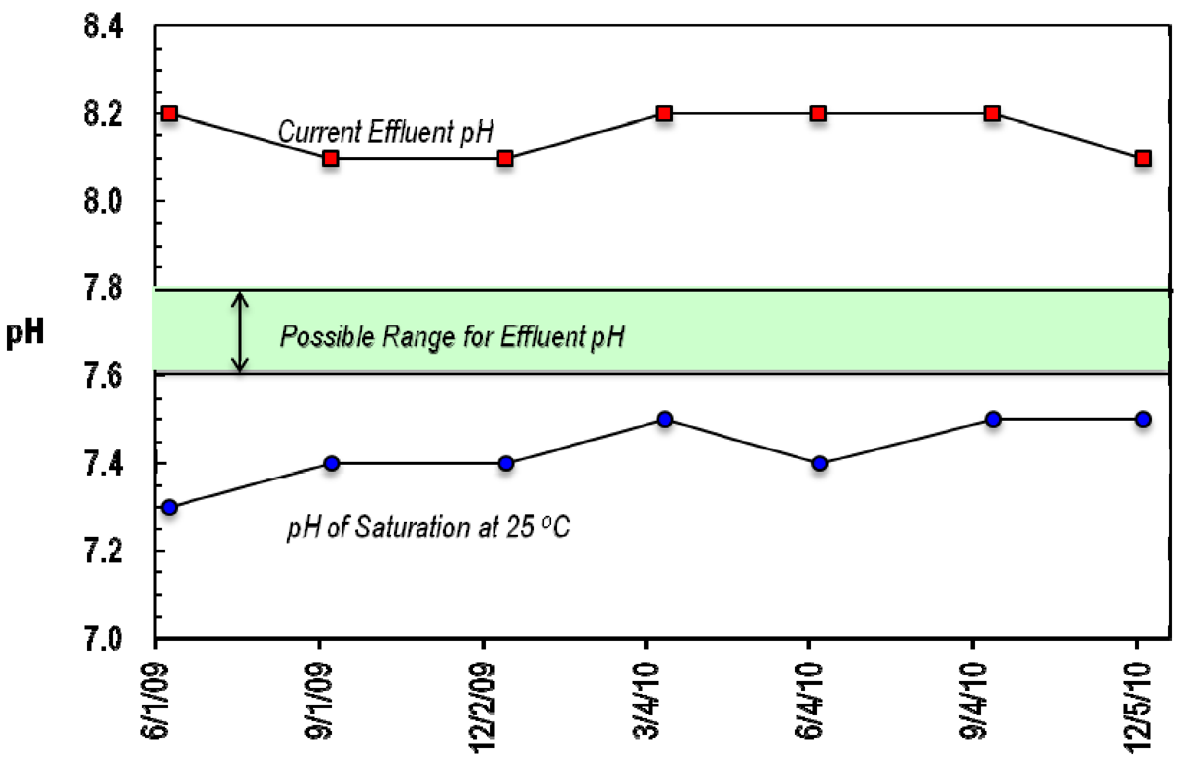

Figure 3.15 Current and Potential Operating Range for WFP Effluent pH Value

Incorporating Ozone with or without UV

Preliminary approaches for implementing ozone with or without UV disinfection at the WFP is discussed below. The two alternatives are summarized in Figure 3.16. Under both Alternative Nos. 1 and 2, ozone is used as a preoxidant in lieu of chlorine dioxide and chlorine addition to the raw water. Chlorine and ammonia addition points are shown upstream of the ozone contactor. If needed, these would be utilized at low doses (0.5 to 1.0 mg/L chlorine) to control bromate formation. However, they are not intended for disinfection or oxidation. Figure 3.15 also shows ozone to be applied in a pipeline contactor configuration. Alternatively, a closed-chamber ozone contactor may be utilized. An engineering and financial analysis needs to be conducted to determine what type of ozone contactor is most appropriate for the WFP.

Alternative No. 1 shows chlorine being added to the settled water with the goal of achieving partial disinfection with free chlorine contact through the filters before ammonia addition. The remaining disinfection requirements would need to be met with chloramine through the clearwell. Pilot scale testing of this approach would need to be implemented to determine the viability of this approach. It is noted that maintaining chlorine through the filters would prevent biological activity in the filters.

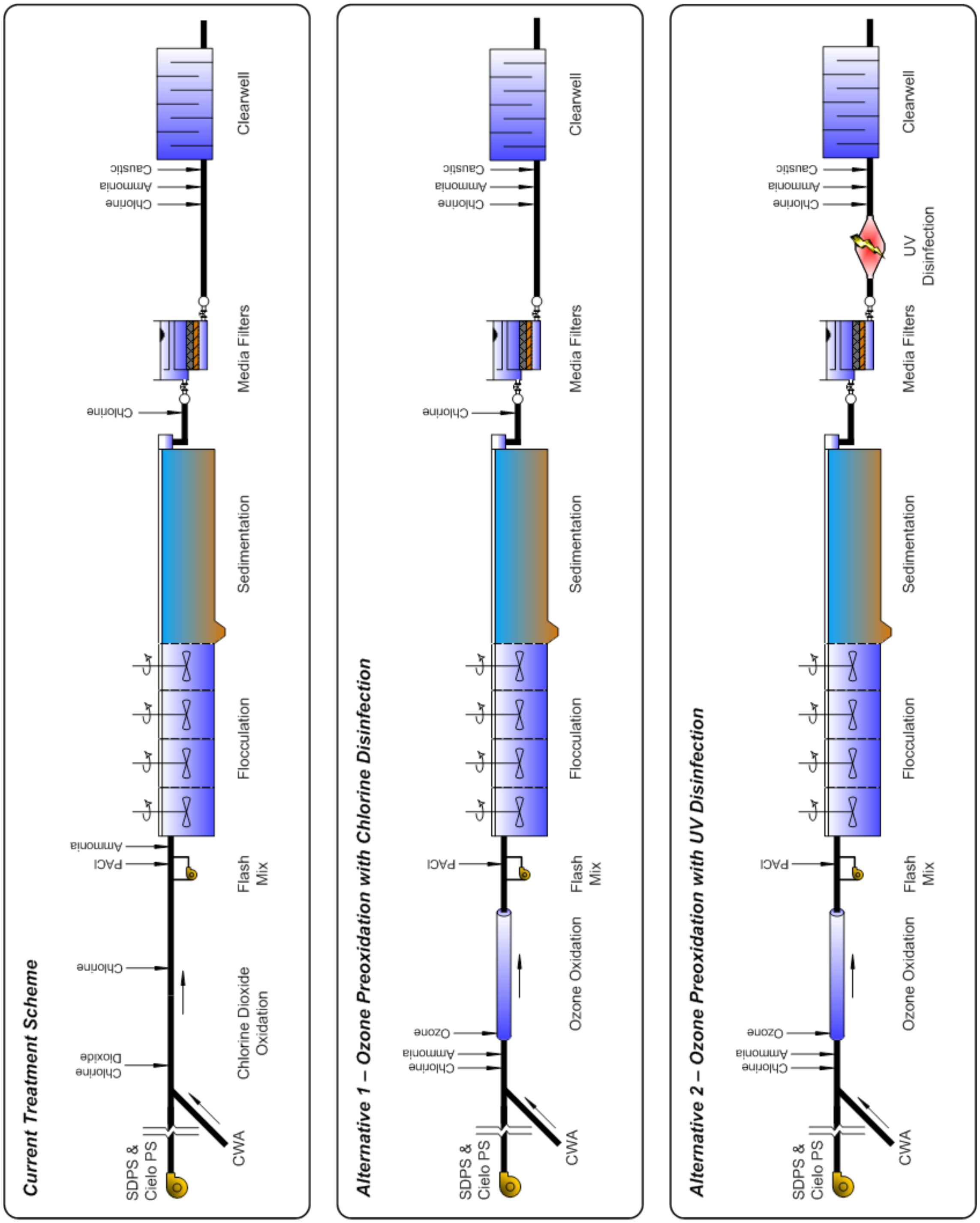

Figure 3.16 Alternative Treatment Options for the WFP

If further evaluation determines that Alternative No. 1 is impractical or undesirable, Alternative No. 2 eliminates free chlorine contact through the filters, and utilizes post-filter UV disinfection to meet the *Giardia* inactivation requirements. Chlorine is then added followed by ammonia addition. A short free chlorine contact time may be needed to meet the virus inactivation requirements. However, this contact time is projected to be quite short and should result in limited DBP formation.

Ozone Design Criteria and Estimated Project Costs

Table 3.15 contains preliminary ozone design criteria for Lake Hodges and CWA source water supplies.

Table 3.15 Preliminary Ozone Design Criteria for Lake Hodges and CWA Source Waters

Source	Ozone Dose (mg/L)
Lake Hodges	5.0
CWA	2.0

Notes
1. Lake Hodges dosage from OMWD work.
2. CWA dosage from MWD experience.

The ozone generation system would consist of ozone generation equipment and building and an ozone contactor. A system sized for typical maximum flow rates (30 mgd) would require a 1,300 ppd system. Estimated project costs and O&M costs for this system are presented in Tables 3.16 and 3.17.

Table 3.16 Estimated Project Cost for Ozone System

Description	Estimates
Ozone Equipment	$5,700,000
Building	$1,000,000
Pipeline Contactor	$600,000
Yard Piping	$650,000
Site Work	$300,000
Electrical & Instrumentation	$1,650,000
Mob/Demob	$300,000
Estimated Project Cost	$10,200,000

Table 3.17 Estimated Project O&M Costs for Ozone System

Source Water	O&M Costs ($/acre-ft)
Lake Hodges	$23.10
CWA	$9.24

The existing 54-inch raw water influent pipeline could be used as an ozone contactor and would provide approximately three minutes of contact time at 30 mgd. Additional contact time could be added by constructing a parallel pipeline to the 54-inch line. In order to use the 54-inch line as a contactor, the 30-inch raw water force main from the CPS (Lake Hodges water) will need to be relocated to tie in to the 54-inch raw water line near the hydroelectric facilities. Pilot study work is needed finalize the ozone generator sizing and ozone contact time.

Recommendations - Other Potential Process Modifications to Improve Performance and Treated Water Quality

The following items present conclusions and recommendations in defining the CIP related to improved performance and treated water quality at WFP:

1. Curtail the practice of m aintaining chloramines through the entire treatment plant. Chloramine addition should occur downstream of sedimentation, or preferably, after filtration.

2. Consider installation of a preoz onation system. Pr eozonation would pr ovide a strong alter native preoxidation process capable of oxidizing manganese, hydrogen sulfide, and T&O chemicals, while providing a modified disinfection strategy that re duces THM format ion and the potential for N DMA formation. Estimated project cost for a preozonation system is $10.2 million.

3. Conduct an ozone pil ot study for a mi nimum of six months to confirm its performance c apabilities. Estimated cost for the pilot study is $500,000.

UTILITY WATER

The WFP supplies water to the plant through a utility water system which consists of four pumps, two 25 horsepower and two 15 horsepower, each with VFDs. The pumps feed off the plant backwash line that feeds the Backwash Water Ta nk. The pumps operate to maintain a pressure setpoint. The utility water is us ed throughout the plant as wash down water, makeup water, carrier water, potable water, etc.

Much of the utility w ater system transmission lines at the plant w ere installed when the WFP w as initially constructed in the late 1960s; meaning it is just over 40 years old. The buried piping greater than two inches in diameter was constructed of asb estos cement pipe. This p ipe material typically has a lif e range of 40 to 70 years. While this pipe still likely has life expectancy left, it is recommended that plant staff inspect portions of the piping to determine its condition to s ee if it should be replaced. The utility water pumps are relatively new and all appear to be in good condition.

A tour of the WFP and discussion with WFP staff revealed that the utility water system is overall in good shape. However, there is one deficiency that needs to be corrected. Flow from the utility water system is continually being fed to the chlorinators and the chlorine dioxide generator. When a large demand is put on the utility water system (typically from line sizes exceeding 1-inch in diameter), system pressure drops for a short period of time until another utility water pump turns on. This drop in pressure causes feed rates at the chlorinators and the chlorine dioxide generator to decrease. To combat this problem, plant staff operate the utility water pumps in manual mode when a high demand utility water connection needs to be used.

This utility water deficiency can be solved by providing a dedicated pump and utility water line to the chlorinators and chloride dioxide generator. It is anticipated that a pump similar to the existing 15 hp pump would be adequate and a 4-inch dedicated line would be adequate. It is possible that one of the existing pumps could be used for this modification, but for this analysis, a new pump is assumed. Estimated project costs associated with these improvements amount to $70,000.

Recommendations - Utility Water

The following items represent conclusions and recommendations in defining CIPs related to utility water system at the WFP:

1. Provide dedicated pumping system to the chlorinators and chlorine dioxide generator. Estimated project cost is $70,000.

CHEMICAL HANDLING

The WFP has several chemical processes that they use on a daily basis. These include the following:

- Gaseous Chlorination
- Sodium Chlorite
- Chlorine Dioxide Generator
- Aqueous Ammonia
- PACL
- Cationic Polymer
- Caustic Soda

The gaseous chlorination system and the chlorine dioxide generator are located in the Operations Building. Storage tanks for each of the other systems are located in the Chemical Storage Area. The aqueous ammonia, PACL, and caustic soda systems are all pressurized systems with metering occurring using a flow meter and a control valve. The sodium chlorite system is used in chlorine dioxide generation. It is transferred to the chlorine dioxide generator using a centrifugal pump. Cationic polymer is conveyed to various locations in the plant using two progressive cavity pumps located in the basement of the Operations Building.

Overall, the chemical handling system is in good shape and effectively operates to assist in treating water at the WFP. However, there are a few items that should be included in a capital improvements plan. These include the following:

1. Replacement of the chlorine dioxide generator
2. Replace the non-pressurized PACL tank
3. Upgrade the controls at each chlorinator
4. Add a spare tank to the Chemical Storage Area
5. Add capability of feeding anionic polymer to the flocculation basins

Replace Chlorine Dioxide System

When installed, the current chlorine dioxide generator was meant to be a temporary unit. The current system was designed for pilot studies, not for full-scale operation. As a result, the current system is limited in its capabilities, redundancy, and capacity. If the system were to fail, there is no backup method for providing chlorine dioxide. As discussed throughout this report, chlorine dioxide addition is a critical unit process in the treatment of the raw water supplies. Upgrading the system would provide a robust, user-friendly system that will provide increased operator control, flexibility, redundancy, and capacity. The current system has a capacity of 500 ppd. This allows up to a 2 mg/L dose at the maximum flow rate of 30 mgd, which is adequate for the WFP. When upgraded, a redundant unit should be provided. To house the new units, an additional 450 ft^2 of covered space is needed. Modifications to utility water piping, chemical piping, and instrumentation will also be needed.

Upgrade PACL Tank

As mentioned, the PACL is operated as a pressurized system. The system utilizes three 13,300-gallon storage tanks. Only two of these tanks are pressure rated. The third tank contains two gear pumps that are used to transfer PACL to one of the other tanks. Although currently working, this setup is not ideal as it requires more operator effort in managing the system and it is recommended that this tank be upgraded. Alternatively, a new tank could be provided and the non-pressurized tank could be used as a spare tank.

Upgrade Chlorinator

The WFP utilizes three chlorinators with the gaseous chlorine system. These chlorinators are all wired together such that they operate as one system. As such, automation only allows the staff to dose chlorine at one location. Allowing the capability to flow pace chlorine at up to three locations would help in optimizing plant performance. Currently, staff must manually make adjustments to dose at multiple locations. It is recommended that these modifications be made to the chlorination system so that plant staff can meter to multiple locations.

Spare Chemical Tank

At times, it is beneficial for the WFP to test different chemicals in optimizing operation of the plant. Currently, there are no spare chemical tanks in the Chemical Storage Area to allow staff to do this. Adding a spare chemical tank (2,000 gallons minimum) would allow plant staff this flexibility. This recommendation can be accommodated by providing a new sodium chlorite tank at an alternate location. The existing sodium chlorite tank could then serve as a spare tank.

New Anionic Polymer Feed Location

Anionic polymer is often used at conventional plants as a flocculant aid and a filter aid. Currently, WFP has the capability of dosing it upstream of the filters. Providing an additional feed point to the flocculation basins would allow plant staff to better optimize its use. It is recommended that additional polymer feed points be added such that anionic polymer can be fed either to the flocculation basins or upstream of the filters.

Estimated project costs for these improvements are shown in Table 3.18.

Table 3.18 Estimated Project Costs for Chemical Handling System Improvements

Description	Estimate
New chlorine dioxide system	$1,300,000
New PACL tank and appurtenances	$100,000
Chlorinator upgrades	$40,000
Anionic polymer feed point	$20,000
Estimated Project Cost	$1,460,000

Recommendations - Chemical Handling

The following items represent conclusions and recommendations in defining the CIP related to chemical handling system at the WFP:

1. Replace existing chlorine dioxide generator pilot unit with a full-scale system.
2. Upgrade non-pressurized PACL tank.
3. Upgrade the chlorinators to increase chlorination flexibility.
4. Provide a new anionic polymer feed location to the flocculation basins.

HEALTH AND SAFETY

Health and Safety at a treatment facility is important and should be heavily considered because of the nature of the processes and equipment at a treatment facility. In walking through the facility and speaking with staff, the following safety concerns were identified.

- Location of the Sodium Chlorite Tank.
- More gas detectors needed.
- Splash shields for chemical feed system skids.
- Valve Access in busy streets.
- Inadequate handrail on SDR dam.

Sodium Chlorite Tank

The sodium chlorite tank is located next to the PACL tanks. Since PACL is an acid, mixing of these chemicals will send off toxic chlorine gases. As a result, it is recommended that sodium chlorite be relocated to a separate area. In doing this, it makes sense to leave the existing sodium chlorite tank and add a new one in its own containment area adjacent to the existing Chemical Storage Area.

Gas Detectors

The pipe gallery is located underground and is enclosed. To ensure detection of hazardous gases, it is recommended that both ammonia, chlorine, and sulfide gas detectors be installed in the pipe gallery.

Splash Shields

The chemical feed skids for caustic soda, PACL, and ammonia are located in the basement of the Operations Building. Currently these feed skids to not have splash shields to protect an operator from chemical spray in case of a leak. It is recommended that splash shields be installed at these locations.

Valve Access

Currently, isolating the CPS is difficult due to location of isolation valves in the busy Del Dios Highway. When plant staff needs to operate these valves, they must follow proper procedures to get clearances to work in the highway. This takes at least a day to do. Moving the two 36-inch valves on the CPS and discharge lines could be accomplished by moving them to the north side of the highway. Doing so would eliminate the risk associated with working in the highway and reduce the time needed to isolate the pump station.

Handrail on SDR Dam

The current handrail on the dam at SDR is inadequate as it provides limited fall protection. In addition, it only runs along one side of the dam. It is recommended that new handrails be installed along both sides of the dam.

Estimated project costs associated with making the recommended plant safety improvements are shown in Table 3.19.

Table 3.19 Project Cost Estimates for Health and Safety Improvements

Description	Estimate
New sodium chlorite tank	$75,000
Gas detectors	$10,000
Chemical splash shields	$5,000
CPS valve relocation	$100,000
Handrail on SDR Dam	$160,000
Estimated Project Cost	$350,000

Recommendations - Health and Safety

The following items represent conclusions and recommendations in defining the CIPs related to health and safety considerations at the WFP:

1. Replace the sodium chlorite tank and relocate it away from the PACL tank.
2. Add ammonia and chlorine gas detectors to the pipe galleries.
3. Add chemical splash shields to the chemical feed skids located in the basement of the Operations Building.
4. Move the two CPS isolation valves out of the Del Dios Highway.
5. Install new handrail on SDR dam.

HYDRAULIC EVALUATION

The WFP has a design capacity of 40 mgd. A hydraulic analysis was conducted to verify hydraulic capacity and to identify any flow restrictions and associated bottlenecks. Most of the information used in the analysis was obtained from the plans associated with the 1993 plant modifications. A plant hydraulic profile was prepared from the hydraulic analysis and is shown in Figure 3.16. Input and output data from the hydraulic model is provided as Appendix B of this master plan.

The hydraulic analysis revealed that hydraulic capacity at the WFP is not an issue up to the design rate of 40 mgd. There are, however, a number of hydraulic elements throughout the plant that deserve discussion related to existing operation conditions and potential plant improvements. These are presented below. Reference Figure 3.17 for calculated HGL elevations at these locations.

Hydraulic Control Points

There are four hydraulic control points that establish water surfaces and hydraulic gradelines within the plant. These control points are:

- V-notch weirs of sed basin launders – controls sed basin water level.
- Filter inlet weirs – established water level in filter inlet channel.
- Filter effluent valves – valves modulate to maintain water level in filter box.
- Weir at filter control structure – maintains submergence of filter effluent valve, conduit, and downstream piping.

It is recommended that the control algorithm to modulate the filter effluent valve and resultant water level be configured to optimize available headloss across the filter.

Plant Inlet

Flow capacity and related headlosses upstream of flash mix are driven by the CWA supply pressures and the pumping head at the SDPS and CPS. Each supply has sufficient hydraulic head to deliver water to the plant. Construction of potential future upstream processes, such as ozonation, will require additional hydraulic head to deliver the same flow. A pre-ozone contact basin, for example, located between flow measurement and flash mix might impose 3 to 4 feet of additional headloss and should be considered when modifying or replacing the SDR pumping station.

Pretreatment Basin

The water surface elevation in the sedimentation basin is estimated at 534.90 feet upstream of the v-notch weirs of the outlet finger launders. This level at 40 mgd is within several inches of the basin overflow weir elevation of 535.24 feet. The basin has sufficient freeboard such that the overflow weir elevation could be raised if overflow conditions become a problem.

Overflows

Two overflow weirs are located within the plant to relieve process flooding as follows:

- Sed basin overflow – weir set at El. 535.24 feet. This weir protects the floc/sed basin, filter inlet channel, and filter box from overflow in the event filter inlet or outlet valves are closed.
- Finished water overflow – protects finished water reservoir from surcharge.

Filters

The filter control structure weir located downstream of the filters is positioned to maintain positive submergence of the filter effluent valves, turbidity sample locations and filtered water conduits. However, when differential head across the media, underdrain, and filter outlet piping reaches 7 to 8 feet, negative head (air vacuum) conditions would occur in the lower filter gullet and in the top of the 30-inch outlet pipe (between the filter box and the backwash supply valve). Therefore, it is recommended that filter headloss should not be operated above 8 feet.

FW Piping

The 48-inch and 54-inch filter piping downstream of the FW conduits serve multiple purposes including:

- Conveys FW to control structure
- Provides FW to backwash supply pumps
- Provides FW to utility water pumps

Minimum plant flows should be limited to 6 to 8 mgd to maintain hydraulic flows and pressures within the FW pipe header down-stream of the filters.

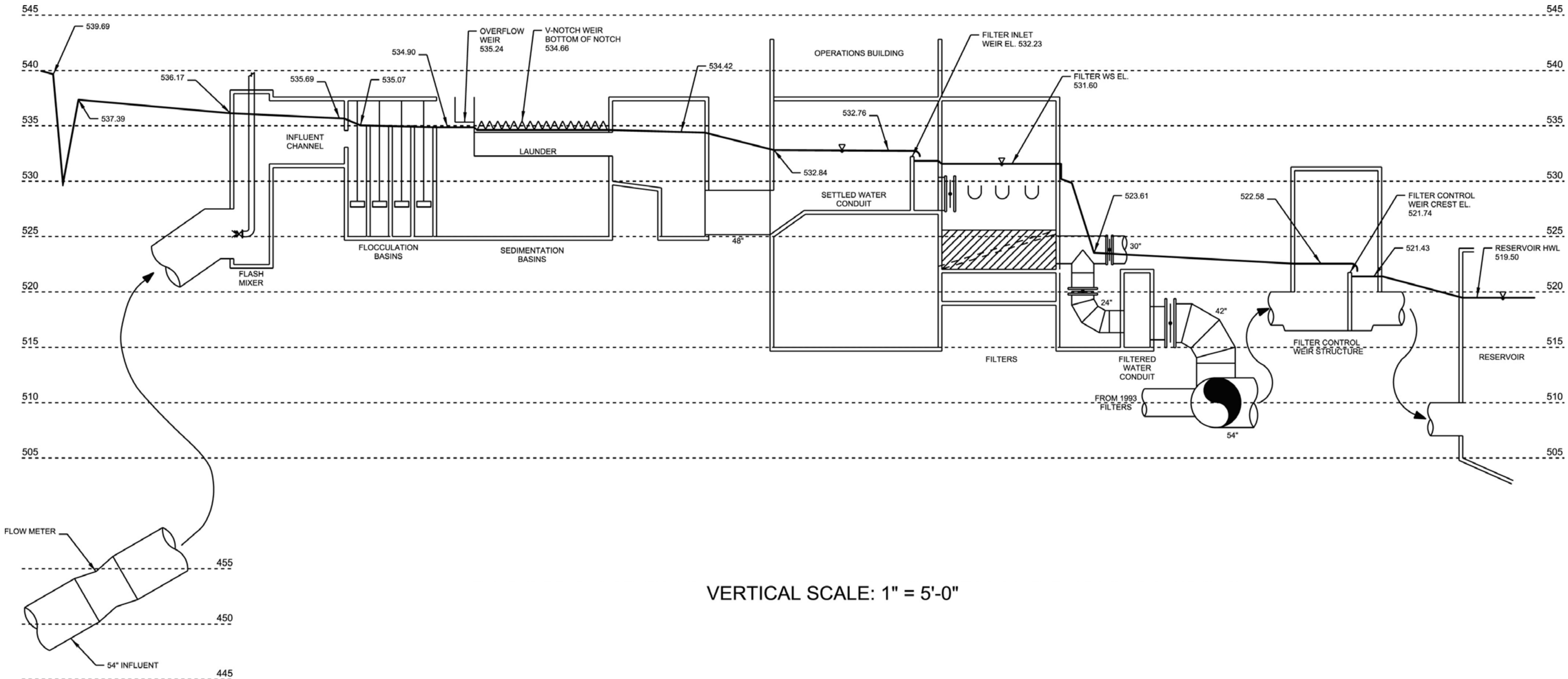

Figure 3.17 Plant Process Hydraulic Grade Line at 40 mgd

BACKGROUND

The raw water delivery facilities are comprised of a series of nine distinct reaches and components. Figure 4.1 illustrates each distinct delivery facility. They are listed below and a discussion for each component follows.

1. Lake Hodges
2. Pipeline from Lake Hodges to CPS
3. Cielo Pump Station
4. Pipeline from CPS to WFP
5. Pipeline from CPS to SDR
6. San Dieguito Reservoir
7. San Dieguito Pump Station
8. Pipeline from SDPS to WFP
9. 15-inch Drain Line

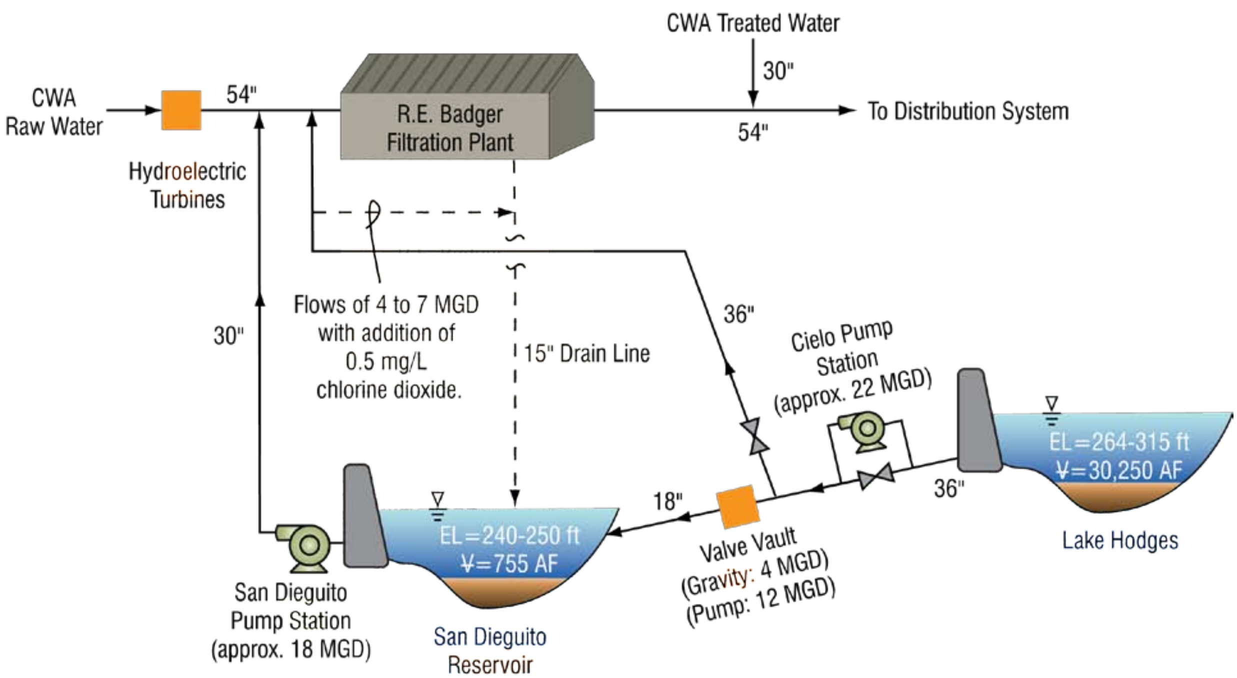

Figure 4.1 Schematic of Existing Raw Water Delivery Facilities

OBJECTIVES

Activities completed in this evaluation of the raw water delivery facilities included:

1. Review and definition of operational and hydraulic capacities of the raw water delivery facilities, including conveyance pipelines and pump stations.
2. Locating, sizing, and phasing of a new SDPS.
3. Providing possible enhancements to the raw water system to eliminate and/or mitigate the impact of Quagga Mussels infestation.
4. Determine potential SDR improvements required to accommodate multiple functions. .

LAKE HODGES

Lake Hodges reservoir and dam are owned and operated by the City of San Diego. Lake Hodges is supplied by the local watershed and has a maximum storage capacity of approximately 30,250 AF as reported in the 2008 Lake Hodges Projects Reservoir Regulation Manual. The maximum operational volume in Lake Hodges is 315 feet. Most of the time, the reservoir operates at a level above 290 feet. The minimum operating level is 264 feet. Lake Hodges is the primary source from which SFID/SDWD receives local water supply.

PIPELINE FROM LAKE HODGES TO CIELO PUMP STATION

Originally, water was conveyed from Lake Hodges to SDR through a flume that was constructed in 1918. In 2003, this flume was upgraded to a 36-inch CML&C pipeline for the stretch from Lake Hodges dam to a point approximately 2,700 feet downstream of the CPS. As shown in Figure 4.1, flow in the 36-inch pipeline from Lake Hodges can be diverted through the CPS. This pipeline is less than ten years old and should be in good condition. Capacity of this pipeline segment is in excess of 30 mgd.

CIELO PUMP STATION

The CPS was constructed in 2003 and delivers raw water from Lake Hodges directly to the WFP. The pump station consists of four vertical turbine pumps. Three each designed for 6.0 mgd at a head of 318 feet and driven by a 450 HP motor, and one designed for 3.0 mgd at 318 feet of head driven by a 250 HP motor.

The CPS was designed to pump Lake Hodges water directly to the WFP through a 36-inch CML&C steel pipeline to the WFP. However, plant staff has flexibility in its use. Plant staff can valve the raw water system such that water from CPS is pumped directly to SDR. This allows nearly a three-fold increase in flows to SDR when compared to gravity conveyance. One other way plant staff uses the CPS is to oxidize water from Lake Hodges to SDR. Plant staff can do this by injecting chlorine dioxide into the 36-inch force main and then transfer the water to SDR through an interconnection at the WFP between the 36-inch CPS force main and the 15-inch plant drain.

During a visit to the CPS and conversation with the WFP staff, the following observations were made:

- The existing pump station inlet and discharge valves are located within Del Dios Highway. Safety is a concern when operating these valves as on-coming traffic presents a hazard.
- The buried isolation butterfly valves to each pump and the 10-inch bypass do not provide tight shut-off.
- Water from Lake Hodges is of a corrosive and anoxic nature, which has caused deterioration of the vertical turbine pumps.
- The Golden Anderson rotary pump control check valves are equipped with control units and hydraulically actuated cylinders. However, the water being used for the hydraulic actuation is Lake Hodges water, which contains sediment and debris. The hydraulic lines need periodic flushing on a weekly basis in keep the hydraulic actuator piping from plugging.

- Quagga Mussel will be introduced into Lake Hodges and SFID/SDWD wants to keep it out of SDR.
- Maximum capacity reported by staff is approximately 22 mgd.
- The firm capacity (largest pump out of service) is 15 mgd.

Recommendations - Cielo Pump Station

The following is recommended for CPS:

1. The CPS inlet and discharge valves should be relocated closer to the CPS to the side of the Del Dios Highway so that they can be operated without going into the road.
2. The buried isolation valves should be replaced with material that is more resilient to the characteristics of Lake Hodges water. This would include a 316 stainless steel valve or coating the valve with an anticorrosive and abrasion resistant coating. The stainless steel valve is likely to cost more than double a coated valve.
3. The vertical turbine pumps are in need of repair. Operation and Maintenance Staff has indicated that a substantial component of the CPS pump refurbishment has been completed as part of the Joint Facilities O&M program and future refurbishments would also be a part of periodic O&M improvements. As a result, pump refurbishment is not part of the CIP.
4. Replace the hydraulic actuators with electric actuators to eliminate the problem with plugging. The electric actuators should be equipped to close the valve in case there is a power outage.
5. Provide Quagga control at CPS to prevent them from getting to SDR. Further analysis of alternatives is presented later.

Table 4.1 Project Cost Estimates for Recommended Improvements to CPS

Description	Estimate
Relocate valves out of highway	$100,000
Replace valves on pump suction	$150,000
Replace hydraulic actuators	$10,000
Estimated Project Cost	$260,000
Note: The listed improvements have been incorporated into the CIP as part of the 30-inch Parallel Pipeline Project.	

PIPELINE FROM CIELO PUMP STATION TO WFP

Water pumped from CPS can be directly transferred to the WFP through a 36-inch CML&C steel pipeline. This pipeline was installed in the early 2000s. Conveyance capacity of this pipeline is 36.5 mgd. At this flowrate, water velocity is 8 ft/sec. This pipeline is still relatively new and is anticipated to be in good condition.

In addition to conveyance from CPS directly to the WFP, plant staff can divert a portion or all of the flow from the 36-inch force main through an interconnection with the 15-inch drain line that terminates at SDR. Plant staff utilizes this diversion as a means for injecting chlorine dioxide into SDR to precondition water from Lake Hodges before entering SDR.

PIPELINE FROM CIELO PUMP STATION TO SAN DIEGUITO RESERVOIR

Water can be conveyed from CPS to SDR by gravity or pumping. By gravity, it actually by-passes CPS and continues in the 36-inch pipeline for approximately 2,700 feet downstream of CPS. At that point, it is diverted into an 18-inch HDPE pipeline that flows to SDR. Gravity flow from Lake Hodges to SDR is regulated through a 6-inch sleeve valve. When pumped, discharge from Lake Hodges flows through CPS and then follows the same flow path as in gravity conditions.

Hydraulic calculations were performed to determine the theoretical gravity flow capacity from Lake Hodges to SDR. The analysis assumed a Lake Hodges operating level of 295 to 305 feet and by-passing the sleeve valve. Under these conditions, maximum flow is approximately 4.3 to 4.8 mgd. If flow is sent through a 100 percent open sleeve valve, capacity is reduced to 2.5 to 3.0 mgd. Plant staff has reported a maximum flow in the range of 4 mgd.

When water is conveyed from SDR to the WFP, it is at rates up to approximately 16 mgd. Because gravity conveyance from Lake Hodges cannot keep up with the amount of water pumped from SDR to the WFP, plant staff frequently runs CPS to augment flow to SDR. Though the CPS was designed to pump directly to the plant, virtually all of its usage is pumping directly to SDR instead. A hydraulic analysis was performed to estimate maximum flow that could be pumped from CPS to SDR will all four pumps in operation. A maximum flow rate of approximately 13 mgd was calculated. Plant staff has observed a maximum flow rate in the range of 12 mgd.

CPS has become the primary means to convey water from Lake Hodges to SDR. According to plant staff, annual power consumption costs are approximately $400,000. These costs are consistent with costs predicted by the Base Case Model described in Section 1. An alternative to using CPS is to install a pipeline parallel to the existing 18-inch HDPE line to increase gravity conveyance to SDR. Several options for doing this are shown in Table 4.2. For purposes of this analysis, it is assumed that the parallel line would also be made of HPDE. In addition, it was assumed the new SDPS will have a firm capacity of 15 mgd (largest pump out of service), and be expandable to 25 mgd, as presented later in this section.

Table 4.2 also shows a payback associated with power savings from eliminating the need to pump from Lake Hodges to SDR. Several options are presented for paralleling the 18-inch pipeline. One option is construction of a 24-inch parallel line that would closely match the initial firm capacity of a future SDPS (15 mgd; discussed later in this section). Storage in SDR would offset the remaining 1 mgd. A 18-inch parallel line is another option; however, at only 14 mgd capacity, this scenario would rely heavily on storage in SDR causing water levels to fluctuate. It has been reported that foul odors from SDR are at least partially due to low water levels revealing sediment in the shallow parts of the reservoir. Trying to maintain SDR at a more constant year-round level would help with odor issues. Another viable option is construction of a 30-inch parallel line. This would provide an additional 18 mgd of gravity conveyance, resulting in a total gravity conveyance capacity of 22 mgd. This excess capacity accounts for any expansion of the future SDPS above its initial firm capacity of 15 mgd.

Construction of a 30-inch pipeline paralleling the existing 18-inch pipeline would cost an estimated $3.9 million. Amortized over 20 years at 5 percent equates to $313,000 annually, a savings of approximately $87,000 annually if pumping from Lake Hodges to SDR were eliminated.

Table 4.2 Conveyance Capacity for Parallel Pipeline Alternatives from CPS to SDR

Pipeline Diameter[1]	Total Conveyance Capacity[2] (mgd)	Estimated Project Cost[3]	Amortized Cost[4]	Annual Project Payback[5]
18-inch	8.7	$2,400,000	$193,000	$ 207,000
24-inch	14	$2,900,000	$233,000	$167,000
30-inch	22	$3,900,000	$313,000	$ 87,000
36-inch	29	$4,900,000	$393,000	$ 7,000

Notes
1. Pipeline material is HDPE.
2. Total conveyance capacity is combined gravity flow of existing 18-inch HDPE line and proposed parallel HDPE line.
3. Estimated pipeline length is 9,000 feet.
4. Based on 20 year period at 5 percent interest.
5. Calculated by subtracting amortization cost from current electrical costs ($400,000).

Recommendations - Pipeline Between CPS and SDR

The following item represents recommendation related to the pipeline between CPS and SDR.

1. Install a new 30-inch pipeline parallel to the existing 18-inch pipeline. Total conveyance gravity capacity of the two parallel pipelines would be 22 mgd.

SAN DIEGUITO RESERVOIR

SDR is a vital component of the local raw water delivery system. It currently operates as an intermediate step between Lake Hodges and WFP. SDR often allows extended use of Lake Hodges water, even after its water quality has deteriorated. The primary objective of this exercise of looking at SDR is to determine the highest and best use of SDR. With that in mind, the following discussion takes place.

Roles and Challenges

SDR provides four functions. Each function has its respective challenges.

1. Operational and emergency storage – SDR had an original volume of 1,130 AF. In 1997, the volume was down to 883 AF. In 2011, available volume is down to 755 AF. How best to maintain and manage this volume, or possibly recover previously lost volume?

2. Pretreatment of Lake Hodges water – Since the mid to late 2000's, SFID/SDWD has proactively and aggressively implemented Lake Management practices at SDR. Results have been impressive-making SDR a vital unit process in the cost effective treatment of Lake Hodges water. It has worked well at 12 mgd and may have to be enhanced and/or enlarged to continue successful performance at 15 mgd.

3. Receiver of residual streams from WFP – Filter waste washwater and portions of the settled sludge streams from the sedimentation basins have been directed to SDR over the years. Preliminary calculations project about 12 acre-ft of solids is deposited into SDR annually. Section 3 presents the most cost effective approach to eliminate solids disposal from WFP to SDR.

4. Receiver of storm water and urban runoff – Storm water and urban runoff finds its way into SDR at the northeast corner. Are there improvements that the dischargers of storm water and urban water runoff must make in order to protect health and safety and water quality in this raw water storage reservoir?

Operational and Emergency Storage

From the perspective of SDR as a pre-conditioning process, assuming local water supplies are limited to approximately 5,700 AFY, the active SDR volume required is estimated at 680 AF. The existing available volume is approximately 755 AF. Therefore, sufficient volume exists for the purpose of pre-conditioning activities. As solids from the WTP are discharged to the SDR, available volume is lost. Figure 4.2 contains a flow and mass balance for SDR. In summary, about 10 to 12 AF is being filled annually. This is primarily a result of residual streams from WFP. With continued discharge of solids, a time will come when the required active volume limit is reached. Two activities must take place to maintain and/or restore operational and emergency storage volumes.

1. Reduce and/or eliminate discharge of solids from WFP into SDR. A proposed plan to implement this practice is presented in Section 3. Estimated project cost to implement the proposed plan is $6.3 million.

2. Dredge SDR.

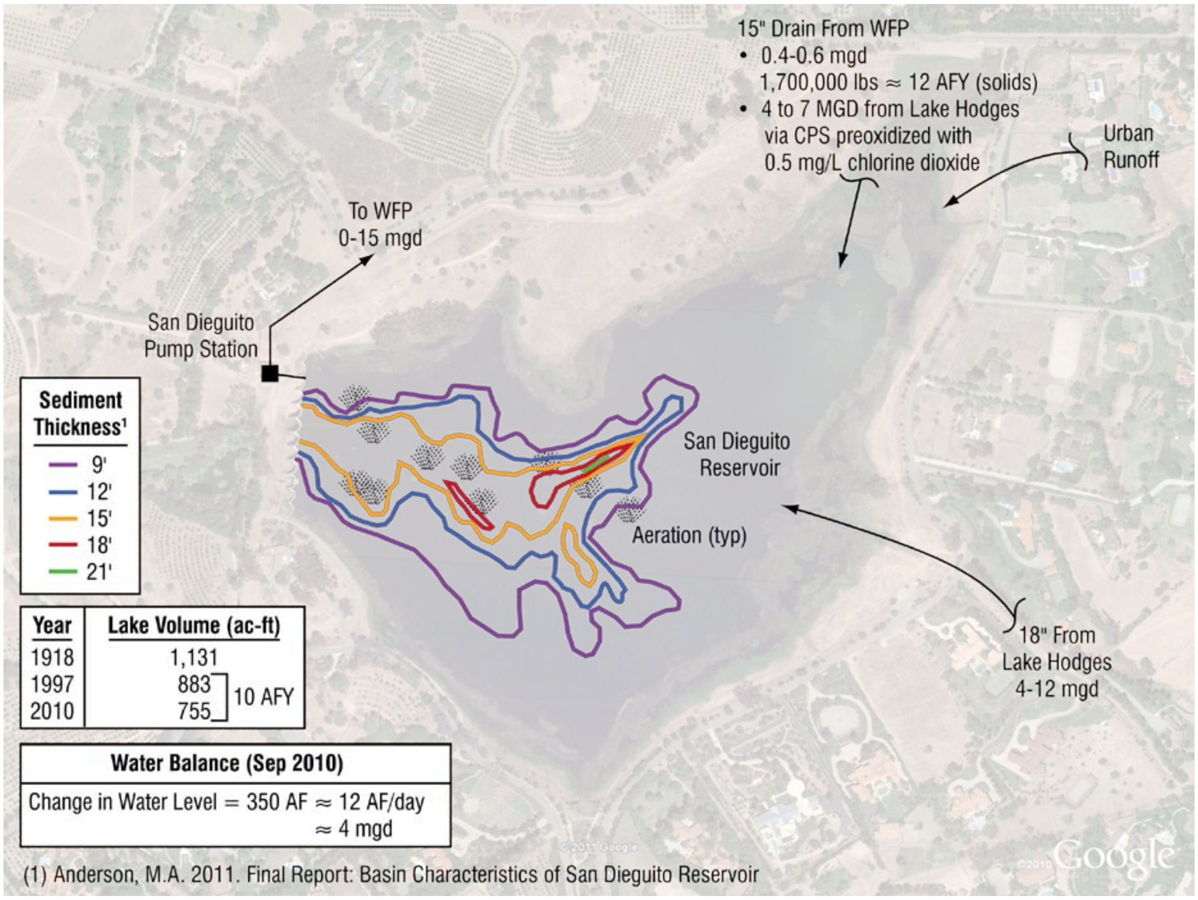

Figure 4.2 San Dieguito Reservoir Flow and Mass Balance

Pretreatment of Water from Lake Hodges

In the mid to late 2000's, SFID/SDWD implemented a Lake Management System for SDR. Use of Aquamats, floating islands, aeration, real time water quality monitors, and perimeter vegetation removal has transformed SDR into an active unit process in the cost effective treatment of local water. As discussed in Section 2, the following observations regarding water quantities in SDR and Lake Hodges were presented.

- TOC is about 10 percent lower in SDR than Lake Hodges.
- Manganese is marginally lower but more consistent in SDR.
- T&O causing compounds, TDS, and coliforms were comparable between the two local source waters.

At the current capacity of SDR (755 AF) and the maximum flow from Lake Hodges at 12 mgd, theoretical residence time at SDR is 20 days. With proposed modifications to add a 30-inch parallel pipeline to bring total transfer capacity to 22 mgd, the residence time would be reduced to 11 days. Current lake management practices can handle 18 mgd of flow through SDR. However, the new proposed SDPS is recommended to have a firm capacity of 15 mgd expandable to 25 mgd (see later discussion). Currently, plant staff adds chlorine dioxide to flow from CPS and sends 4 to 7 mgd to SDR as part of their lake management program. With a new parallel pipeline, gravity flows from Lake Hodges to SDR would have to be regulated to accommodate this practice. To allow recycling of greater volumes, the lake management system would need to be expanded to increase aeration capacity. Estimated project costs for this expansion are $150,000.

Quagga Mussel Control Measures

Quagga and zebra mussels are small freshwater bivalve mollusks from the Dreissenid family. CWA published its Dreissenid Mussel Response and Control Plan in December 2010. The plan was approved by California Department of Fish and Game in January 2011. Based on CWA control plan, Lake Hodges and SDR were not infested by Quagga mussels as of September 2010. Lake Hodges will be receiving water from Olivenhain reservoir through hydroelectric turbines. Studies referenced in the CWA control plan found that veligers are apparently damaged and eventually killed by turbulent forces in water. However, there is a potential for veligers to make it into Lake Hodges and subsequently travel downstream to SDR. As such, Quagga control is an important consideration in protecting both the CPS and the SDPS. Discussion on alternate treatments for Dreissenid mussel control follow.

Desiccation

Desiccation provides mussel kill above the water line. The approach would be to partially drain SDR for approximately one month during summer. As a result, SDR would be off line for a month. Objectionable odor might also be reported because of low water level in the reservoir. This approach is not desirable.

Chlorine Dioxide

Chlorine dioxide is deemed to kill adult mussels and veligers effectively in pipelines. The injection point for chlorine dioxide would be installed at the CPS to maximize protection of the raw water system. The pump station bypass would be modified to allow for chlorine dioxide to be dosed either in pumping mode to WFP or in gravity mode to SDR. Based on proximity of residential buildings, safety considerations are likely to direct using a three-chemical generation system. Chemicals stored at the CPS site would be sodium chlorite, sodium hypochlorite, and hydrochloric acid. Capital cost for the equipment is $400,000. Operations cost at 25 mgd and 1 mg/L would be around $90,000 annually. Dead mussels would end up at WFP or in SDR. Drawbacks of the treatment are to add chlorite (MCL = 1.0 mg/L) and chlorate (not regulated, public notification above 0.8 mg/L) to the raw water. It would also add a remote chemical facility that may be challenging to operate. This approach is feasible but not preferred except if beneficial to the water treatment process.

Ozone

Ozone is deemed to kill Dreissenid adult mussels and veligers effectively. As early as 2007, publication from Ontario Power Generation in Canada reported a 98-percent reduction in settlement of zebra veligers at 0.080 mg/L and clean concrete walls at 0.5 mg/L ozone dose. Other publications and workshops mention 97-percent reduction of veligers with 0.1 mg/L ozone dose. Injection point for ozone would be installed at CPS to maximize protection of the raw water system. The pump station bypass would be modified to allow for ozone to be dosed either in pumping mode to WFP or gravity mode to SDR. Estimated project cost is $2,700,000 for a redundant system. Operations cost would be around $30,000 annually. Dead mussels would end up at WFP or in SDR. The drawback of the treatment is the potential brominated DBPs formation and the lack of space available eat the CPS. It would also add a remote chemical facility that may be very challenging to operate. The approach is feasible but not preferred except if beneficial to the water treatment process.

Physical Removal

Power plants have been using automatic strainers to protect their intake against Dreissenid mussels on the Great Lakes for decades. 25-micron automatic strainers (Amiad, Bollfilter, or equal) eliminate both veligers and adult mussels. Strainers would be installed at the CPS. Pump station bypass would be modified to allow strainers to be used in pumping mode to WFP or gravity mode to SDR. Strainer backwash wastewater and mussels could be discharged to the sewer pump station that is located at the same site. Project cost with 100 percent redundancy is $280,000. The approach would create additional head losses (around 5 pounds per square inch (psi) or about 10 feet) and reduce gravity flow to SDR. The approach is feasible but not preferred.

Zequanox

Zequanox is manufactured by Marrone Bio Innovations in Northern California. The product is made of 100-percent not-genetically modified dead cells. The product is delivered in dry form. Adult mussels, juveniles, and veligers see the product as a food source. They eat the dead cells and die. The product should receive EPA Section 3 approval this year. NSF approval study will be performed in 2012 either by Sligo County in Ireland or by CWA. Ontario Power generation has scheduled a full-scale testing at one of their facilities in August 2011 after jar testing and pilot testing was successful. The product is still in its development phase. Based on preliminary testing, a 6-hour contact time at 150 mg/L would generate 97-percent mortality over a 5-week period. Maintenance doses at 50 mg/L or less would be required after the initial treatment over a three-month period to achieve eradication of mussels. The approach is promising. It would not require additional effort in handling and storage of chemicals. It would not add potential environmental constraints. It would not add head losses to the conveyance system.

Recommendations - Quagga Mussels

Adult mussels, juveniles, and veligers have not been detected in Lake Hodges and SDR but will most likely in the future. The following actions are recommended:

1. Check with CWA on a quarterly basis for detection of veligers in Lake Hodges.
2. Maintain SDR being closed to the public. Recreational boating is the major transportation mechanism for mussels.
3. Maintain a water quality-monitoring program. Goals of the program are two-fold:
    a. Understand environmental conditions the reservoir would offer to the mussels;
    b. Establish pre-mussel water quality parameters to detect changes that would reveal the presence of mussels. For example, mussel filtration activities would decrease turbidity of the water in the reservoir and the water would become clearer.
4. Review case studies/lessons learned with the use of promising natural control measures such as Zequanox.

5. Review the feasibility of remote dosing of chlorine dioxide or ozone when assessing future treatment processes at the WFP.

Receiver of Residual Streams from WFP

A recommended plan to eliminate future solids disposal to SDR is presented in Section 3. Cost for this plan is $6.3 million. As discussed in the recommended plan, filter waste washwater would still be diverted to SDR after treatment to remove solids.

Other Potential SDR Enhancement Projects

In addition to raw water from Lake Hodges, a portion of water in SDR is from storm water and urban water run-off that is primarily conveyed to SDR through the County of San Diego's storm water management system. The dischargers of storm water and urban water runoff may be required to construct improvements to avoid flooding and/or quality issues created by their discharges to a raw water storage reservoir. In addition, to avoid flooding during certain portions of the year, the water elevation in SDR must be lowered to accommodate high storm water conditions. This requirement exposes an existing sediment mound that has been created by the build-up of solids in the reservoir over several years. The exposed sediment mound causes periodic odor problems depending upon atmospheric and other conditions.

Effective maintenance and management of SDR may require the implementation of improvements driven by a wide range of objectives including:

- Lowering the existing sediment mound in order to avoid periodic conditions that increase the potential for odors.
- Vegetation removal in order to reduce solids build-up from decaying vegetation.
- Dredging for the purpose of recovering additional reservoir capacity for storage and/or treatment purposes.
- Dredging channels to better control high strormwater flows through SDR and avoid potential flooding problems.
- Addition of siltation/sedimentation basins to reduce deposition of solids from low flow urban runoff.
- Addition of artificial wet lands in order to provide addition treatment of urban runoff if necessary.

SFID and SDWD have commissioned a consulting firm to better define project descriptions and costs for these potential SDR enhancement projects. This evaluation is currently underway and the projects and associated costs included in this Joint Facilities Master Plan are based upon preliminary finding of that effort. The District's consultant will ultimately provide more detailed planning level project descriptions for each of the recommended projects including assessment of the environmental permitting requirements, capital and O&M cost, and implementation schedules.

The following five preliminary projects have been identified by the Districts'' SDR Consultant:

- Addition of siltation basins to accommodate low flow urban water runoff.
- Providing channels through dredging or other methods to better control storm water flows through SDR and avoid potential flooding problems.
- Addition of natural treatment wetlands to address urban water quality impacts if required.
- Lowering of the sediment mound in order to reduce periodic odor issues.
- General dredging of the reservoir to recover additional storage volume.
- Vegetation removal to reduce solids build up from decaying vegetation.

Multiple potential projects preliminarily identified by the Districts' SDR Consultant and included in this Joint Facilities Master Plan are directly driven by storm water and urban water impacts to the SDR. Though SFID and SDWD do not believe they are responsible for the cost to implement these improvements, the Joint Facilities Master Plan is including the preliminary project descriptions and costs in order to facilitate future planning and discussions with the County of San Diego.

Recommendations - San Dieguito Reservoir

The following items represent recommendations in defining possible CIP projects related to SDR. Costs for each project are summarized in Table 4.3.

1. Expand the lake management aeration system to accommodate increased flows from Lake Hodges.
2. When finalized, move forward with the improvements identified in the Districts' SDR Project Development Report.

Table 4.3 Project Cost Estimates for Recommended Improvements to SDR

Description	Estimated
SDR Enhancements	$150,000
SDR Siltation Basins	$350,000
SDR Sediment Mound Reduction	$1,000,000
Inlet Channel Modifications	$1,300,000
Natural Treatment Wetlands	$750,000
SDR Vegetation Removal	$750,000
TOTAL ESTIMATED COST	$4,300,000

SAN DIEGUITO PUMP STATION

The SDPS moves raw water to the WFP through a 30-inch CML&C steel line. It was originally constructed in 1964. In 1967, the pump station was enlarged and equipped with five vertical turbine pumps. These pumps are set in pressurized cans. The pump station consists of four 500 hp pumps and one 250 hp pump. According to plant staff, the maximum pumping capacity of the pump station is approximately 16.5 mgd. The SDPS force main was constructed approximately the same time as the SDPS.

The SDPS is critical to operation of the WFP. The pump station is more than 44 years old and has reached the end of its operating life. The pump station does not meet current codes and requires a large amount of maintenance to keep it running. The layout of the pump station is not ideal. Hydraulically, the pump station does not meet Hydraulic Institute Standards. Rehabilitating the existing SDPS is not recommended for the following reasons:

- The pump station would have to be brought up to current seismic and electrical codes.
- Rehabilitation would not allow the pump station to remain online and in use.
- Piping to the pump station is old and isolation valves are in operable. Replacement of the suction piping and valves may not be feasible.

Construction of a new pump station is recommended. It should be built at a separate site from the existing SDPS to allow operation of SDR and SDPS during construction. Construction of a new pump station would require abandonment/removal of some of the existing yard piping. Discussion on firm capacity and preferred location of a new SDPS follows.

Capacity

Recent historical flows show the SDPS pumped at 12.2 mgd or less 90 percent of the time (Figure 4.3) and less than 15 mgd 99 percent of the time. Future flow volume of local water is expected to be limited to 5,700 AF annually. SFID/SDWD would prefer to utilize this volume during the winter months. Figure 4.4 shows that based on recent historical plant flows, the 5,700 AF allotments could be taken from November to April without flows from the SDPS exceeding 15 mgd. Based on this information, sizing the SDPS for a firm capacity (capacity with the largest pump out of service) of 15 mgd is adequate.

Although SFID/SDWD may prefer taking all of their future local water allotment during the winter months, they would not be precluded from doing so in the other months of the year. Assuming maximum flows of 30 mgd during the summer months, plant staff could supply up to 50 percent of plant flows with local water. Provisions could be taken during construction of a new 15 mgd pump station to make it easily expandable by adding spare pump cans.

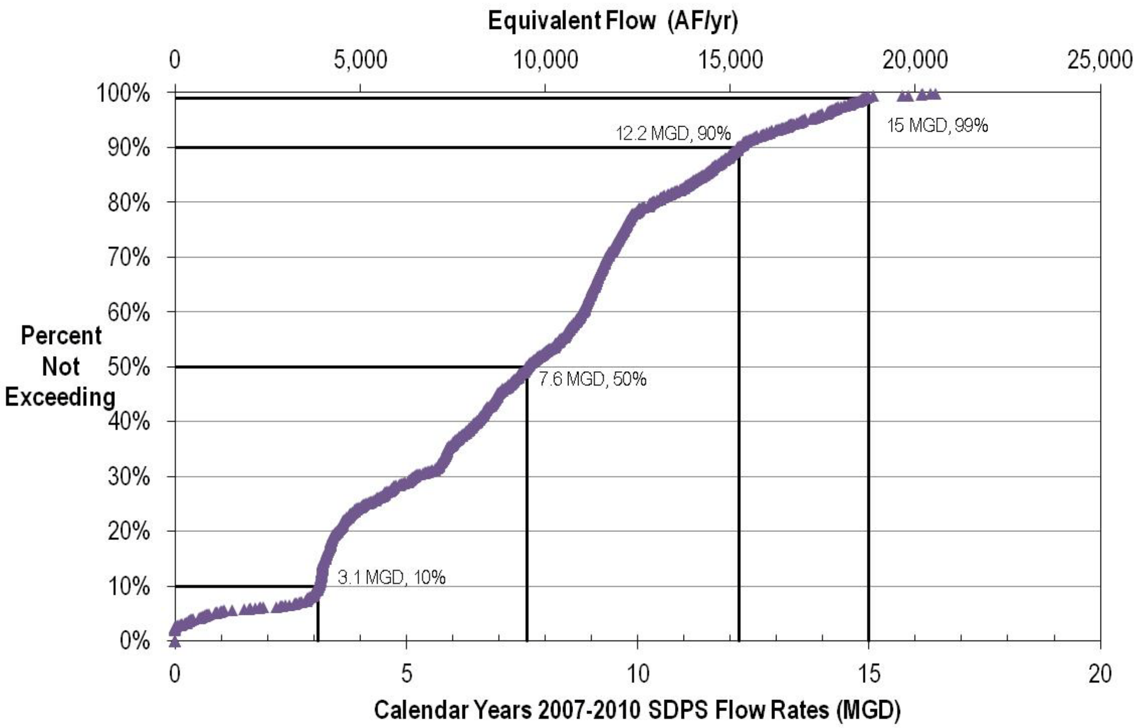

Figure 4.3 Historical SDPS Flow Rates

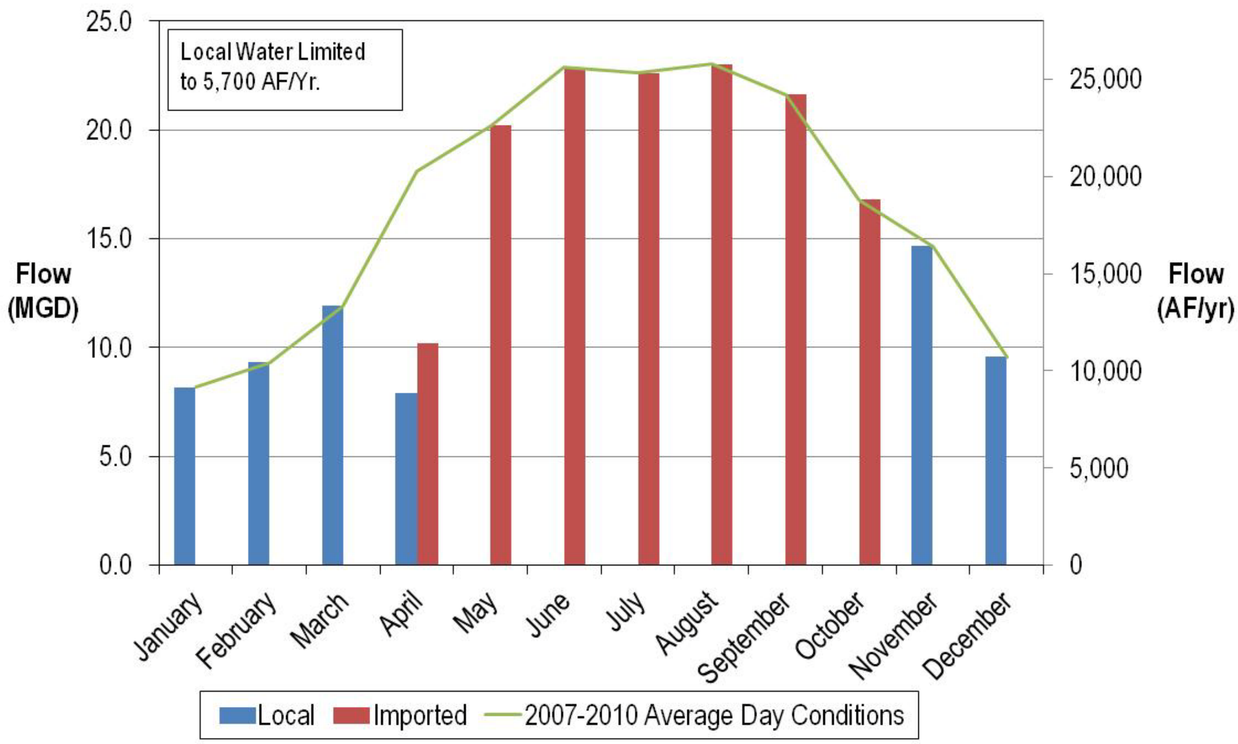

Figure 4.4 Possible Future Flow Rate Conditions

Potential Pump Station Locations

Three primary locations are available for the new pump station: downstream and west of the dam; upstream and northeast of the dam (Figure 4.5); or a floating pump station. Each option is described below. Table 4.4 presents pros and cons of two site locations. The location of the floating pump station is considered part of the "upstream" location.

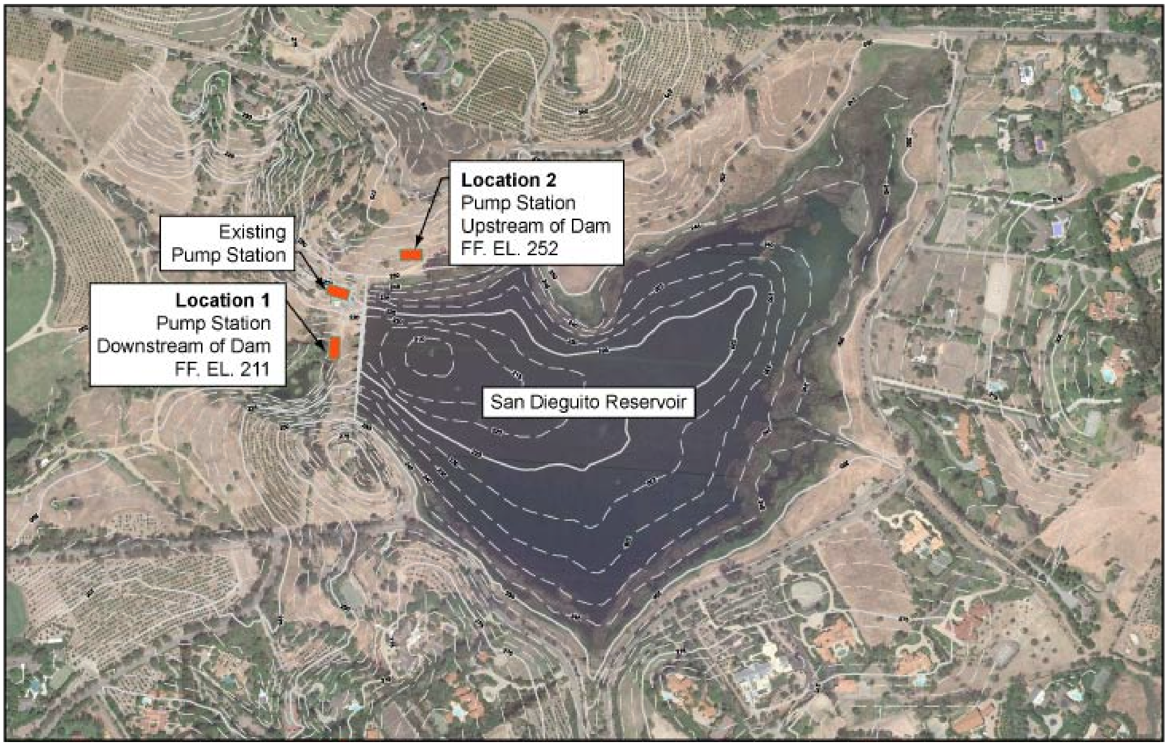

Figure 4.5 Potential Locations for the New SDPS

Location 1: Pump Station Downstream of Dam

The downstream pump station location would be located south of the existing SDPS along the existing access road. Finished floor would be at EL. 211.0. Four (three duty, one standby) 500-hp vertical turbine pumps would be installed in pressurized closed bottom cans.

The pump suction pipeline would be a 36-inch diameter cement mortar lined and coated steel pipeline. It would receive water from the reservoir through two existing 24-inch pipelines that run through the dam. Existing penetrations (in lieu of new penetrations) would be used to minimize impact of construction activities on the integrity of the dam and facilitate the permitting process. The 24-inch pipelines would be lined with a NSF approved cured in-place liner to improve longevity and minimize friction losses (Insituform or equal).

Each 24-inch pipeline would convey half the maximum flow, or about 7.5 mgd. The existing 24-inch inlet pipelines have their respective centerline at EL. 235.5 and EL. 211.92. Submergence required to minimize air entrainment would limit the minimum operation level to EL. 240.0 at 15 mgd.

It would be technically feasible to run a new suction pipeline below the dam. However, the risk of damaging the integrity of the structure during construction and the risk of tipping the dam over in case of seepage of the new suction pipeline in operation most likely makes this approach undesirable particularly to the Division of Dam Safety (DODS).

Location 2: Pump Station Upstream of Dam

Adjacent to SDR

The upstream pump station would be located on the north ridge of the reservoir east of the dam. Finished floor would be higher than the top of the dam at EL. 252.0. Four (three duty, one standby) 500-hp vertical turbine pumps would installed on open bottom can intakes.

Centerline of the 36-inch suction header would be set approximately at EL. 229.5 to allow for operation of the reservoir down to EL. 240.0 at 15 mgd and comply with requirement of the *Hydraulic Institute Standard* for open bottom can intakes. Based on site soil characteristics, deeper cans or concrete wet well could be considered at the subsequent stages of the design to increase usable water volume.

Several questions will need to be explored further during pre-design of the new pump station. These include the number of intakes (reservoir draw points) and the configuration of the intake. At minimum, one intake will be needed; however, the addition of two or more intakes would provide the flexibility of drawing water from different elevations in SDR. Intakes for multiple draw points could be configured by constructing an intake structure in the reservoir that uses gates to control the level from which water is drawn. Another possibility is to use dedicated feed lines for each reservoir draw point. Flow into each draw point would be controlled using isolation valves. From both intake options, water would flow into a common pipeline to the new pump station.

Floating Pump Station

The floating pump station would include two pieces: the pumps located on a barge placed in the reservoir and an electrical/instrumentation building located on land near the reservoir. The barge and pumps would be premanufactured and shipped to the site. The building either would be a premanufactured building or constructed on-site. Electrical and piping between the barge and the shore could either be “floating” or could run across the reservoir bottom.

The configuration of the pump station, including the number of pumps will need to be finalized during pre-design. One other consideration that will need to be explored further includes how the pumps on the barge will be maintained: by boat or by transporting the barge closer to shore.

Review of Table 4.4 leads us to recommend that the new SDPS be built at the upstream and northeast alternate location. This location presents the following advantages.

- It avoids the risk of altering a dam structure built at the beginning of the twentieth century
- It offers the opportunity to increase usable water volume in SDR
- It presents easier and faster permitting process
- It has a similar project cost to a location downstream of the dam

Table 4.4 Comparison of Alternative Locations for a New San Dieguito Pump Station

Criteria	Downstream	Upstream	Comment
Surveying	=	=	Both sites are flat enough but have enough slope for surface drainage
Soil Characteristics	=	= -	Upstream PS. It is possible that zones of fresh rock may occur at shallow depths that would require blasting. A seismic refraction geophysical survey is recommended as part of preliminary design
Hydraulics	++	-	Closed bottom can at EL. 200.0 vs. open bottom can at EL. 233.0
Protection From Flooding	--	++	Pressurized can below dam vs. open bottom can and pump floor above dam
Intake Constructability/ Continuity of Service	--	+	Downstream PS: full reservoir dewatering required for dam penetration in-situ lining, and installation of elbow, standpipe, and screen near dam. Upstream PS: full reservoir dewatering not required
Ease of Permitting	--	++	Upstream PS. Not working at the dam will make permitting easier and faster
Potential Additional Usable Water Volume	-	++	Upstream PS. Wet well bottom at EL. 230.0 would increase usable volume by 290 acre-feet
Potential Redundant Intake Pipeline	--	++	Not possible vs. No problem
Access	++	=	Existing access road vs. new access road
Aesthetics (Visible/noise)	+	-	Upstream PS. Highly visible site may require special architectural treatment
Utilities	+	-	Proximity of existing utilities vs. none
Security	=	=	
Construction Cost	=	=	Closed bottom can vs. open bottom can. Partially existing intake vs. new intake. Existing access vs. none. Existing utilities nearby vs. none. Risk of impacting 1918 structure integrity vs. new separate structure
Notes: ++ Significant benefit + Moderate benefit	= Neutral - Moderate drawback -- Significant drawback		

As mentioned in Table 4.4, and based on a planning effort level, project costs are anticipated to be similar for both upstream and downstream locations. Using *Pumping Station Design* Third Edition by Garr M. Jones as a reference and an Engineering News-Record Construction Cost Index (ENR-CCI 20 Cities) of 9080, the order of magnitude project cost estimate for a new SDPS is $4,000,000.

Recommendations - San Dieguito Pump Station

The following recommendations are made for the SDPS:

1. Construct a new pump station upstream of the dam with an initial firm capacity of 15 mgd and expandable to 25 mgd.

PIPELINE FROM SAN DIEGUITO PUMP STATION TO WFP

The SDPS force main is over 40 years old and consists of approximately 8,800 feet of 30-inch CML&C steel pipe. The following observations have been made about the pipeline:

- The condition is unknown, as it has not been inspected.
- WFP staff has observed roots flowing into the plant, which may be an indication for degraded line condition.
- The forcemain runs through a housing subdivision and plant staff have limited or no access to areas where the line was installed.
- Operation of the line is imperative as it is the only means of bringing water from SDR to the WFP.
- Failure of this line could result in damages to homes and plant staff may not be able to access the line to make repairs.

Based on the observations above, the following recommendations are made:

- An inspection of this line is needed to determine its condition. Recommendations include each of the following:
  - Video inspection to inspect visual condition.
  - Leak detection using a SmartBall® by Puretechnologies or similar technology to find leaks, which may indicate corrosion.
  - Electromagnetic detection to determine pipe thickness.
- The line will need to be replaced or relined eventually, but the existing life of the pipeline will be determined by an inspection.
- Replacement of the line should follow a different alignment. An alignment is shown in Figure 4.6 and is approximately 10,000 lineal feet. Feasibility of this alignment needs to be confirmed.

Figure 4.6 Possible Future Alignment of a New Pipeline from SDR to WFP

Sizing of a new SDPS is recommended at 15 mgd (10,400 gpm) and expandable to 25 mgd. Velocities from this flow are appropriate for the existing pipeline, even if the pipeline were to be relined. If a new line is installed in the future, it is recommended to also be 30-inches. This would provide capacity for future flow (if needed). It would also allow replacement of the forcemain to be at a different time than replacement of the SDPS as the hydraulics would be similar. Alternatively, a new 24-inch pipeline could also be considered. However, this alternative would require the new SDPS and forcemain to be constructed at the same time so that the pumps matched the system hydraulics.

The existing line is adequately sized to handle the proposed 15 mgd flow rate. Relining of the pipeline would likely reduce the effective diameter to approximately 27-inches. At 15 mgd, this equates to a velocity of just under 6 ft/s, which is adequate. Replacement of the forcemain to handle 15 mgd could be accomplished with a 24-inch pipeline. However, for future expansion purposes, a 30-inch pipeline should be considered.

Costs for relining are typically less expensive than replacement of the pipeline. However, because the SDPS forcemain is both larger diameter and high pressure, there are only a limited number of lining manufacturers and contractors that can do this work. As a result, costs vary depending upon contractor workload. It is possible that relining would be the most expensive option. As a result, costs for relining/replacing the existing forcemain is presented as the same total project cost estimate to be $4.5 million.

Recommendations - Pipeline from San Dieguito Pump Station to WFP

The following items represent conclusions and recommendations in defining possible CIP related to SDPS and pipeline from SDR to WFP:

1. Inspect existing 30-inch pipeline to determine condition and longevity.
2. Construct a new 30-inch pipeline or reline the existing pipeline from SDR to WFP. Timing will be based on outcome of inspection.

15-INCH DRAIN LINE FROM WFP TO SDR

The 15-inch drain line was installed in the late 1960s and consists of approximately 7,300 feet of predominantly asbestos cement pipe with small amounts of cast iron and steel piping. This pipeline provides an avenue for the WFP to recycle decant from the sludge drying beds and wash water ponds to the SDR. In addition, the line serves to provide a means of recycling raw water with chlorine dioxide to SDR. The line has an estimated hydraulic capacity of almost 8.0 mgd, which is ample to meet plant needs.

Condition of the 15-inch drain line is unknown. While it is over 40 years old, it could still have many years of life left. It is recommended that the line be inspected to determine its condition and remaining useful life by performing both video inspection and wall thickness measurements. If it needs to be replaced, the estimated project cost is $2,000,000.

Recommendations - 15-inch Drain Line form WFP to SDR

The following recommendation related to the 15-inch drain line is:

1. Inspect the condition of the 15-inch drain line, and replace or reline if necessary.

54-INCH TREATED WATER LINE

Treated water from the WFP leaves the plant through a 54-inch steel pipeline. This line is original to the construction of the plant and its condition is unknown. Several years ago, a parallel 54-inch line was added for approximately one-mile downstream of the plant in order to provide reliability to the distribution system.

Recommendations - 54-inch Treated Water Line

The following recommendation related to the 54-inch treated water line:

1. The old 54-inch line should be inspected to determine its condition and remaining useful life. Options for rehabilitation include relining or replacement. Estimated costs for rehabilitation is $7,500,000.

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INTRODUCTION

Work efforts related to the electrical and process control systems associated with the Joint Facilities are addressed in this section. Six primary activities were performed.

1. Present the results of Fault Current and Arc Flash studies that were performed for the CPS and WFP electrical systems.
2. Evaluate existing stand-by power generation capacity and necessary stand-by power equipment replacement and/or upgrades.
3. Identify potential measures to improve energy efficiency at the Joint Facilities, as well as rebates and incentives offered by SDG&E.
4. Identify improvements to the Joint Facilities electrical systems and present conceptual alternatives for implementing improvements and associated capital costs.
5. Evaluate the feasibility of implementing solar photovoltaic technology at the WFP as a supplemental source of energy.
6. Present conclusions and recommendations of our process control system evaluation.

Note that although the existing hydroelectric facility is an integral component of the WFP electrical system, it is covered separately in Section 6 of this report.

BACKGROUND

Relevant background information on the SDPS, CPS, and the WFP follow.

Cielo Pump Station

The CPS receives utility power from a single SDG&E feed. SDG&E power is transformed to 480 V at the main power transformer, which feeds the 480 V service entrance gear (MSC-2). MSC-2 feeds a transfer switch capable of transferring between utility power and standby generator. The transfer switch feeds MCC-2, which feeds large pumps and other miscellaneous loads supporting the pump station.

A standby generator is not located at the facility; however, there is a generator connection panel with means to connect to a portable generator. The maximum size of a generator that could be connected based on the size of the generator connection panel is 800-kW. An 800-kW generator is not capable of running the loads for the entire pump station. Therefore, when running on standby power, CPS must be operated at reduced capacity.

San Dieguito Pump Station

The SDPS receives power from a single SDG&E utility feed. Due to its age and extensive upgrades and adjustments made to the electrical equipment, the electrical distribution system is not reliably documented. Because the SDPS is not fed from the hydroelectric facility, it cannot directly utilize power produced from the hydroelectric facility located at the WFP.

The SDPS and the electrical distribution equipment that feeds the facility has reached the end of its useful life. In April of 2010, Malcolm Pirnie created Technical Memorandum No. 2 titled Badger Water Treatment Plant Major Electrical System Improvements Preliminary Design, which identified all the station electrical equipment to be in very poor condition. According to Technical Memorandum No. 2, poor condition was defined as, "Beyond useful life of 25 years and physical condition," and, "Includes a significant amount of aftermarket modifications." The ultimate recommendation of Technical Memorandum No. 2 was the complete replacement of the electrical system at the SDPS.

CWA Flow Control Facility

The CWA Flow Control Facility is powered from a separate SDG&E service.

Badger Water Filtration Plant

Currently, electrical power is provided from two sources:

1. Jointly owned hydroelectric facility that utilizes head from the imported raw water pipeline to generate power that is used by the WFP and excess power is sold to the local power Utility.

2. Local power utility (SDG&E).

SDG&E provides power to the facility at 12 kV via an existing distribution line. It is transformed to 4.16 kV at the main power transformer, which feeds the 5 kV switchgear located in the hydroelectric facility. The two hydroelectric generators provide power at 4.16 kV and are also connected to the 5 kV switchgear. Power to the WFP is fed from a single distribution feeder from the common 5 kV switchgear. The single feed is tapped in an electrical manhole; one tap is routed to a 500-kVA transformer that feeds the backwash treatment facility and the solids treatment facility, while the other tap is routed to a 300-kVA transformer that feeds the main plant loads. A 150 kW standby propane gas generator can support the loads on the emergency power distribution panel 'EP' through an automatic transfer switch.

SDG&E Service Connections

According to staff, all facilities (CPS, CDPS, CWA Flow Control Facility, WFP) are fed from different SDG&E substations. As such, an SDG&E outage at one facility may not necessarily be experienced at the other facilities. Consequently, it is important that each of the Joint Facilities is equipped with an independent source of stand-by power, whether it be portable or permanently installed.

FAULT CURRENT AND ARC FLASH

An arc flash safety program is required to satisfy requirements of the Occupational Safety & Health Administration (OSHA). The National Electric Code (NEC) requires that electrical equipment that is likely to require examination, adjustment, servicing, or maintenance while energized be field marked to warn qualified persons of potential electric arc flash hazards. The methods for determining arc flash severity, selecting proper personal protective equipment (PPE), and planning for safe work practices are identified by NFPA 70E, Standard for Electrical Safety in the Workplace. The governing documents associated with an Arc Flash study consist of NFPA 70E, NFPA 70 (the National Electrical Code), and CFR 29 Part 1910 (Occupational Safety & Health Act). The NEC is the prescriptive code dealing with electrical design and construction requirements. However, the NEC does not apply to the operation and maintenance of electrical systems. This function is addressed by NFPA 70E, which places responsibility of electrical safety in the workplace upon the owner. OSHA 1910.132(d)(1) also states that, "The employer shall assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of PPE."

NFPA 70E represents a national consensus safety standard for electrical safety in the workplace that facilitates how to comply with the OSHA and NEC standards referenced above. The first edition of the Standard for Electrical Safety in the Workplace (NFPA 70E) was issued in 1979. However, the 2000 edition was the first edition that brought attention to the hazards of arc flash phenomena. Major updates to NFPA 70E including the 2004 and 2009 editions continue to further define the safety requirements related to arc flash. In a standard interpretation letter dated July 25, 2003, OSHA's Russell Swanson stated, "Industry consensus standards, such as NFPA 70E, can be used by employers as guides to making the assessments and equipment selections required by the standard. Similarly, in OSHA enforcement actions, they can be used as evidence of whether the employer acted reasonably." New as well as existing equipment is required to conform to these standards. There is no grandfather clause that exempts existing equipment from being labeled.

NFPA 70E identifies the levels of Shock Hazard and Arc Flash Hazard associated with working on or maintaining electrical systems, and identifies the level of PPE and the work procedures required to maintain a safe condition in the workplace. The Electrical Energized Work Practices outlined in NFPA 70E incorporates measures to help avoid or minimize the potential safety risk to employees from an arc flash or electrical shock. To minimize hazards, there are various methods that can be employed including, working on equipment that has been rendered electrically safe (de-energized, locked-out, and tagged-out), wearing proper PPE, and maintaining restricted access areas around electrical equipment as defined in NFPA 70E. Working on de-energized equipment is the only way to eliminate risks of electrical shock or arc flash; however, this method is not always feasible considering the critical nature of water treatment and distribution facilities. To understand and identify the level of risk associated with working on energized electrical equipment, a mathematical model of the electrical system is necessary to calculate the potential arc flash hazards and approach boundaries at each piece of electrical equipment. According NFPA 70E 130.3(A)(1) it is acceptable make the Arc Flash Protection boundary 4.0 feet in lieu of an incident energy analysis to determine the hazard/risk category and requirements for PPE, so long as the system is between 50 and 600 volts, and the product of clearing time and available bolted fault current does not exceed 100 kA cycles. According to NFPA 70E 130.3(B)(2), it is acceptable to select personal and other protective equipment using tables 130.7(C)(9), 130.7(C)(10), and

130.7(C)(11). If a task is not in the table or the requirements of the notes referenced in the table are not met, then the table cannot be used and it is necessary to perform the task with the equipment de-energized.

To meet requirements of NFPA 70E for some portions of the Joint Facilities electrical distribution system with respect to labeling, identifying the potential incident energy, approach boundaries, and selecting the level of PPE associated with specific equipment, a complete mathematical model of the facility's electrical system was developed. Components of this study included an up-to-date, accurate, and complete electrical one-line diagram; identification all power wire sizes and lengths; determination of all system impedances; determination of all power sources; and determination of the current settings and setting options for all protective devices. After this data collection task was completed, the power distribution model was then constructed and the fault current levels at each point in the electrical system were calculated. Building upon the fault current study and using field obtained protective device settings; a preliminary protective device coordination study was conducted. Based upon calculated fault current levels, results of the protective device coordination study, and system voltage levels, a preliminary Arc Flash study and the final Shock Hazard analysis were conducted.

San Dieguito Pump Station

Previous work products, site visits, as well as discussions with facility staff indicate that the electrical equipment at the SDPS has exceeded its usable life and is no longer reliable. A fault current and arc-flash analysis was not performed on the SDPS electrical distribution equipment. Because the equipment has reached its usable life, it would not be responsible or safe to assume the electrical protective equipment will function according to the original design intent. As such, the safest way to protect personnel is to de-energize electrical equipment before any maintenance or repair work is performed. To safely account for this reliability issue, plant staff should only perform maintenance or repairs on SDPS electrical equipment when it is proven to be de-energized. Furthermore, complete de-energization can only be achieved by opening the knife switches inside the SDG&E substation; opening the main 480V breaker will de-energize the majority of the facility, however if the SDG&E substation remains energized, the line side of the main 480V breaker will also be energized. It should be noted that with respect to arc flash hazard levels, the line side of the main 480V breaker is likely the most dangerous point in the SDPS power system because of its proximity to the SDG&E system, which acts as the energy source in the event of an arc flash.

Cielo Pump Station

To model the CPS electrical system, a field investigation was performed to collect required electrical equipment ratings, trip settings, model numbers, etc. The as-built drawings of the pump station were also used to determine conductor sizes and lengths, as well as electrical system loading.

The electrical system model requires the Utility service characteristics to determine the amount of energy available during an arc flash condition. Carollo coordinated with Gina Samuelson from SDG&E to get this information.

A few assumptions were made to complete the model. One assumption that needed to be made was how to accurately represent a portable generator that may be used in emergency situations. Based on the emergency loading shown on the As-Built Drawings, Carollo performed a generator sizing calculation in Cummins Power Suite. The sizing calculation showed that an 800 kW generator is required to meet the requirements of the emergency load information. The conductors from the generator termination box to the ATS are adequately sized for an 800 kW generator. Therefore, an 800 kW generator was modeled. Other assumptions are listed in the Assumptions Section in Appendix C.

The CPS arc flash study results are presented in two tables:

1. Present Settings – Results shown for the settings of all protective equipment within the facility as observed during field visits with no alterations. The arc flash results with the present settings are shown in Table 5.1.

2. Proposed Settings – Results shown with alterations made to protective equipment settings to reduce potential arc-flash hazard at equipment. To prevent nuisance tripping and coordination issues, it is important that the recommended alterations are discussed and fully understood before changes are made in the field. When changes to protective device settings are implemented, they should be implemented with a sequenced procedure that allows sufficient proving time at the new settings. The intent of the proposed settings is to provide an alternate setting that reduces the arc flash potential without causing nuisance tripping and does not have an adverse affect to the distribution system coordination. The arc flash results with the proposed settings are shown in Table 5.2.

Upon agreement of the final settings, arc flash labels will be printed for each piece of equipment identified in the arc flash results table. Applicable information including the equipment tag, arc flash hazard boundary, incident energy, hazard category, and required PPE, is printed on the label. An example of the format for the label is shown in Figure 5.1. The complete arc flash analysis for the CPS has been provided in Appendix C.

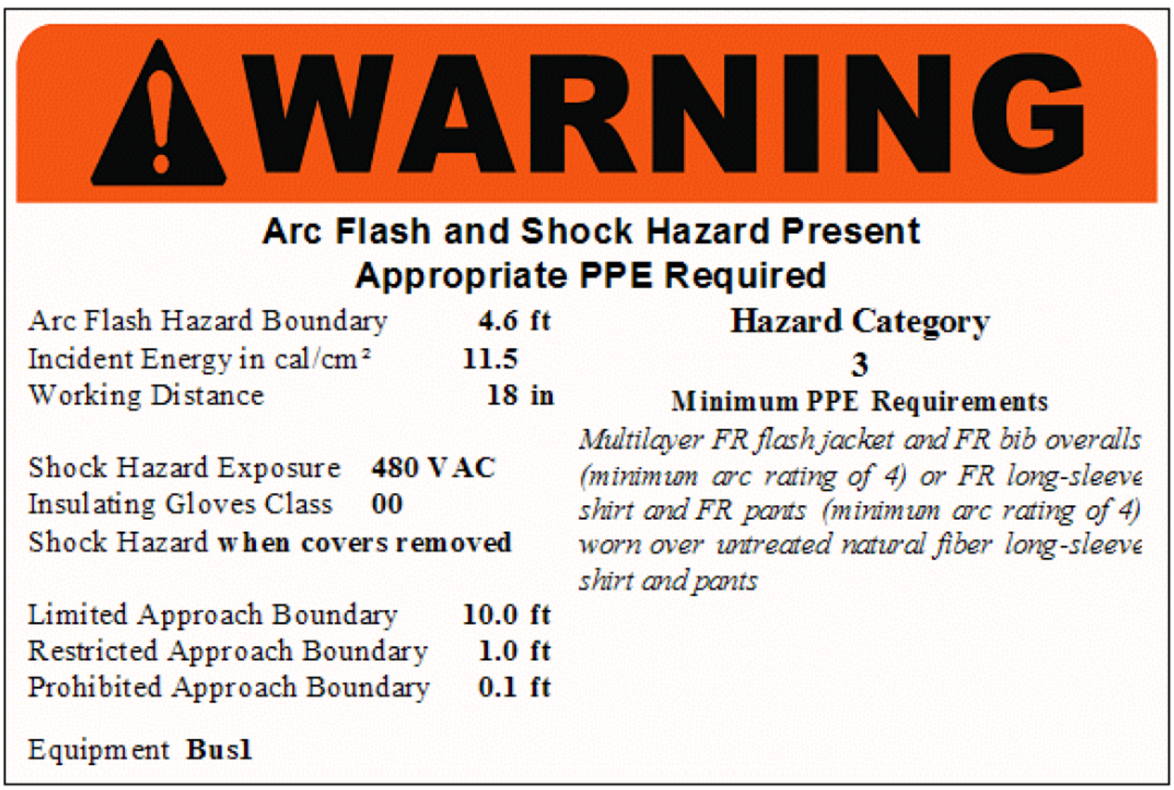

Figure 5.1 Sample Arc Flash Warning Label

Table 5.1 Cielo Pump Station Arc Flash Results – Present Settings

ID	kV	Total Energy (Cal/cm^2)	Flash Protection Boundary (ft)	PPE Description	Hazard Category
AC-2	0.48	0.3	0.7	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
AC-2 DISCONNECT	0.48	0.3	0.8	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
ACP-2	0.48	0.2	0.6	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
ACP-2 DISCONNECT	0.48	0.3	0.7	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
ATS Utility Bus	0.48	31.2	7.6	A total clothing system consisting of FR shirt and pants and/or FR coveralls and/or arc flash coat and pants (clothing system minimum arc rating of 40)	Cat 4
MCC-2	0.48	31.2	7.6	A total clothing system consisting of FR shirt and pants and/or FR coveralls and/or arc flash coat and pants (clothing system minimum arc rating of 40)	Cat 4
MCC-2 LINE	0.48	31.2	7.6	A total clothing system consisting of FR shirt and pants and/or FR coveralls and/or arc flash coat and pants (clothing system minimum arc rating of 40)	Cat 4
MSC-2	0.48	137.7	16.1	Must be de-energized before work is performed.	> Cat 4
P-1-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-1 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1

Low Hazard (yellow)

High Hazard (red)

Table 5.1 Cielo Pump Station Arc Flash Results – Present Settings (continued)

ID	kV	Total Energy (Cal/cm^2)	Flash Protection Boundary (ft)	PPE Description	Hazard Category
P-2-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-2 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-3-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-3 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-4-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-4 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
T2 Load Side	0.48	158.8	17.2	Must be de-energized before work is performed.	> Cat 4

Low Hazard

High Hazard

Table 5.2 Cielo Pump Station Arc Flash Results – Proposed Settings

ID	kV	Total Energy (Cal/cm^2)	Flash Protection Boundary (ft)	PPE Description	Hazard Category
AC-2	0.48	0.3	0.7	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
AC-2 DISCONNECT	0.48	0.3	0.8	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
ACP-2	0.48	0.2	0.6	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
ACP-2 DISCONNECT	0.48	0.3	0.7	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
ATS Utility Bus	0.48	2.1	2	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
MCC-2	0.48	2.1	2	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
MCC-2 LINE	0.48	2.1	2	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
MSC-2	0.48	137.7	16.1	Must be de-energized before work is performed.	> Cat 4
P-1-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1

Low Hazard

Changes highlighted in green.

High Hazard

Table 5.2 Cielo Pump Station Arc Flash Results – Proposed Settings (continued)

ID	kV	Total Energy (Cal/cm^2)	Flash Protection Boundary (ft)	PPE Description	Hazard Category
P-1 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-2-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-2 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-3-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-3 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-4-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-4 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
T2 Load Side	0.48	158.8	17.2	Must be de-energized before work is performed.	> Cat 4

Low Hazard (yellow)

High Hazard (red)

Changes highlighted in green.

Badger Water Filtration Plant

Preliminary Arc Flash calculations were conducted for the portion of the WFP electrical system that extends from the point of interconnection with the SDG&E 12 kV system down to the primary side of the padmount transformers for the WFP and the Backwash & Solids Handling facilities, including the 4.16 kV hydroelectric generation facility. Because of the proximity of this portion of the WFP electrical system to the SDG&E system, and the lack of significant impedance given that the equipment is close-coupled, the preliminary calculations indicate that the arc flash hazard is greater than category 4. In addition to the physical characteristics of the system, the arc flash incident energy calculation is also dependent on the clearing time of the protection devices. As such, the arc flash hazard may be reduced if the clearing times of the protection devices are sufficiently fast. However, due to the age and physical condition of the electrical equipment and the associated protection devices, relying on the protection scheme to operate in the manner and timeframe for which it was originally intended is not prudent or safe. Consequently, it is recommended that all 12 kV and 4.16 kV equipment within the WFP electrical system, including the hydroelectric facility and the line side of the padmount transformers powering the WFP and the Backwash & Solids Handling facility, be treated as having an arc flash hazard level of greater than category 4. Based on this categorization, this equipment should not be maintained while energized. Furthermore, SFID Staff should practice extreme caution when working in front of this equipment. One area of particular concern is the inside of the hydroelectric building, which contains the 4.16 kV main distribution switchgear for the entire facility, because SFID staff frequently enters this building to adjust the flow rate setpoints for the plant.

The most conservative approach to mitigating exposure to the arc flash hazard in the hydroelectric building would be to completely de-energize the 4.16 kV main switchgear before entering the building. This is obviously not practical because it would require a complete plant shutdown every time the plant flow rate setpoint needs to be changed. The recommended arc flash hazard mitigation approach is as follows:

1. To make plant flow rate setpoint adjustments, entering the hydroelectric building with the 4.16 kV main switchgear energized should only be considered safe if the operator remains in front of the generator control panel. If an arc flash were to occur, the generator control panel would act as a barrier between the operator and the arc flash.

2. If it is necessary for an operator to enter into any area in the hydroelectric building that has unimpeded access to the front of the 4.16 kV main switchgear, the switchgear should be completely de-energized.

With respect to the low voltage (480 V and below) portions of the WFP electrical system, Article 130.3(A)(1) of NFPA 70E states that the arc flash protection boundary for voltage levels between 50 and 600 Volts can be determined without hazard analysis calculations for a system under the condition that the product of the clearing time and available bolted fault current does not exceed 100 kA-cycles. To confirm that the 480 Volt equipment at the WFP did not exceed 100 kA-cycles, the system was modeled and bolted fault currents were calculated. Based on the calculated fault currents, the maximum clearing time was determined for all 480 Volt equipment. Table 5.3 shows calculated fault current for each piece of equipment, typical minimum over-current protection device clearing times, and the resulting kA-cycle values. Because all kA-cycle values are less than 100, hazard analysis calculations are not required for these portions of the WFP electrical system; identification of the arc flash hazards will be based on NFPA 70E Table 130.7(C)(9).

Table 5.3 Calculated Fault Current for Electrical Equipment at the WFP

Equipment Designation	Preliminary Fault Calc (Amps)	Typical Minimum Clearing Time at Instantaneous Operation (Cycles)	Fault Current-Cycles at Typical Minimum Clearing Time (kA-Cycles)
Main 5kV Switchgear	8040	1	8.0
MSB (Backwash & Solids Treatment Facilities)	12740	3	38.2
MCC-1 (Backwash Treatment Facility)	12740	3	38.2
MCC-2 (Solids Treatment Facility)	12740	3	38.2
Power Distribution Panel "P"	9080	3	27.2
MCC-1M	9080	3	27.2
MCC-2M	9080	3	27.2
MCC-3M	9080	3	27.2
MCC-3MA	9080	3	27.2
MCC-3MB	9080	3	27.2
Automatic Transfer Switch	9080	3	27.2
Emergency Power Distribution Panel "EP"	9080	3	27.2
MCC-1EM	9080	3	27.2
MCC-2EM	9080	3	27.2
MCC-3EM	9080	3	27.2
MCC-4EM	9080	3	27.2
Breaker Panel "A" (Filter Console)	9080	3	27.2
Breaker Panel "D" (Filter Console)	9080	3	27.2
PP-1	2900	3	8.7
PP-2	2900	3	8.7
Polymer Load Center	2800	3	8.4
Panel LEA	2800	3	8.4
Panel LC	2800	3	8.4
Panel ED	873	3	2.6
Station Power Panel (by 5 kV SWGR)	1550	3	4.7

Section 130.3(B)(2) of NFPA 70E states that the Personal Protective Equipment application can be identified by using Hazard/Risk Categories as defined in table 130.7(C)(9) in lieu of performing an incident energy analysis. A dual label method will be used to inform plant staff of the arc flash hazard for each piece of equipment. A warning label will identify the arc flash protection boundary and shock hazard. In addition, the warning label will direct the staff member to a Hazard/Risk Category table. A second label will include the applicable portion of the Hazard/Risk Category table for the specific equipment. For example, a panelboard will include the portion of the Hazard/Risk Category table that pertains to panelboards. An example of the warning label is shown in Figure 5.2 and examples of the Hazard/Risk Category labels are shown in Figure 5.3. The complete arc flash analysis for the WFP has been provided in Appendix C.

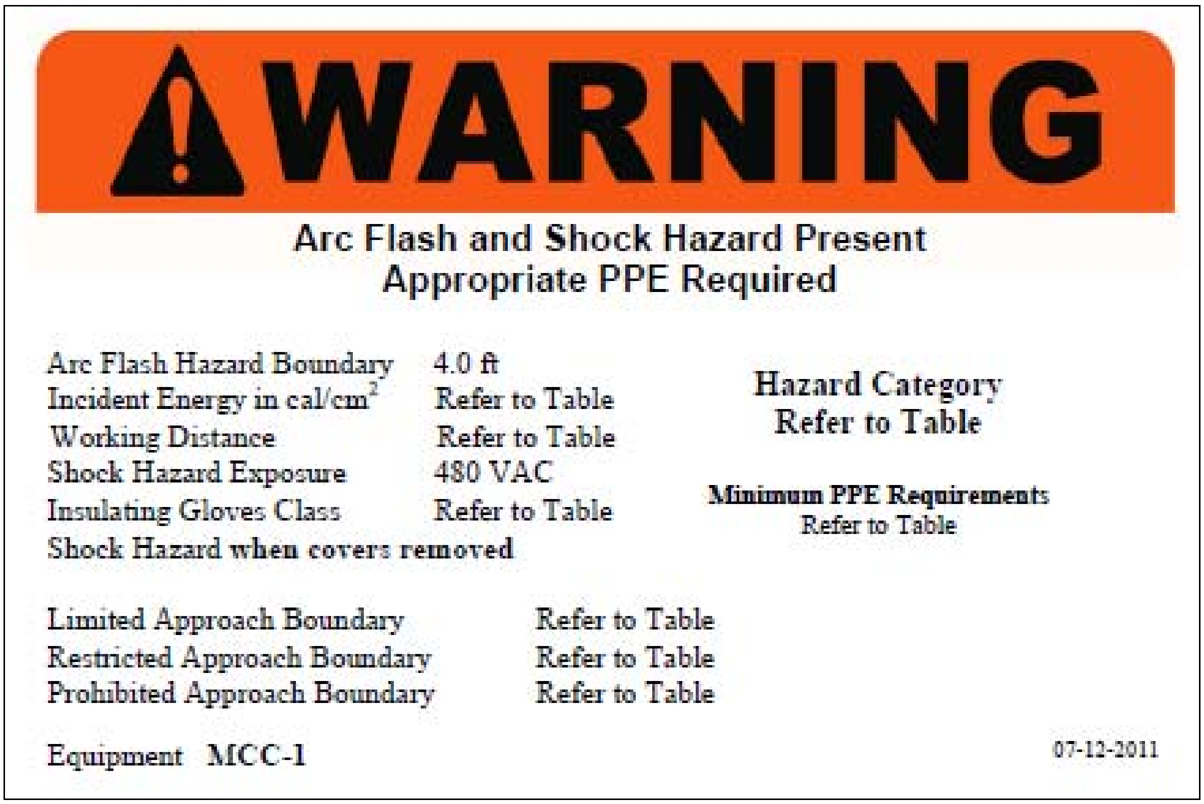

Figure 5.2 Sample Arc Flash and Shock Hazard Warning

Tasks Performed on Energized Equipment	*Hazard/Risk Category*	*Rubber Insulating Gloves*	*Insulated and Insulating Hand Tools*
Panelboards or Switchboards Rated >240 V and up to 600 V (with molded case or insulated case circuit breakers) - Note 1			
Perform infrared thermography and other non-contact inspections outside the Restricted Approach Boundary	1	N	N
CB or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	Y	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard or switchboard	2*	Y	Y

General Notes (applicable to the entire table):

(a) Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.

(b) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which wok will be done, and are manufactured and tested in accordance with ASTM F 1505, *Standard Specification for Insulated and Insulating Hand Tools*.

(c) Y= yes (required), N=no (not required).

(d) For systems rated less than 1000 volts, the fault currents and upstream protective device clearing times are based on an 18 in. working distance.

(e) For systems rated 1 kV and greater, the Hazard/Risk Categories are based on a 36 in. working distance.

(f) For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (1/2 cycle fault clearing time or less), the hazard/risk category required may be reduced by one number.

Specific Notes (as referenced in the table):

1. Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time.

Figure 5.3 Sample Hazard/Risk Category Labels

STAND-BY POWER

Cielo Pump Station

Rather than having a permanently installed stand-by engine generator, the CPS is equipped with a connection to the electrical system that allows use of a trailer-mounted portable engine generator when there is an SDG&E outage. Although the CPS electrical service has historically been susceptible to SDG&E "brown outs," the expense of installing a permanent stand-by generator does not appear to be justified at this time. Furthermore, there is limited physical space to do so without impeding truck access around the pump station building.

San Dieguito Pump Station

At one time, stand-by power to the SDPS was provided by two gas turbines located adjacent to the pump station building. The gas turbines have been de-commissioned for several years, thus at present, the pump station is not equipped with stand-by power, which is a significant operational limitation for the WFP during SDG&E power outages at the pump station.

Because of the criticality of this facility, it is recommended that the design of the new SDPS include stand-by power. The stand-by power capacity and generation technology (e.g., diesel, natural gas, propane, dual-rated) should be determined in the initial phases of the pump station design. However, it is anticipated that the most practical and economical generation technology will be diesel engine generation with onsite storage. With respect to generation capacity, a minimum of 50 percent of the rated pumping capacity of the facility is recommended.

CWA Flow Control Facility

Recently, staff installed a connection to the flow control facility electrical system for a trailer-mounted portable generator. Consequently, the expense of installing a permanent stand-by generator does not appear to be justified at this time.

Badger Water Filtration Plant

The WFP is currently equipped with two types of onsite power generation equipment: the hydroelectric facility and a 150kW propane engine generator. Because the hydroelectric facility is equipped with induction generators, rather than synchronous generators, the facility can only operate in parallel with the SDG&E service. Thus, if the SDG&E service for the WFP suffers an outage, the hydroelectric facility cannot produce power. Consequently, the hyrdroelectric facility, in its current configuration, is not a source of stand-by power for the WFP.

Although the existing 150kW propane engine generator has provided reliable stand-by power to the WFP, it is reaching the end of its useful life. Therefore, replacement of the existing generator is recommended as part of the overall WFP electrical system upgrade. The new stand-by power capacity and generation technology (e.g., diesel, natural gas, propane, dual-rated) should be determined in the initial phases of the WFP electrical system upgrade design. However it is anticipated that the most practical and economical generation technology will be diesel engine generation with onsite storage. Additionally, a detailed electrical load analysis should be conducted to determine the appropriate stand-by power capacity for the WFP based on the operational needs of the plant during an SDG&E outage.

ENERGY EFFICIENT TECHNOLOGIES

There are several energy efficient technologies that should be considered in the design of improvements and/or equipment replacement at the Joint Facilities.

Premium Efficiency Motors

Electrical motors consume a large fraction of the electrical energy at the Joint Facilities and can provide a opportunity for energy and cost savings. In general, premium efficiency motors are manufactured with larger quantities of iron and copper, which reduces the electrical losses, thus increasing motor efficiency. Although premium efficiency motors are standard for modern installations, in older facilities, such as the SDPS and the WFP, there are often applications where replacing existing motors with new premium efficiency motors can result in energy cost savings. Depending on the motor hp, load conditions, and runtime, operating a premium efficiency motor can result in an energy cost savings in the range of 1 to 5 percent.

According to staff, all existing motors greater than 5 hp have been upgraded to premium efficiency motors, thus it is unlikely that efficiency of motors could be significantly improved.

Variable Speed Drives

Depending on the application, use of variable speed drives (VFDs) over traditional throttling valves for pump flow control can equate to energy and cost savings. By controlling flow by reducing the speed of pumps using VFDs rather than running the pump at full speed, power usage can be reduced exponentially. The ability to improve energy efficiency with VFDs is dependent on the specific flow and head conditions, and thus should be evaluated on a case-by-case basis. In some cases, using a VFD can result in an energy savings in the range of 20 to 30 percent.

Energy Efficient Lighting Practices

The use of energy efficient lighting practices can reduce power consumption at the Joint Facilities. Existing luminaries with low efficiency and ballasts with high harmonic content and poor power factor should be replaced to meet the energy requirements set by the California Energy Code, Title 24. Use of energy efficient lighting technology and methods such as high efficiency fluorescents, Light Emitting Diodes (LED), solatubes, and intelligent lighting controls should be considered in the design of new structures.

Smart Motor Control Centers

Understanding and reducing carbon footprint has recently become a priority in the water and wastewater industry. Next to water purchasing costs, energy costs are the largest operating expense for the Facilities. Quantifying the carbon footprint and energy usage for an operating plant typically involves a best guess and estimating approach based on a careful review of past energy bills, estimation of power usage for each process in the facility, and a comparison of that plant's processes to typical models. Installation of smart MCCs can allow SFID/SDWD to continuously monitor and trend power usage and power quality, not only for a facility as a whole, but for each individual process—even down to each individual motor. By having this information readily available, operators know which processes are consuming the greatest amount of energy, or are causing the greatest power quality issues. This information would allow operators to make adjustments to each step of the process, while receiving real-time power savings and quality feedback. Implementation of digital bus technology can also help the Joint Facilities reduce maintenance costs. Because equipment maintenance is typically scheduled and performed based on averages and estimates, a piece of equipment may be scheduled for replacement before it reaches its full useful life. What may be even worse is for a piece of equipment to be used beyond its useful life; creating inefficiencies in the process, down time, and upon ultimate failure—panic. Digital bus technology can improve these inefficient maintenance programs by providing information that can be used to identify failing equipment, sense and alert the operator to common maintenance issues, and track equipment performance. Ultimately, the information can be utilized to create a predictive maintenance program based on actual data rather than averages and estimates. Implementing Smart MCC technology into the new upgraded electrical distribution system at the Joint Facilities will provide plant operators with the necessary information to improve the plant's operation and efficiency, resulting in reduced plant maintenance costs, reduced energy costs, and a smaller carbon footprint.

SDG&E REBATES AND INCENTIVES

SDG&E offers financial incentives, design assistance, and performance audits to help optimize the benefits of energy efficiency in water treatment facilities.

Rebates

SDG&E offers rebates to customers for selecting energy efficient equipment and methods. Energy Efficiency Business Rebates (EEBR) offered by SDG&E to business customers for installing/implementing energy-efficient lighting and lighting practices, premium efficiency motors, network power management software, variable frequency drives on HVAC systems, and several more. SDG&E provides a comprehensive catalog of all EEBR on their website. To apply for EEBRs, an application must be submitted after components are installed and operational.

Custom Incentives

SDG&E offers custom incentive programs including their Energy Savings Bid Program (ESB). The ESB program allows a customer to propose the incentive amount for their project. To apply for the ESB program, an application must be submitted and approved. Upon installation, SDG&E will schedule a post installation inspection to validate installation. Depending on the incentive requested, a power usage monitoring and verification plan may need to be submitted to provide proof that power usage was reduced as a result of upgrades.

Interest-Free Financing

SDG&E offers an On-Bill Financing Option (OBF) that allows qualified commercial and taxpayer funded customers to pay for energy-efficient business improvements through their SDG&E bill. OBF works in conjunction with rebate and incentive programs to provide an interest free financing option to customers.

Benchmarking

For SDG&E customers who participate in energy efficiency programs, it is required to perform benchmarking with the EPA's ENERGY STAR Portfolio Manager. The Portfolio Manager tracks and assesses energy performance across the entire facility power portfolio and rates the facility's energy performance on a scale of 1 to 100 relative to similar businesses.

Audits

SDG&E offers technical audits and technology incentives to provide on-site facility evaluations for customers. The audits range from simple site assessments to comprehensive engineering studies designed to determine load reduction potential and energy efficiency opportunities.

SOLAR PHOTOVOLTAIC POWER GENERATION

Although operation of the existing hydroelectric generation facility significantly reduces the plant's carbon footprint, implementation of other renewable energy technologies may allow for further reduction of green house gas emissions resulting from consumption of commercial electricity.

At large scale, renewable energy technologies that are most commonly implemented are hydroelectric power generation, wind turbines, solar photovoltaic (PV), and fuel cells. The WFP currently has a hydroelectric facility to take advantage of the excess head on the plant influent line from CWA. Wind turbines are not feasible due to a lack of wind resources at the site, as well as possible political and environmental obstacles. Fuel cells are typically considered renewable only if a gas supply is generated on-site, such as digester gas or landfill gas. Because the WFP does not have an onsite source of gas, a fuel cell installed there would require a commercial gas supply, which would impact not only the renewable classification of the system, but also project economics. Consequently, of large-scale renewable energy technologies available, solar PV is the only one that warrants further analysis for implementation at the WFP.

To evaluate the feasibility of implementing solar PV technology, five areas on the plant site were identified as potential locations to install solar PV equipment. These areas are illustrated in Figure 5.4. The size of these potential locations was estimated and then used as the basis for feasibility analysis presented in Table 5.4.

The feasibility analysis is based on the concept of Net Present Value (NPV), which is a widely accepted method for evaluating the value of capital expenditures and investments. Mathematically, the NPV of a project or investment is equal to the sum of the cash flows associated with the project/investment over a specified period discounted to account for the time value of money. Conventionally, the decision to pursue a project/investment is governed by whether the NPV is greater than or less than zero. Projects having NPVs greater than zero suggest economic viability.

As indicated in Table 5.4, the NPVs associated with solar PV systems constructed at each of the five locations, as well as the NPV associated with a system that covers all five sites, are all significantly negative. The unfavorable NPVs are primarily the result of the high capital cost associated with the technology and the relatively insignificant energy production incentive offered by the California Solar Initiative through SDG&E.

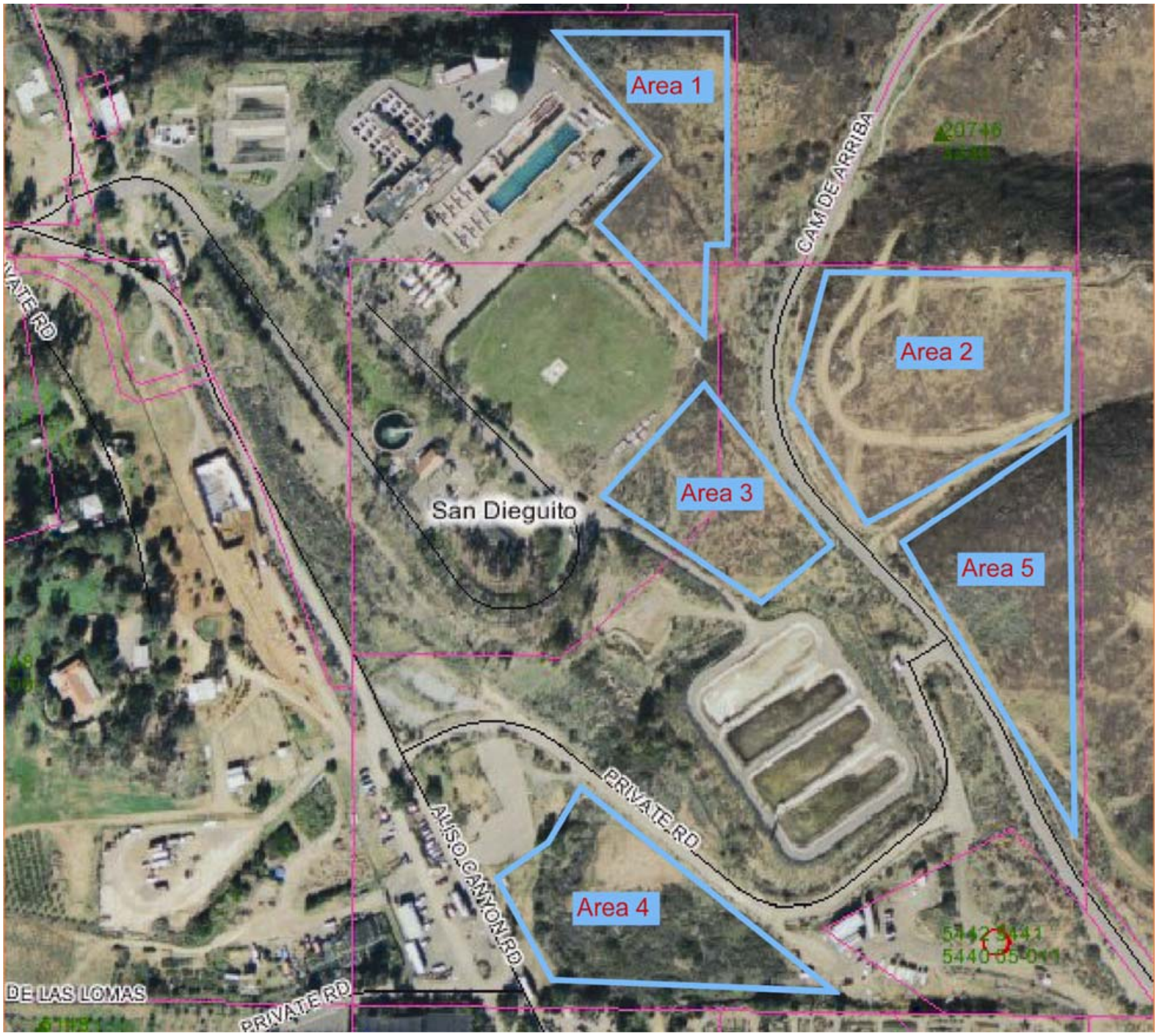

Figure 5.4 Five Potential Areas to Install Solar Photovoltaic Equipment

With respect to the feasibility of implementing solar photovoltaic technology at the SDPS, it was assumed that the economic evaluation would yield the same negative results as the evaluation performed for the WFP. This is a valid assumption because the economic performance of solar photovoltaic projects is primarily driven by the high capital cost associated with the technology and the relatively insignificant energy production incentives currently available, which are both completely independent of facility location.

Table 5.4 Economic Feasibility Analysis of Potential Solar Photovoltaic Locations on the WFP Site

Location[1]	Area (Acres)	Utilization Factor[2]	Panel Coverage Area (Acres)	Solar Array Size (kW)[3]	Year 1 Energy Production (kWh)[4]	Year 1 Energy Production Value[5]	Capital Cost[6]	California Solar Initiative Incentive 5 Year Total[7]	Net Present Value[8]
Area 1	2.39	30%	0.72	287	473,550	$ 47,355	$ 2,296,600	$ 353,522	$ (1,007,600)
Area 2	3.55	50%	1.78	710	1,171,500	$ 117,150	$ 5,680,000	$ 874,568	$ (2,492,670)
Area 3	1.82	60%	1.09	437	721,050	$ 72,105	$ 3,496,600	$ 538,290	$ (1,534,221)
Area 4	2.92	50%	1.46	584	963,600	$ 96,360	$ 4,672,000	$ 719,363	$ (2,050,309)
Area 5	2.41	30%	0.72	289	476,850	$ 47,685	$ 2,312,000	$ 355,986	$ (1,014,622)
Areas 1-5	13.09	44%	5.77	2307	3,806,550	$ 247,500	$ 18,456,000	$ 1,231,785	$ (9,574,238)

Notes

1. See Figure 5.4 for potential locations.
2. Utilization factor is an estimated percentage of the total area that can be used for installation of solar panels. The geographical orientation and geometry of the area in question are the primary factors affecting the utilization factor. This factor also accounts for spacing between individual panel arrays.
3. Estimated solar array size calculated based on 400 kW per acre of panel area.
4. Estimated year 1 energy production calculated based on 1650 kWh per installed kW of solar panels.
5. Year 1 energy production value calculated based on an average energy price of $0.10 per kWh.
6. Estimated capital cost calculated based on $8.00 per installed Watt.
7. 5-year total incentive calculated based on $0.15 per kWh, which is the current incentive offered by the California Solar Initiative (CSI) through SDG&E. The total incentive amount of $1,231,785 is calculated based on 1000 kW of the total 2307 kW system size because the current CSI program limits eligible systems to 1000 kW.
8. Refer to Appendix D for detailed Net Present Value Calculations.

POWER SYSTEM IMPROVEMENTS

This section provides an overview of the configuration and condition of the existing distribution system at the Joint Facilities. This section will further define improvements required to meet near and long term electrical power needs. Four distribution concepts are discussed and compared to provide cost effective and reliable options for upgrading the Joint Facility's power distribution system.

Overview of Existing Facilities

Relevant discussion on the WFP, SDPS, and CPS follows.

Badger Water Filtration Plant

The majority of the WFP Electrical Equipment was installed in 1968. In 1993, electrical distribution equipment was added to support flocculation, additional chemical feed, and other miscellaneous plant process loads. In 2002, electrical distribution equipment was added to support backwash and solids treatment facilities. The 1968 equipment has reached its useful life and is generally unsafe. The 1968 MCC circuit breaker operator handles are erratic and loose and do not have a positive connection. The 1968 main and distribution circuit breakers are not true dead front design. These issues represent an operations reliability issue as well as an increased risk of shock and arc flash hazard to plant staff. Spare parts for the 1968 and 1993 equipment are available from aftermarket suppliers. However, they are not typically stocked so lead times will likely be long and costs will be significantly higher than that of current issue replacement parts. Manufacturer support for the 1993 and 2002 equipment is available. However, support for the 1968 equipment will likely be unreliable and costly.

San Dieguito Pump Station

The SDPS electrical equipment is past its useful life and has had extensive upgrades and adjustments. Electrical power demand at the SDPS is nearly six times that as the demand at Badger WFP. However, due to the two-mile separation of the facilities, the SDPS is not directly powered from the hydroelectric facility. There is currently no electrical feed between the hydroelectric facility and San Dieguito as each are fed by a separate SDG&E feed.

Cielo Pump Station

The majority of the CPS electrical equipment was installed in 2002. Major equipment is still manufactured and replacement parts are readily available. Currently, there is no on-site standby generation at the CPS. However, there are provisions to connect a portable generator in the event of Utility power failure. Due to sizing of portable generator connection panel, the CPS would need to be operated at a reduced capacity when run from a portable generator.

Proposed Concepts for Electrical Distribution Improvements

Four proposed concepts to improve electrical distribution for the Joint Facilities were developed. Each is presented below.

Concept 1 – Basic Design

Concept 1, shown in Figure 5.5, represents the most basic of options for upgrades to the Joint Facilities distribution system. Separate Utility sources are provided at the two facilities, meaning that the electrical demand of the SDPS cannot be directly powered from the hydroelectric generating facility. Concept 1 replaces the WFP main switchgear and all 1968 and 1993 electrical equipment distributed throughout the facility. It involves complete replacement of the SDPS along with the electrical distribution equipment.

A standby diesel generator was sized to support the entire WFP. It is connected at the WFP 4.16 kV switchgear. The switchgear will be capable of automatic transfer upon sensing a power disruption from the Utility. A standby diesel generator was sized to run the new SDPS at approximately half capacity. The generator is connected to the 480 Volt SDPS switchgear with automatic transfer capability.

Concept 2 – Combined Power System

Concept 2, shown in Figure 5.6, represents a consolidation of power sources for the Joint Facilities. A single Utility source feeds the main 12 kV distribution switchgear connected directly to the hydroelectric generators. The distribution switchgear feeds switchgear responsible for power distribution to the WFP loads. The 12 kV distribution switchgear feeds the SDPS switchgear via a single underground electrical feed installed alongside the pump station discharge pipeline. The SDPS can directly utilize the generation capability of the hydroelectric facility. Concept 2 replaces the WFP main switchgear and all 1968 and 1993 electrical equipment distributed throughout the facility. It involves complete replacement of the SDPS along with the electrical distribution equipment.

A standby diesel generator was sized to support the WFP loads. It is connected at the WFP 480 Volt switchgear. The switchgear will be capable of automatic transfer upon sensing a power disruption from the Utility. A standby diesel generator was sized to run the new SDPS at approximately half capacity. The generator is connected to the 480 Volt SDPS switchgear with automatic transfer capability.

Concept 3 – Combined Power System with Redundant Services

Concept 3, shown in Figure 5.7, is similar to Concept 2, with one addition: a redundant Utility feed to the main 12 kV distribution switchgear is connected directly to the hydroelectric generators.

Concept 4 –Maximum Redundancy and Reliability

An enhancement to Concept 3, Concept 4 provides redundant feeds to the SDPS switchgear via a dual isolated underground electrical feed installed alongside the pump station discharge pipeline. Tiebreakers were included at the 12 kV distribution switchgear, WFP switchgear, and the SDPS switchgear. Tiebreakers add additional flexibility, redundancy, and safety by allowing isolation of distribution busses. Bus isolation can allow for maintenance and repair work to be done de-energized, while a portion of the plant still operates. Tiebreakers allow for isolation of faults to one side of the tie, permitting a portion of bus loads to operate when a fault is present on bus. Tiebreakers add flexibility, by allowing even loading of transformers, selective use of the hydroelectric turbines, and capability to utilize both Utility feeds concurrently.

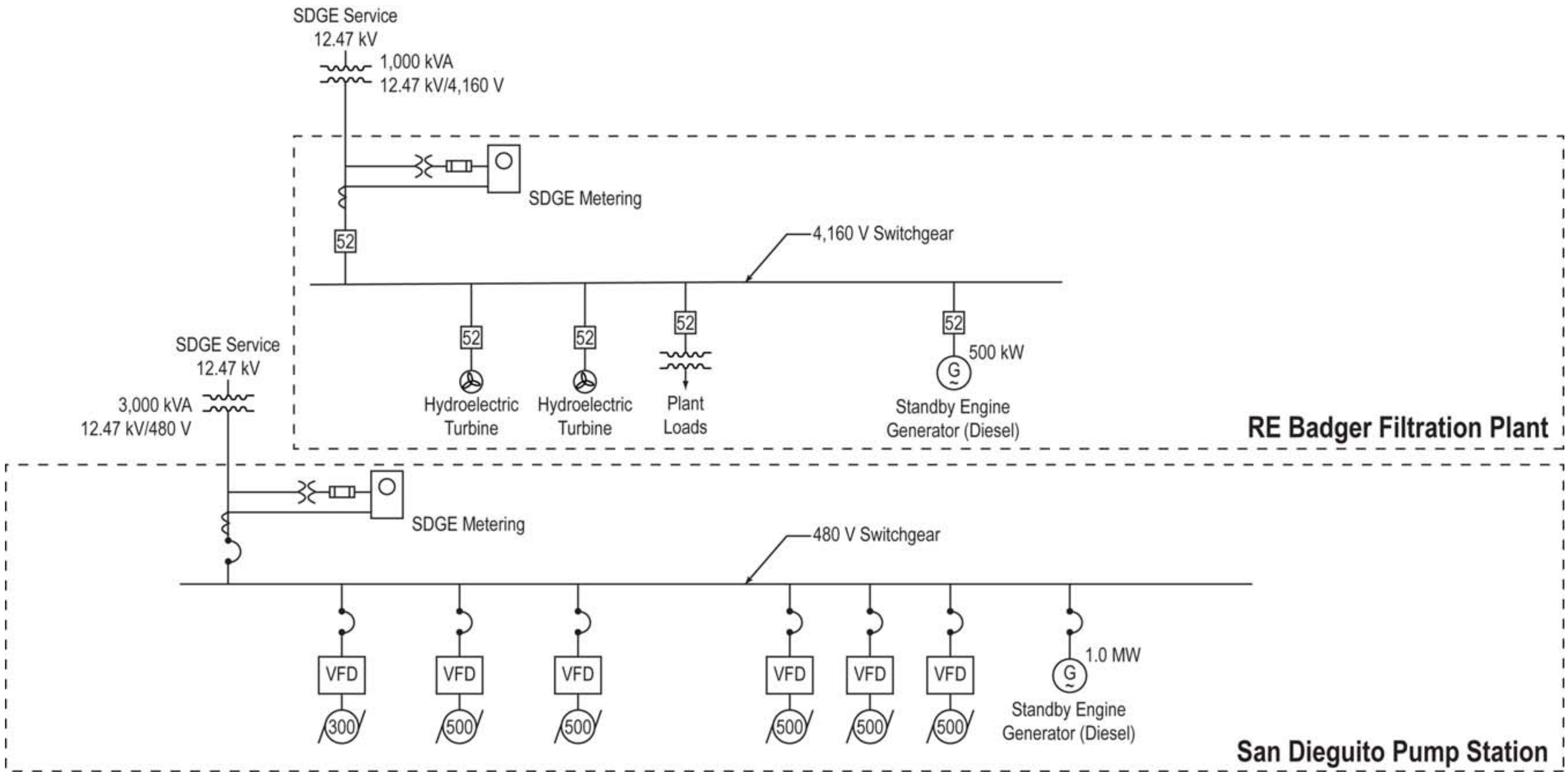

Figure 5.5 Preliminary One Line Diagram for Concept 1 – Basic Design

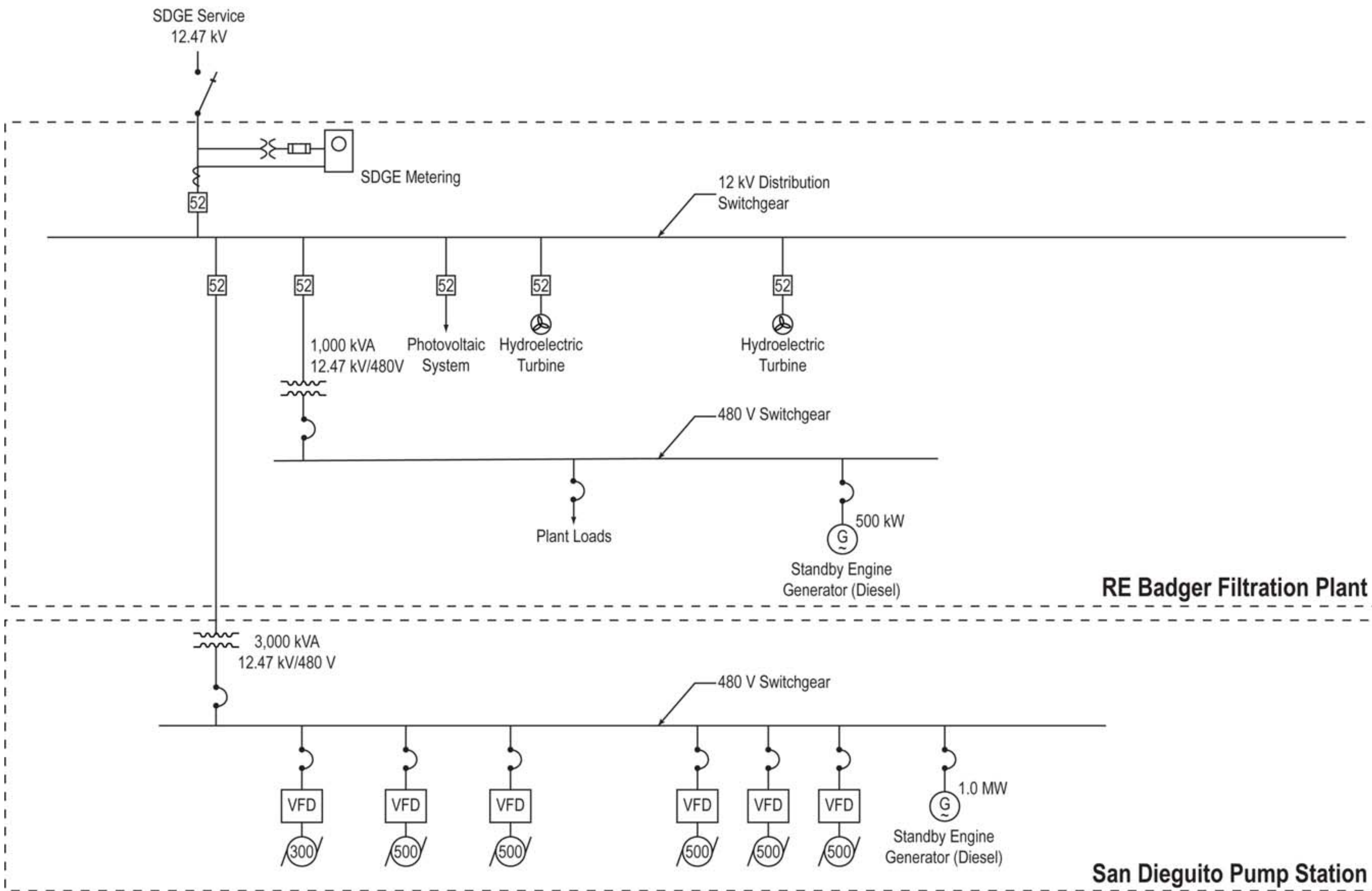

Figure 5.6 Preliminary One Line Diagram for Concept 2 – Combined Power System

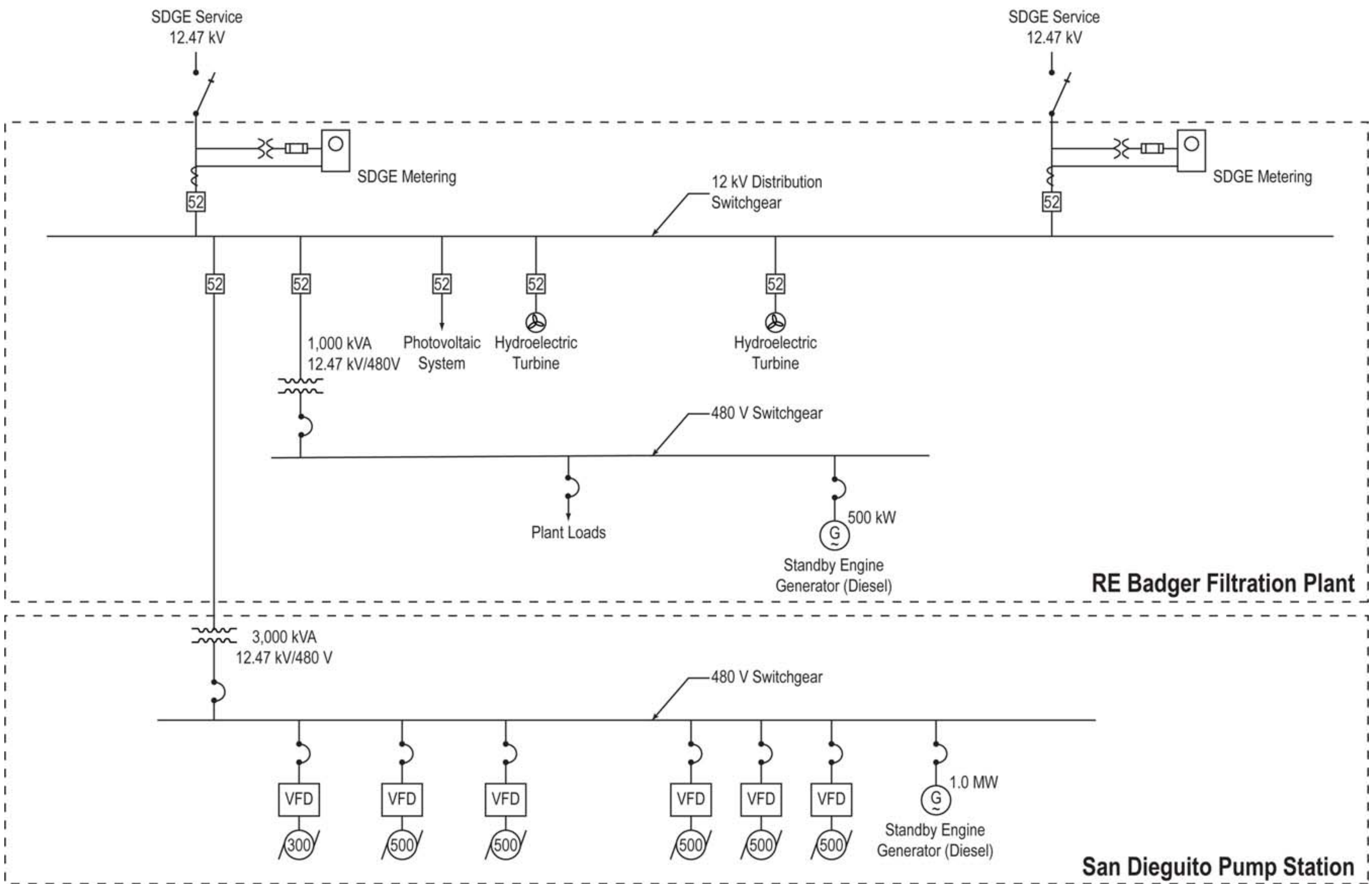

Figure 5.7 Preliminary One Line Diagram for Concept 3 – Combined Power System with Redundant Services

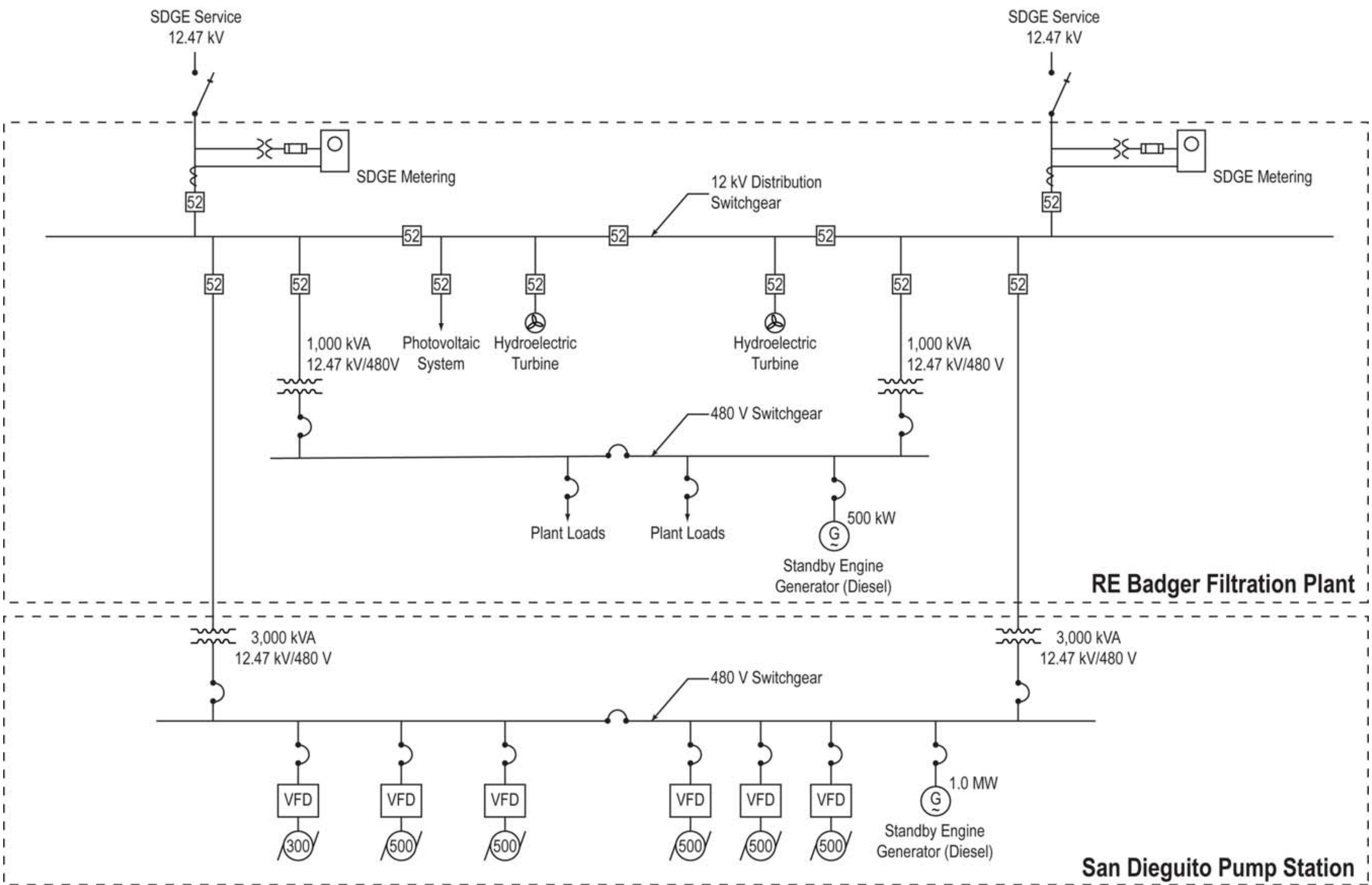

Figure 5.8 Preliminary One Line Diagram for Concept 4 – Maximum Redundancy and Reliability

Comparison of the Four Concepts for Electrical Distribution Improvement

Table 5.5 provides a summary of advantages and disadvantages of each of the four-power distribution concepts discussed.

Table 5.5 Comparison of the Four Concepts for Electrical Distribution Improvement

Advantages	Concept 1	Concept 2	Concept 3	Concept 4
Capital Cost	X			
Consolidated to one Utility bill		X	X	X
SDPS can directly utilize hydroelectric power generation		X	X	X
Minimal power export to SDG&E		X	X	
Transmission level rate structure		X	X	X
Utility redundancy at the 12 kV distribution switchgear			X	X
Redundant feeds to SDPS				X
Redundant feeds to the WFP loads				X
Ability to isolate portions of the major distribution gear using tie breaker for maintenance or repair purposes				X
Disadvantages	**Concept 1**	**Concept 2**	**Concept 3**	**Concept 4**
Capital Cost				X
No Utility redundancy at the WFP distribution switchgear	X			
No Utility redundancy at the 12 kV distribution switchgear		X		
No Utility redundancy at SDPS	X			
No redundant feed to the SDPS		X	X	
No redundant transformers feeding the WFP loads	X	X	X	
No ability to isolate portions of the major distribution gear for maintenance or repair	X	X	X	
Two separate Utility bills	X			
SDPS cannot directly utilize hydroelectric power generation	X			
Majority of hydroelectric power gets exported to SDG&E	X			
Distribution level rate structure	X			

Project cost estimates for the four concepts are presented in Table 5.6.

Table 5.6 Project Cost Estimates for Four Concepts for Electrical Distribution Improvements

Concept No.	Description of Concept	Estimated Project Cost ($)
1	Basic Design	$2,100,000
2	Combined Power System	$3,000,000
3	Combined Power System with Redundant Services	$3,200,000
4	Maximum Redundancy and Reliability	$4,800,000

High Voltage Substation Economic Feasibility Analysis

Currently, SDPS and WFP connect to the SDG&E electricity grid at 12 kV. This section evaluates the economic feasibility of SFID/SDWD designing, constructing, owning, and operating a high voltage substation that would connect to the SDG&E electricity grid at a transmission level voltage, such as 69 or 115 kV. The underlying assumptions for this analysis are the following:

1. A high voltage (e.g., 69 or 115 kV) SDG&E transmission line exists in close proximity to either the WFP or SDPS.
2. SDG&E would agree to provide SFID with electric service at a transmission level voltage.
3. Taking electric service at a transmission level voltage would result in an average reduction in electricity rate of $0.02 per kWh.

The analysis was conducted for each of the four electrical distribution system improvement concepts presented above. Note that with respect to installation of a high voltage substation, Concept Nos. 3 and 4 are identical. Table 5.7 summarizes results of the analysis.

In addition to the economic advantages associated with owning and operating a high voltage substation as well as taking service at transmission level voltage (Concept Nos. 1 and 2), SFID/SDWD would have control over design and maintenance of the substation. The additional control would enhance reliability of the substation beyond that associated with typical SDG&E-owned facilities.

WFP Low Voltage Equipment Replacement WFP

In addition to the overall power system improvements identified in Concepts Nos. 1 to 4 above, much of the existing low voltage equipment, including motor control centers, switchboards, and lighting transformers & panel boards, at the WFP are in need of replacement. The primary justification for replacement is the fact that the equipment is reaching the end of its useful life. Additionally, including replacement of this equipment in an overall electrical system upgrade project would likely result in a more cost effective project due to economies of scale in procuring the equipment. The specific pieces of equipment that are recommended for replacement and the associated estimated costs are summarized in Table 5.8.

Table 5.7 Economic Feasibility Analysis of a High Voltage Substation

Concept No.	Capital Cost	Year 1 O&M Cost[1]	Annual Energy Consumption[2,3] (kWh)	Annual Energy Cost Savings[4]	30-Year Net Present Value[5]	Payback[5] (Years)
1	$540,000	$16,200	2,836,000	$56,720	$99,892	22
2	$900,000	$27,000	5,026,000	$100,520	$283,829	19
3 & 4	$1,800,000	$54,000	5,026,000	$100,520	$(1,402,579)	>30

Notes

1. Annual O&M cost calculated based on 3% of capital cost.
2. Annual energy consumption for the SDPS is based on: 4 - 500 hp pumps @ 50% load, 24 hrs/day for 5 months of the year, motor efficiency = 96%.
3. Annual energy consumption for the WFP is based on an average instantaneous power demand of 250 kW.
4. Energy cost savings calculated based on a $0.02/kWh reduction in the existing average SDG&E energy rate.
5. Refer to Appendix E for detailed Net Present Value and Payback calculations.

Table 5.8 WFP Low Voltage Equipment Replacement Cost

Equipment	Replacement Cost
Padmount Transformer (Backwash & Solids Treatment Facilities)	$35,000
MSB (Backwash & Solids Treatment Facilities)	$6,000
MCC-1 (Backwash Treatment Facility)	$40,000
MCC-2 (Solids Treatment Facility)	$40,000
Padmount Transformer (WFP)	$32,000
Power Distribution Panel "P"	$11,000
MCC-1M	$48,000
MCC-2M	$24,000
MCC-3M	$64,000
MCC-3MA	$16,000
MCC-3MB	$16,000
Automatic Transfer Switch	$64,000
Emergency Power Distribution Panel "EP"	$5,000
MCC-1EM	$32,000
MCC-2EM	$16,000
MCC-3EM	$40,000
MCC-4EM	$24,000
Breaker Panel "A" (Filter Console)	$4,000
Breaker Panel "D" (Filter Console)	$4,000
Lighting Transformers & Panelboards	$50,000
TOTAL	$571,000

ELECTRICAL SYSTEM RECOMMENDATIONS

The following is a summary of the electrical system improvement recommendations.

1. Implement Concept 1, which includes separate power systems for the SDPS and WFP. The primary justification for not powering the SDPS from the WFP is the fact that the capital cost associated with installing the connection is not justified by the benefit. This is compounded by the fact that under most operating scenarios, the SDPS would not be able to operate on power produced by the hydroelectric facility. Having the WFP serve as the primary source of power for the SDPS raises concerns about reliability because of the distance between the two facilities and the fact that the electrical line would be routed through several areas that a not under the direct ownership or control of SFID/SDWD.
2. With respect to the design concept for the new SDPS electrical system, a 480 V distribution system supported with a standby engine generator is recommended. The size and type of the standby generator should be evaluated and determined in the initial phases of the new SDPS design. Although it may be economically advantageous to install a high voltage substation and take SDG&E service at a transmission-level voltage, it is not likely that SDG&E owns a high voltage transmission line close enough to the SDPS site for this alternative to be economical.
3. Install a high voltage substation at the WFP by connecting to the 69 kV power lines located east of the plant. Economic feasibility analysis suggests a payback of about 20 years. If SFID elects to build a new high voltage substation, construction of the substation can occur independently from the WFP electrical system upgrade. Although technically feasible, constructing the substation independently is not as cost effective as including it in the WFP electrical system upgrade for a few reasons.
    a. If a high voltage substation is not included in the WFP electrical system upgrade, some new 12KV service equipment will be required initially that cannot be used after the substation is built.
    b. There will be additional cost associated with coordinating with SDG&E because the SDG&E interconnection will be modified twice; once for the WFP electrical system upgrade and once for the high voltage substation installation.
4. The results of the diagnostic testing that was conducted on the main plant transformer in November of 2011 indicate that the condition of the transformer is deteriorating. In order to protect the reliability of the facility, replacement of this transformer should be expedited. As it was initially conceived, the WFP electrical system upgrade project includes replacement of the main plant transformer and associated primary and secondary switchgear. Thus, the current condition of the transformer substantiates the high prioritization of the WFP electrical system upgrade project.
5. In addition to the modifications to the WFP medium voltage equipment included in Concept 1, replacement of the low voltage equipment, as indicated in Table 5.8, is recommended.

PROCESS CONTROL SYSTEM EVALUATION

The Joint Facilties is currently utilizing Rockwell's RSView32 SCADA-HMI application software (version 7.2) together with Microsoft Windows Server and XP operating systems. The RSView32 SCADA-HMI application has approximately 5,700+ tags currently configured and active. The historical database Historian is configured with Microsoft's SQL Server coupled with Worksmart Automation's Report Builder and Microsoft Excel application software. The database application includes custom application code in accordance with historical data management and reporting requirements. The Joint Facilities is currently utilizing Rockwell's integrated alarm system in-lieu of a Win-911 or SCADAlarm after hours alarm notification system. This alarm management system configuration appears to be serving SFID/SDWD satisfactorily.

SFID/SDWD's WFP SCADA system is configured with redundant Rockwell RSView32 server nodes and a single Microsoft SQL database server. In addition, there are a number of SCADA client nodes distributed geographically throughout the plant. The core SCADA-HMI system consists of the following:

- Operator Workstation No. 1
- Operator Workstation No. 2
- Maintenance Supervisor's Office
- Operations Office
- Chief Operator's Office (Elijah's Office)
- Filter Gazebo
- Laboratory
- Chemical Metering Area (downstairs)
- Cielo Pump Station (aka, Raw Water Pump Station)
- San Dieguito Pump Station
- Distribution Yard (Distribution Operations Supervisor Office)

There is also one additional RSView32 application running in a stand-alone configuration at the Larrick Reservoir facility (industrial PC running RSView32).

The process control network contains the following nodes:

- ICP-110 @ WFP
- ICP-112 & ICP-111 @ WFP (Filters)
- ICP-113 @ WFP
- ICP-114 @ WFP (Dioxide PLC)
- ICP-115 @ SDR
- ICP-116 (Post Clearwell Analyzer)
- ICP-117 @ WFP (Filter Control Weir)
- ICP-119 (Post Clearwell Analyzer)
- ICP-120 @ WFP (radio front end processor)
- ICP-210 @ WFP
- Master Data Concentrator Programmable Logic Controller (PLC) on DH+ network (located @ WFP)
- Actiflo® PLC on DH+ network (located @ WFP)
- Badger PLC (phone line front end processor)

- Andritz PLC
- San Dieguito Pump Station RTU
- Larrick Reservoir RTU
- Lake Hodges Dam RTU
- Cielo Pump Station RTU (aka SDPS)
- Balour Reservoir RTU
- Encinitas Ranch Reservoir RTU

The communication network is split into two core networks: 1) a SCADA information network, and 2) a process control network. Both networks are IP based configurations. All of the process area PLCs are connected to the process control network through a combination of fiber and copper and communicate via ODVA's Ethernet-IP protocol.

The process control system communication network is comprised of a mixture of multiple fiber optic segments and multiple 900 MHz FHSS RF subnets as well as a 2.4 GHz link to SFID's distribution system. There are also a few legacy DH+ and RIO communication links still being utilized. The legacy DH+ communication segments should be upgraded to direct Ethernet-IP connections if possible.

The existing process control system will require some significant maintenance and upgrades in the near future due to technological obsolescence. Major changes in operating system and application software will be the primary force for change. In addition, the hardware (both servers and clients) is near the end of its useful service life and that will also provide incentive for a future upgrade.

Additionally, there are several improvements identified below that should be considered in SFID/SDWD's future SCADA system planning discussions. To further define the process control improvements and develop the associated budgetary cost estimates, it is recommended that SFID/SDWD perform a detailed SCADA Master Plan.

Recommended Process Control System Improvements

Based on our understanding of the current system and our discussions with staff, we propose the following recommendations:

1. SCADA-HMI system server and workstation hardware and software upgrades. The hardware is nearing the end of its useful life expectancy and the operating system and SCADA-HMI application software must be addressed soon.
2. Integration of Microsoft's Terminal Services technology into the SCADA-HMI system infrastructure.
3. Network communication equipment upgrades, including managed switches.
4. Reconfigure or replace existing network server rack to provide physical space for future expansion.
5. Conduct a detailed network security evaluation to determine if modifications to the existing system are necessary to improve network security. The evaluation should also include potential methods for securely accessing the network from remote locations (e.g., outside a firewall).

6. Integration of a Network Management System (NMS) into the SCADA-HMI system interface, including an OPC Gateway for direct integration of network diagnostic information into the SCADA system graphic screens, database, and alarm management system.

7. Integration of energy consumption data into the overall SCADA-HMI system interface, including required power monitoring components at various levels (Motor, MCC, Switchgear, Facility).

8. Integration of real-time motor current transducers and related data into SCADA-HMI system to provide a powerful analytical tool to assist operations staff with advanced diagnostics and preventative maintenance.

9. Provide consolidation and cleanup of all fiber optic communication segments into a central termination enclosure, e.g., termination of all fiber cables into a consolidated rack-mount patch panel located in the 19" equipment rack.

10. Integration of "Time Sync" functionality across the entire process control system network infrastructure, both SCADA information and process control networks (servers, clients, PLCs, and RTUs).

11. Integration of SFID/SDWD's SCADA-HMI system with the CMMS system. Provide for an appropriate exchange of information between the two systems.

12. Cleanup and resolve all SCADA-HMI system documentation conflicts and inconsistencies.

13. Expand existing SCADA-HMI system documentation to reflect current system configuration, including network communication diagrams, PLC I/O diagrams, and RTU configurations.

14. Integration of a document management application into the SCADA-HMI system to provide operations staff with a central repository for all SCADA related information.

15. Eliminate all legacy Allen-Bradley DH+ communication network segments and related equipment. Upgrade to Ethernet communications for consistency and to avoid future issues with obsolete components and technologies.

16. Reconfigure the existing video surveillance system to increase operational functionality and utilization.

17. Provide an enhanced operational interface for laboratory data input and integration into the SCADA-HMI and Historian systems. Also, provide a streamlined and consolidated report generation interface utilizing data from both sources (manual lab data input + SCADA-HMI system data).

18. Review and discuss integration of the AMS data with the SCADA-HMI system data.

19. Provide Ethernet communications to additional devices, including VFDs, MCCs, PQAs, etc.

20. Integration of Distribution system RTU information into the WFP SCADA-HMI system. The existing Distribution system has approximately 40+ TESCO RTUs with relatively small I/O point counts at each facility. This information can be integrated directly into the existing WFP RSView32 SCADA-HMI system application, further assisting SFID/SDWD with their consolidation efforts.

The estimated cost for these recommendations, including the planning/design effort, is $400,000.

SCADA System Maintenance and Supervision

In theory, SCADA systems and automation are implemented as one of many tools available to operators to facilitate the operation of a plant. However, because of poor planning, implementation and/or maintenance, SCADA systems can require a disproportionate amount of attention, stealing resources from the primary task of treating water.

The improvements to the SCADA system recommended herein, if planned and implemented properly, should reduce the level of supervision and maintenance effort required of staff. As such, it is not anticipated that these improvements would result in an increase in staffing requirements for the Joint Facilities.

However, staff may need to be increased if functionality of the SCADA system is expanded (e.g., implementation of asset management and/or maintenance software) or the responsibilities of the staff are modified to included tasks that have been historically outsourced, such as SCADA and PLC software programming.

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Section 6 HYDROELECTRIC GENERATOR EVALUATION

The hydroelectric facility at the WFP is at or nearing the end of its useful life. Several components are in need of immediate repair or replacement. This section provides an evaluation of the existing hydroelectric facility, identifies potential improvements including a replacement facility, and details associated costs and incentives associated with potential improvements.

DESCRIPTION OF EXISTING FACILITY

The WFP receives water from three sources: CWA Second Aqueduct, Lake Hodges, and SDR. Water from CWA's Second Aqueduct is at a high pressure (originally 180 psi) and must be reduced to approximately 35 psi before it enters the WFP. The WFP hydroelectric facility was constructed in 1985 to produce electricity from the pressure drop and flow associated with the CWA pipeline. Pipelines for source water from Lake Hodges and San Dieguito Reservoir tie into the WFP influent downstream of the hydroelectric facility making CWA the only water source available to generate power.

The facility consists of two Francis hydroelectric turbines, each with a different flow capacity. Table 6.1 presents information about each turbine. Each turbine has a bypass line and bypass valve used to control flow into the WFP when there is not enough volume, the turbine/generator is not available, or in the event of a power outage. This bypass valve is also used during startup and shutdown of the turbines as well as to supply additional flow to the WFP in excess of turbine flow capacity.

The hydroelectric turbines are located in a 27 foot by 55 foot building. There is little space inside the existing building for additional equipment or turbines.

Table 6.1 Characteristics of the Existing Hydroelectric Facility

Design Criterion	Unit	Turbine No. 1	Turbine No. 2
Flow Capacity	cfs	27	40
Rated Net Head	ft	315	315
Turbine Efficiency	%	91.5	91.5
Turbine Output	kW	657	969
Turbine nominal rated speed	rpm	1200	1200
Generator Voltage	kV	4.16	4.16
Generator Power Output	kW	600	885
Generator Apparent Power	kVA	800	1180
Generator Current	Amperes	111	164
Minimum Power Factor	Percent	75	75

EXISTING ELECTRICAL SYSTEM

Interconnection to SDG&E occurs at the 12 kV service switchgear located outside of the hydroelectric generator facility. The service switchgear includes a bi-directional revenue meter, a main circuit breaker, and a transformer to step the 12 kV down to 4.16 kV for the generator switchgear connection. The bi-directional revenue meter measures power and energy used by the WFP or excess power delivered to SDG&E. This equipment appears to be in good condition. There does not appear to be available space for expansion to add circuits.

Protective relaying for the service equipment is located in the control panel line-up inside the hydroelectric building. Protection for the service entrance equipment includes overcurrent protection, differential protection (which encompasses the generator switchgear and generators), and several functions to detect utility power loss or power system faults, including over- and under-voltage and frequency, and ground overvoltage. These relays trip the 12-kV main breaker.

The 5-kV switchgear inside the hydroelectric building has two contactors to connect the generators and two fused switches. One of these switches delivers power to the station power transformer for low-voltage loads in the hydroelectric building, and the other feeds power to the two pad-mounted transformers that power the WFP.

This equipment appears to be 5-kV motor control equipment, and was manufactured by Ideal Electric as part of the generator system. Ideal Electric (now known as Hyundai Ideal Electric) still manufactures generator switchgear, but now uses a different class of circuit breaker switchgear. As such, replacement parts for the existing equipment will be increasingly difficult to obtain.

At least one of the switches in the generator switchgear was reported to be inoperable. While the overcurrent protection is provided by fuses, it is still important to ensure that disconnect switches are safely operable to allow for system maintenance and to quickly respond to and isolate problems. Additionally, replacement parts are difficult to find and replacement of the existing switches with modern technology may not be feasible due to space constraints.

Most protection functions rely on power from a battery system. The battery system is critical to safety and equipment protection.

The generators have brushless exciters, which require minimal maintenance. The neutral connections are grounded through resistors to limit their contribution to fault current and reduce circulating neutral currents.

EXISTING CONTROLS

Protection and control devices for the generators and the service switchgear are located in the generator control panel lineup. Protection is provided by numerous single-function solid-state and electro-mechanical protection relays, which were recently tested and some found to be defective. Control components are generally obsolete.

Flow rate controllers are used to maintain total water delivered through each generator system at the selected rate. When a generator is in service, its associated flow is controlled by adjusting the wicket gates (turbine inlet). Otherwise, the flow controller adjusts the bypass valve to achieve the required flow. These controls use a single-loop controller, which requires an operator to convert the desired flow rate into a percentage for each generator, and enter that value into the controller at the generator control panel. These controls are not integrated into the plant PLC-based control system, and must be adjusted locally in the hydroelectric building. Furthermore, the flow signals needed to run the facility are unreliable and wired in such a way that if power is lost at the hydro facility, the flow signal to the WFP is lost, which creates operational problems with the WFP control algorithms, including chemical flow pacing.

The existing controls do not allow the generators to operate unless they are connected to the SDG&E power source. Thus, the hydroelectric facility in its current state cannot serve as a standby power source in the event of an SDG&E outage.

EXISTING HYDRAULICS

A flow control station constructed and owned by CWA is located upstream of the WFP hydroelectric facility. The flow control station consists of two adjustable sleeve valves. The station was originally constructed to control flow rate while the hydroelectric facility would reduce pressure.

The CWA's Second Aqueduct is made up of multiple pipelines: Pipeline Nos. 3, 4, and 5. Originally, the hydroelectric facility was connected to Pipeline No. 3, which carried raw water. However, after the hydroelectric facility was constructed, CWA began delivering raw water through Pipeline No. 5. This pipeline has a higher pressure, approximately 250 to 290 psi. The existing turbines were not designed to handle this additional pressure. The existing turbines were designed to handle a maximum differential pressure of 145 psi and an influent pressure of 184 psi. Therefore, control of the existing CWA sleeve valves in the flow control station was modified to control pressure instead of flow rate. The flow control station reduces pressure from 250 psi down to 150 psi to allow the turbines to operate at their original rated head.

Operating the sleeve valve installation to reduce pressure leaves the hydroelectric turbine facility vulnerable to pressure surges. This is due to the slow opening and closing times associated with sleeve valves. Therefore, in 2010, two surge relief valves were installed to reduce surge by bypassing flow from the inlet of the turbines to the outlet of the turbines.

SUMMARY OF PREVIOUS REPORTS

Several reports and field investigations have taken place recently on the hydroelectric facility:

- Evaluation of the R. E. Badger Hydro Turbine Facility, MWH, July 2009.
- Badger Water Treatment Plant Hydro Field Service, Soar Technologies, January 2011.
- Maintenance Testing of Protective Relays, Electrical Reliability Services (Emerson Network Power), Inc., June 4, 2011.

Evaluation of the R.E. Badger Hydro Turbine Facility

This report focused on condition of the existing facility, required improvements for performance and safety, and alternatives for the future. The report recommended several improvements categorized as low, medium, and high priority. The report recommends abandoning the hydroelectric facility after 2017 because the estimated paybacks associated with replacement of the turbines and total replacement of the facility exceed the 20-year life of the equipment.

Installation of a surge relief valve was implemented. The other high priority recommendations, replacement of the hydraulic power unit and synchronizer, were addressed. The medium priority improvements (updated controls) and low priority improvements (extensive maintenance of the turbine and generator) have not been implemented.

Badger Water Filtration Plant Hydro Field Service

The field service report recommended upgrading the synchronizers, and installing a PLC and operator interface unit at the powerhouse. The PLC would connect to the existing WFP controls and allow for remote monitoring and control of the hydroelectric facility. This would also allow the flow into the WTP to be changed remotely.

Currently, the hydroelectric facility controls flow into the WFP. However, during a power outage, the turbines shut down and raw water is forced around the turbines through bypass valves and piping. The bypass valves are controlled by the hydraulic power unit (HPU). Once hydraulic pressure is used up in this HPU during a power outage, the bypass valves would not be able to control flow. Therefore, Soar recommends adding an accumulator to store hydraulic pressure power or to provide an additional power feed for the HPU to supply standby power.

Other recommendations included servicing the hydroelectric turbine including all related equipment, switches, and alarms, and testing the surge relief valves during a power failure as outlined in the MWH report.

Maintenance Testing of Protective Relays

This field service report outlines results of recent protective relay tests and recommendations for further repairs and enhancements. Signs of aging were noted for most relays, and several were found to be defective. One differential relay (on B phase) was found to be out of tolerance. Components that are not functioning properly and should be replaced include one differential relay (C phase), the negative sequence relay, both generator reverse power relays, and loss of field relays. The reactive power meter for generator 2 was found to be inaccurate.

EXISTING SDG&E GENERATION INTERCONNECTION AGREEMENT

SFID's generation interconnection agreement went into effect in 1985 and extends to 2017. It stipulates SDG&E will purchase all power generated by the hydroelectric facility at a standard rate. According to Chris Brown (SDG&E), SFID's account representative for the WFP SDG&E account, the current interconnection agreement cannot be extended past its original expiration date of June 30, 2017. At that point, SFID can either choose to cease operation of the hydroelectric facility, or enter into a new interconnection agreement with SDG&E. Chris

Brown also indicated that it may be possible to terminate the current interconnection agreement before the expiration date, and enter into a new interconnection agreement.

If SFID chooses to terminate the current interconnection agreement and enter into a new agreement with SDG&E based on the operation of the existing hydroelectric facility or the operation of a new hydroelectric facility, there are many different rate structures and tariffs available. Furthermore, SDG&E offers agreements with durations of 10, 15, and 20 years. Some examples of the SDG&E tariffs that are currently available are:

- Schedule S: Standby Service. This is very similar to SFID's current agreement, in which SDG&E purchases excess energy produced by the hydroelectric facility at a standard SDG&E rate, which varies with market conditions.
- Schedule WATER: Water Agency Tariff for Eligible Renewables. This is purchase contract exclusive to water and wastewater utilities that is based on a fixed purchase price for 10, 15, or 20 years.
- Schedule RES-BCT: Local Government Renewable Energy Self-Generation Bill Credit Transfers. This tariff allows an SDG&E customer to use renewable energy generated at one site to offset energy consumed at other sites having different SDG&E accounts.

Assembly Bill 32 Climate Change Scoping Plan

In 2008, the California Air Resources Board (CARB) began the implementation of the Assembly Bill (AB) 32 Climate Change Scoping Plan, which defines the strategy and comprehensive actions required to achieve the statewide greenhouse gas emission reductions specified by AB 32 (2006). Among the many actions stipulated by the AB 32 Climate Change Scoping Plan is achieving a goal of having at least 33 percent of California's energy produced by renewable energy sources, such as hydroelectric facilities, by the year 2020. To meet this ambitious goal of 33 percent renewable energy, CARB is seeking to implement a cap-and-trade program that will in simple terms force polluters to pay for their emissions, which in turn creates a strong incentive to reduce emissions. Large-scale polluters, such as electric utilities including SDG&E, are among the entities that will be most affected by AB 32.

The greenhouse gas emission reductions and renewable energy targets established by AB 32 ensure that SDG&E will continue to support renewable energy programs into the foreseeable future. Consequently, it is very likely that SFID can continue the practice of operating a hydroelectric facility and exporting energy to the SDG&E grid well into the future.

ELECTRICAL SYSTEM IMPROVEMENTS

The existing generator switchgear is capable of handling existing plant loads and generator production. It is expected that larger generators would not exceed the switchgear ratings. There are no provisions to extend the equipment so connecting new feeder circuits, such as the SDPS, would require replacement of the switchgear. Replacement of the switchgear would allow for expansion of the power system, improved protection, and greater system reliability. New switchgear could be integrated with the service equipment, which would provide more space inside the hydroelectric building for other improvements. If the existing switchgear is not replaced, it should be inspected and serviced on a regular basis to ensure all components are safe and fully functional.

The service equipment is suitable for existing plant loads and generator capability, but is not expandable to add circuits at 12 kV or 4160-volts. The transformer is suitable for existing generator capabilities, but could be marginally suitable or undersized if larger hydroelectric generators are installed.

New service equipment can be designed to allow the SDPS to be powered from the WFP service, which would allow power generated by the hydroelectric generators to directly offset power used by the pump station. Standby power generation to back up both facilities can also be incorporated into new equipment utilizing the hydroelectric turbines or separate standby engine generator sets. This is discussed in more detail in Section 5.

The battery system was recently tested and found to be functioning properly. Due to the importance of the batteries in system protection and safety, a routine testing and maintenance program should be implemented.

CONTROL SYSTEM IMPROVEMENTS

Defective protective relays should be repaired or replaced. If new switchgear or controls are installed, new multi-function relays should be incorporated into the new equipment, and temporary repair or replacement of defective relays should be performed to ensure proper system protection until new equipment is placed in service. The ideal location for the protective relays is in new switchgear. If the switchgear and controls are to be retained, or replacement is not expected for several years, replacement of the entire protective relay system with modern multi-function relays should be considered. All of the existing relays can be replaced with a few select multi-function relays. One generator protection relay would be needed for each generator, a transformer protection relay will be required for the 12 kV main breaker (and possibly an additional relay to meet SDG&E interconnection requirements), and a bus differential relay can be included or the differential protection functions can be incorporated into the other relays to allow failures to be isolated with less impact on other systems. The inaccurate VAR meter can be replaced if desired, or more sophisticated electronic metering can be installed.

Replacing the generator control system should be included if new generators are installed. Even with the existing generators, a new control system can offer operational benefits. A PLC-based system will be able to integrate generator system operation with the plant control system so that generators can be automatically started when needed, and flow control set points can be entered from SCADA. Digital governors can be included to allow more effective synchronizing, and to allow the turbine generators to operate as a standby power source for the WFP in the event of an SDG&E power outage.

Use of hydroelectric generators as a standby power source can be integrated into a new control system. This system would configure the governor and voltage regulator to maintain proper system frequency and voltage when the hydroelectric generators are not connected to SDG&E. This is only feasible when total flow from CWA is sufficient to generate power for all operating plant loads with a sufficient reserve to allow stable control. Load control logic can be incorporated to limit plant power loads (including pumping at the SDPS) to ensure that the standby power system is stable. The turbines would use flow required to provide the power demand, and flow through the bypass valves would be controlled to obtain the required total plant influent flow. This system may not be feasible if the CWA flow control station is used to maintain a fixed flow rate.

Some previous reports recommended replacement of the automatic synchronizer. If the existing controls are retained, the governors can be replaced to improve synchronizing capability. Synchronizer replacement requires evaluation of the existing turbine controls, and will require additional work to ensure that the new synchronizer works effectively. Reasons for a new synchronizer seem to be based on problems synchronizing generator no. 1, which were determined to have been a result of damage to that unit after a pressure surge, which have since been repaired. If the control system is replaced, a new synchronizer should be included. Otherwise, synchronizer replacement should only be considered if problems synchronizing the generators persist.

ALTERNATIVES FOR THE HYDROELECTRIC FACILITY

Five alternatives were identified for either rehabilitating the existing hydroelectric turbines or replacing the entire hydroelectric facility. A discussion of each alternative follows.

Base Condition

The base condition is defined as the current state of the hydroelectric facility and the following assumptions have been made:

1. No major equipment upgrades or replacements will be implemented.
2. The existing facility is capable of operating for five more years.
3. Operation and maintenance costs associated with the base condition will be significantly higher than the other alternatives.
4. The reliability (i.e., availability) of the facility will be significantly less than the other alternatives.

Alternative 1 - Upgrade Existing Turbines to Operate at Higher Pressure

The original manufacturer of the turbines, RainPower (formerly known as Sørumsand Verksted A/S) was contacted about the potential of modifying the existing turbines to allow them to operate at higher pressure. According to the manufacturer, this alternative is not recommended for the following reasons:

1. Safety concerns with the turbine casing and related piping because this was originally designed for a lower pressure.
2. The turbine will likely have a lower efficiency when operated at elevated pressures. This lower efficiency will yield only marginal increases in power production and will have detrimental effects on system wear and associated maintenance.
3. Operating at a higher pressure will accelerate system wear and likely shorten lifespan.
4. Design pressure of the piping system and thrust restraint systems are unknown.

Consequently, this alternative was eliminated from further consideration.

Alternative 2 - Upgrade Existing Turbines to Improve Safety and Reliability

There are several upgrades that would improve safety and reliability of the existing turbines. Upgrading the existing turbines to improve safety and reliability will extend the life of the facility 10-years.

- Replace the HPU for both turbines
- Maintenance of the turbines and generators, including:
  - Check spiral casing for cracks
  - Check main shutoff valve tightness
  - Check for cavitation on wicket gates and draft tube
  - Measure clearances between runner and wear rings
  - Measure clearance between runner and head cover wearing ring
  - Check for cavitation on runner
  - Check guide vanes for damage
  - Check clearance between wicket gates
  - Check clearance between wicket gates and covers
  - Inspect wicket gate bearings
  - Inspect o-ring sealing
  - Check leakage of wicket gates
  - Inspect leakage along the shaft (under a range of loads)
  - Check dismantling joint for leakage
  - Test generator windings

Alternative 3 - Replace Existing Turbines

With this alternative, the existing turbines would be replaced in kind with new turbines that would operate within the same head and flow conditions. Because head and flow conditions would not change, the maximum energy production capability of the facility would not increase. However, it is anticipated that the actual energy production would increase because new turbines would be more efficient and reliable than the existing turbines. Furthermore, replacing the turbines would extend the life of the facility 15-years.

If SFID elects to proceed with this alternative, coordination with SDG&E will be needed. The hydroelectric facility may be out of service for a period longer than allowed in the existing generation interconnection agreement.

Alternative 4 – Replace the Entire Hydroelectric Facility

This alternative entails the complete replacement of the hydroelectric facility with a new facility. The new facility would be located in a new building that could be constructed adjacent to the existing hydroelectric building. This would allow the existing facility to maintain operation during construction of the new facility, which would be financially advantageous because it would allow SFID to remain in compliance with the existing SDG&E generation interconnection application as it relates to shut down duration.

Assuming that the existing CWA pipeline is suitably rated, the new hydroelectric facility could be designed to operate at inlet and differential pressures of 250 psi and 215 psi, respectively, which would result in a substantial increase in the system's energy production capability and help offset the project cost of the new facility. The lifespan of this alternative is 25-years.

ECONOMIC FEASIBILITY ANALYSIS

To evaluate and compare economic feasibility of the five alternatives described above, a Net Present Value (NPV) analysis was performed. For the purpose of the NPV analysis, the base condition was defined to quantify economic feasibility of "doing nothing" and continuing operation of the hydroelectric facility in its current state. Project costs for each of the alternatives shown in Table 6.2 are representative of all recommendations made above.

NPV Analysis

Results of the NPV Analysis are presented in Table 6.2.

Table 6.2 Results of the Net Present Value Analysis of Five Alternatives to Upgrade or Replace the Hydroelectric Facility

Alternative No.	Lifespan	Project Cost	Year 1 O&M Cost	System Availability	Estimated Annual Energy Production (kWh)	Net Present Value(1)	Payback(1) (Years)
Base	5	$ -	$ 70,628	75%	2,354,282	$ 571,428	0
1	*This alternative not included in NPV analysis because it is not mechanically viable.*						
2	10	$ 1,600,000	$ 56,503	90%	2,825,138	$ 45,711	9.7
3	15	$ 5,000,000	$ 59,642	95%	2,982,090	$ (2,394,290)	>15
4	25	$ 7,600,000	$ 57,513	98%	5,751,271	$ 2,171,576	19.5

Note
1. Refer to Appendix F for NPV and Payback calculations.

Based on the NPV results presented in Table 6.2, all alternatives with the exception of Alternative No. 4 were eliminated from consideration for the following reasons:

1. Although the base alternative appears to have an immediate payback, because of the age, physical condition, and associated safety concerns, continuing operation of the facility without significant upgrades cannot be considered to be a reliable source of revenue.

2. Alternative No. 1 was eliminated from consideration because it is not mechanically viable.

3. Alternative No. 2 was eliminated from consideration because the payback period is essentially equal to the estimated remaining life of the facility after improvements are made. This implies that the investment in improvements is not likely to be recovered over the remaining life of the facility. This risk is compounded by the fact that economic performance of the facility is largely dependent on equipment and structures that are nearly 30 years old.

4. Alternative No. 3 was eliminated from consideration because the payback period exceeds the estimated remaining life of the facility after the improvements are made.

Sensitivity Analysis for Alternative No. 4

To further refine the NPV and payback calculations for Alternative No. 4, a sensitivity analysis was conducted. The sensitivity analysis consisted of five different scenarios in which the average SDG&E export rate was varied from $.07 per kWh to $0.11 per kWh, and the average annual SDG&E energy rate escalation was varied from 2.5 percent to 5.0 percent. For each of the five scenarios, the NPV and payback were calculated and a probability of occurrence was assigned. Expected NPV and payback values for Alternative 4 were calculated by applying the probability of occurrence values to the respective NPV and payback values for each scenario. Results of this analysis are presented below in Table 6.3 (see page 6-12).

As shown in Table 6.3, based on the sensitivity analysis Alternative No. 4 has an expected payback period of 18.4 years, and an expected net present value of $3.53M. In simple terms, if this alternative is implemented, SFID can expect to recover the capital expenditure of the project in addition to O&M costs 18.4 years after the facility is commissioned, which is more than six years before the anticipated end of useful life. Furthermore, in the 25-year lifespan of the facility, it is expected to create $3.53M (2012 dollars) in value for SFID. Generally, accepted economic theory stipulates that any project having a net present value greater than zero should be implemented because it creates value for the owner/investor. Projects having greater net present values are obviously more lucrative.

RECOMMENDATIONS

1. Based on the expected NPV and payback calculations summarized in Table 6.3, it is recommended that SFID proceed with complete replacement of the existing hydroelectric facility with a new facility designed to operate at inlet and differential pressures of 250 psi and 215 psi, respectively. Prior to starting final design of the new hydroelectric facility, it is recommended that SFID work with SDG&E to identify the most advantageous interconnection and power purchase terms. After these terms are identified, the NPV and payback calculations should be refined to confirm that replacement of the hydroelectric facility is economically viable based on the actual interconnection agreement terms that will be in place when the facility is commissioned.

2. In the interim, while the new hydroelectric facility is being designed and constructed, the following measures are recommended to enhance the safety and convenience associated with operating the existing hydroelectric facility:

   a. Integrate the existing flow controls into the WFP SCADA/Control system. This may require replacement of the existing flow controllers. In addition to improving flow control, this measure would also provide WFP staff with the ability to adjust flow setpoints remotely, as opposed to the current configuration which requires an operator to make setpoint changes manually at the flow controller in the hydroelectric building.

   b. Replace the existing 4.16 kV switchgear to which the hydroelectric generators are connected. Although this switchgear is not technically dedicated to the hydroelectric facility because it also distributes power to the remainder of the WFP power system, replacement is recommended because of its age, physical condition, and associated safety concerns. Refer to Section 5 for additional information on the replacement of the existing 4.16 kV switchgear.

Table 6.3 Hydroelectric Facility Alternative No. 4 Net Present Value Sensitivity Analysis

	Scenario 1 (Worst Case)	Scenario 2	Scenario 3	Scenario 4	Scenario 5 (Best Case)
Year 1 Average SDG&E Export Rate ($/kWh)	$ 0.0700	$0.0800	$0.0900	$0.1000	$0.1100
Average Annual SDG&E Energy Rate Escalation	2.50%	3.00%	3.50%	4.00%	5.00%
Payback (Years)	24.3	19.5	16.4	14.1	12.1
Net Present Value at Year 25	$227,049	$2,171,576	$4,327,347	$6,717,583	$10,531,815
Probability of Occurrence	20%	30%	30%	15%	5%
Expected Payback (Years)					18.4
Expected Net Present Value at Year 25					$3,529,315

Analysis Assumptions (fixed for all scenarios):

Maximum Annual Energy Production (kWh)	5,868,643
System Availability	98%
Actual Annual Energy Production (kWh)	5,751,271
Annual R.E. Badger WFP Energy Consumption (kWh)	2,190,000
Annual Energy Export to SDG&E (kWh)	3,561,271
System Capital Cost (2012 Dollars)	$7,600,000
Equipment Lifespan (Years)	25
Year 1 Operation & Maintenance Cost ($/kWh)	$0.01
Year 1 O&M Cost (2012 Dollars)	$57,513
25 Year O&M Expenditures (2012 Dollars)	$2,096,871
Average SDG&E Energy Import Rate ($/kWh)	Equal to Average SDG&E Energy Export Rate
Average Annual Inflation Rate	3.00%
Project Discount Rate	3.00%

INTRODUCTION

The WFP has been in operation for over 40 years. Most of the structural components of the plant (buildings, flocculation/sedimentation basins, filters, clearwell, and washwater tank) are part of the original plant. Some of the mechanical components (sludge collection equipment, washwater pumps, chlorination system, and emergency generator) are also part of the original plant. Because of the age of some of the plant components and equipment, this mechanical and seismic evaluation was completed.

This section provides the findings from our mechanical and seismic vulnerability evaluations of the WFP. The mechanical reliability evaluation is an update to the 2003 Badger Water Filtration Master Plan and includes items that should be addressed to improve safety, reliability, and operability. The seismic evaluation was performed to identify those structures and structural elements at the plant that are most susceptible to earthquake-related damage and to provide recommendations for appropriate mitigation.

MECHANICAL RELIABILITY EVALUATION

Our mechanical evaluation involves a survey of plant mechanical equipment to determine the following:

1. Identify equipment in need of repair/replacement that will improve safety, reliability, and/or operability of the plant.
2. Identify equipment for which availability of spare parts and serviceability may be difficult.
3. Identify urgency for repair/replacement.

Site Review

Carollo staff met with members of the plant operations staff on June 9, 2011 to visually inspect equipment conditions. Observation was limited to equipment that was readily visible and currently in service.

Facilities and Equipment Not Covered in this Memorandum

Portions of the plant, such as the CPS and SDPS as well as the hydroelectric facility, are being covered in Section Nos. 4 and 6, respectively. The Actiflo® System, solids contact clarifier, and centrifuge were not evaluated because the equipment is not currently operational. With the exception of the sludge removal equipment in the sedimentation basins, mechanical issues with unit process equipment (i.e., flash mix, flocculation, filtration, lagoons, etc.) are discussed in Section 3.

Review of Reports

The following reports reviewed as part of this analysis are:

- 2003 R. E. Badger Water Filtration Plant Master Plan by McGuire Environmental Consultants, Inc.
- 2009 Asset Management Master Plan by Dexter Wilson Engineers, Inc.

Observations

The 2003 R.E. Badger Water Filtration Plant Master Plan identified mechanical equipment deficiencies that needed to be addressed. Most of the recommended improvements have already been addressed. Others, such as the replacement of the finished water reservoir drain valves, will be completed within the next year. Two items that have not been addressed are:

1. Improvements to the Chlorine Storage Room to provide proper sealing of room during a chlorine leak.
2. Replacement of sedimentation basin sludge collection system.

The chlorine dioxide storage and feed system has operated as a pilot system since its introduction at the plant. Consideration should be given to making it more permanent and operator friendly.

Our mechanical analysis revealed that most of the plant mechanical equipment is in good operating condition. For instance, plant staff has done a great job of maintaining and upgrading the chemical storage and feed systems. Figure 7.1 illustrates an impressive chemical dosing panel design and manufactured by plant staff.

Figure 7.1 Ammonia Chemical Dosing Panel Designed and Manufactured by WFP Staff

Conclusions and Recommendations - Mechanical Reliability

Most of the p lant's mechanical equipment is in good operating condition. Our conclusions and recommendations resulting from our mechanical assessment are presented in Table 7.1. Many of these deficiencies are small and can be taken care of by plant staff. Item Nos. 2, 3, 4, 5, and 6 have been accounted for in the CIP.

Table 7.1 Deficiencies Noted During the Mechanical Assessment

Item	Item	Description	Estimated Project Cost ($)
1	Chlorine Storage Room	The scrubber system must maintain the storage room at a slightly negative pressure to ensure complete capture of chlorine gases. Several inlet louvers need actuators and all pipe penetrations through the wall need to be sealed to ensure safety. New Air Monitoring equipment is needed.	$35,000
2	Utility water feed to the chlorinators	Large demands in the utility water system impact utility water flow and pressure to the chlorinators. A dedicated utility water line to the chlorinators is recommended.	$70,000
3	Individual flow meters for each chlorinator	Plant staff can automatically feed chlorine to only one feed point. It is recommended that individual flow meters be installed on each chlorinator to facilitate the automatic feed of chlorine to multiple points in the plant.	$40,000
4	Backwash water refill pumps	The plant is still operating with the original backwash water refill pumps. These pumps are nearing the end of their useful life and should be replaced.	$100,000
5	Sedimentation Basin Sludge Removal System	The sludge removal equipment is original to the plant. This equipment still operates well, but is approaching the end of its useful life. The equipment should be replaced in the near future.	$1,500,000
6	Utility Water Yard Piping	Condition of the piping is unknown, plant staff reports some of it is old AC pipe and needs to be replaced. Some of the valves need to be replaced.	$100,000
7	Propane Lines	Plant staff has indicated the buried propane line is corroding and needs to be replaced.	$5,000
8	Secondary Containment for Chemical Lines	The chlorine and chlorine dioxide lines to the hydroelectric facility and the caustic and ammonia lines to the filter control weir all need secondary containment.	$40,000

SEISMIC EVALUATION

Our seismic evaluation involves the general assessment of existing structures and major equipment supports to help determine whether these facilities have sufficient capacity to resist seismic demand requirements set forth in current building codes and design standards. Our approach includes the following steps:

1. Site review of the structures and major equipment supports.
2. A review of original design drawings.
3. Perform calculations for select structures and structural elements.

Site Review

Carollo staff met with members of the plant operations staff on June 9, 2011 to visually review structures and conditions. Visual observation of all structural elements was limited to those structures located above grade and to those portions of tanks that were not full of water. Photographs were taken of potential deficiencies and a select number of photographs depicting relevant issues discussed in this report are presented in Appendix H.

Review of Design Drawings and Reports

As-built structural drawings for a majority of the structures at the site were reviewed and are listed below.

- 1967 Joint Reservoir and Transmission Main Drawings, by James M. Montgomery, Consulting Engineers, Inc.
- 1968 Joint Filtration Plant Drawings, by James M. Montgomery, Consulting Engineers, Inc.
- 1984 R.E. Badger Filtration Plant Hydroelectric Project, by International Engineering Company, Inc.
- 1993 R.E. Badger Filtration Plant Modification and Rehabilitation Drawings, by Montgomery Watson, Consulting Engineers, Inc.
- 1993 Geotechnical Report, by Woodward-Clyde Consultants.
- 2002 R.E. Badger Filtration Plant Solids Handling and Backwash Recovery Project, by CDM.
- 2010 R.E. Badger Filtration Plant Utilities Upgrade and Disinfection Project J-401 and J-402, by Malcolm Pirnie.

Calculations

Potential deficiencies identified in the site-walk and drawing review were checked by performing structural calculations as needed. A full structural analysis of each structure was not performed and our evaluation did not include analyses of smaller non-structural systems, such as piping, HVAC, fire sprinklers, and other similar mechanical systems. Potential deficiencies for these systems observed during the site walk have been noted and presented herein.

Seismic Evaluation Criteria

The current building code and design standards relevant to particular structure types were used as a basis for checking selected structures and conditions. Table 7.2 provides a summary of the standards used in this seismic evaluation.

Table 7.2 Standards Referenced for Seismic Evaluation

Structure Type	Relevant Standard
Concrete tanks, filters, and reservoir	ACI 350-06, *Code Requirements for Environmental Concrete Structures*
Masonry buildings	2010 California Building Code
Washwater Tank	AWWA D100-05, *Welded Carbon Steel Tanks for Water Storage*

Table 7.3 contains seismic evaluation parameters used in the seismic evaluation of structures and components. The WFP is comprised of numerous structures that have different functions. However, the purpose of the plant is to provide potable water to the public. Therefore, a number of structures are critical to this process and are considered indispensible. These structures are classified as having an "Occupancy Category" IV in accordance with the 2010 California Building Code. The occupancy category is used to establish an importance factor for a structure. Nearly all structures evaluated fall into this occupancy category and necessitate an importance factor of 1.5. The importance factor is a multiplier that increases seismic design forces required for design or evaluation. Building codes and standards are established to help protect life safety. Meeting minimum load requirements for these codes and standards does not ensure that a structure will remain operational or undamaged. Application of an importance factor in design helps attain a better performance level for code prescribed seismic forces. Therefore, the same standard is considered appropriate for this seismic evaluation. Throughout this evaluation, where stresses are noted as possibly exceeding allowable levels by more than 50 percent, this level of overstress suggests significant damage.

Table 7.3 Seismic Evaluation Parameters

Parameter	Value
Site Soil Class	D
Latitude Coordinate for Site	33º 3' 7''
Longitude Coordinate for Site	-117º 10' 24''
Mapped Short-Period Spectral Response Acceleration, S_s	1.06g[(1)]
Mapped Long Period Spectral Response Acceleration, S_1	0.39g[(1)]
Short-Period Site Coefficient, F_a	1.08
Long-Period Site Coefficient, F_v	1.62
Design Short-Period Spectral Response Acceleration, S_{DS}	0.76g[(1)]
Design Long-Period Spectral Response Acceleration, S_{D1}	0.42g[(1)]
Occupancy Category	IV
Seismic Use Group (AWWA D100-05)	III
Importance Factor, I	1.50

Note
1. g = vertical acceleration due to gravity at the Earth's surface

Washwater Tank

The Washwater Tank is a circular welded steel tank that is located at the northeast side of the plant. The tank has a capacity of 1.0 million gallons and is regularly filled to that capacity to provide water for backwashing the filters. The tank was constructed in 1968 and is one of the original structures at the plant. The tank has a diameter of 46 feet and a height of approximately 82.5 feet. The perimeter shell is constructed with 8-foot tall radial steel plate sections that are butt-spliced together both vertically and horizontally. Access to the top is provided by a steel staircase that spirals around the circumference of the tank. The tank is mechanically anchored to a concrete ringwall footing with 2- inch diameter galvanized steel anchor bolts spaced at approximately 32 inches on center. An anchor seat, fabricated with 1/2-inch and 3/4-inch steel plate, is welded to the side of the tank shell wall at the base. The concrete ringwall has a stem wall height of 2 feet and a base spread that is 16 inches thick by 4.83 feet wide. See Appendix I, Figures I.1 and I.2, for an elevation of tank and a detail of the ring wall footing and anchor, respectively.

Grade around the tank is relatively flat and paved with asphalt. A concrete ringwall footing is located directly below the shell of the tank circumference. The bottom shell of the tank is founded on 2 inches of asphaltic concrete and compacted backfill. The roof of the structure is framed with steel and does not have any interior support columns.

The 1968 Joint Filtration Plant drawings detail the appurtenances and foundation of the tank, but do not specify any material type or sizes of the tank components. It appears that the tank was a deferred submittal item that is likely detailed on a shop drawing, and was not available for review. Therefore, material of the members and the thickness of the roof, bottom, and shell are not known. For purposes of this seismic evaluation, a number of assumptions regarding material properties and original design parameters were made due to lack of information in the drawings. These assumptions are outlined in Table 7.4. The drawings do specify that the tank be designed in accordance with AWWA D100, which is and was the standard for design of welded steel tanks for water storage.

Table 7.4 Assumed Material Property Values for the Washwater Tank

Property	Value[1]
Material Class	Type 1
Steel Shell Yield Strength, F_y	30,000 psi
Steel Anchor Bolt Yield Strength, F_{yb}	36,000 psi
Joint Efficiency	85%
Concrete Footing Compressive Strength, f'_c	4,000 psi
Density of Water	62.4 pcf
Density of Steel	490 pcf

Note
1. psi= pounds per square inch
pcf = pounds per cubic foot

The tank was viewed from the bottom exterior during the site review. Access to the top is restricted and labeled as confined space. The exterior coating appears to be in good condition with no apparent signs of corrosion or other deterioration. The anchor bolts all appeared to be in good condition with no signs of corrosion.

According to staff, the tank operates at between 62 and 78.5 feet above the base of the tank. The tank has a 16-inch diameter steel overflow pipe that is set at 1.0 foot above the operating height and extends down the exterior of the tank, supported by steel brackets. The tank has a common inlet/outlet pipe that penetrates the side of the tank about 9 inches above the bottom shell. The tank is constructed with a knuckle at the roof to wall connection that has a radius of 2.5 feet and provides a freeboard of approximately 3.5 feet above the specified operation level at the inside perimeter of the tank.

Findings

Calculations for the tank were performed in accordance with equations and requirements for seismic design of welded steel tanks set forth in AWWA D100-05. This is the industry standard for design and evaluation of welded steel tanks used for water storage. For the concrete elements of the foundation, capacities were estimated using ACI 350-06. This is the relevant code for the design and evaluation of environmental concrete structures. Calculations for the following aspects of the tank were conducted to determine what, if any, deficiencies exist:

- Shell hoop tension over the height of the tank.
- Shell compressive stress at the bottom course.
- Maximum soil bearing load with seismic overturning.
- Stability of the tank against overturning.
- Maximum anchor bolt load in tension and shear.

Shell Hoop Tension

The welded steel tank perimeter shell confines the liquid load, developing circumferential tension in the steel shell. This is known as hoop tension. While the hoop tension demand increases with depth of water, reaching a maximum at the base of the tank, the actual stress is a function of the thickness of the shell. The design drawings did not specify this information and it appears that the welded steel tank was a deferred submittal item, having been designed during construction of the WFP. Given this limitation, stresses in the shell can only be evaluated in a general way. Shell thickness can be verified by non-destructive means using an ultrasonic testing device and/or locating original erection drawings. It is likely that shell thickness varies over the height, with the thickest course at the bottom and stepping to thinner sections in the panels above. Based on calculated demands with seismic loads, shell thickness at the base should be at least 3/4-inches thick plus any corrosion allowance to avoid excessive tensile stress. A graph of hoop tensile stress is provided in Figure 7.2. It shows a plot of the minimum required shell course thickness against the height of the tank.

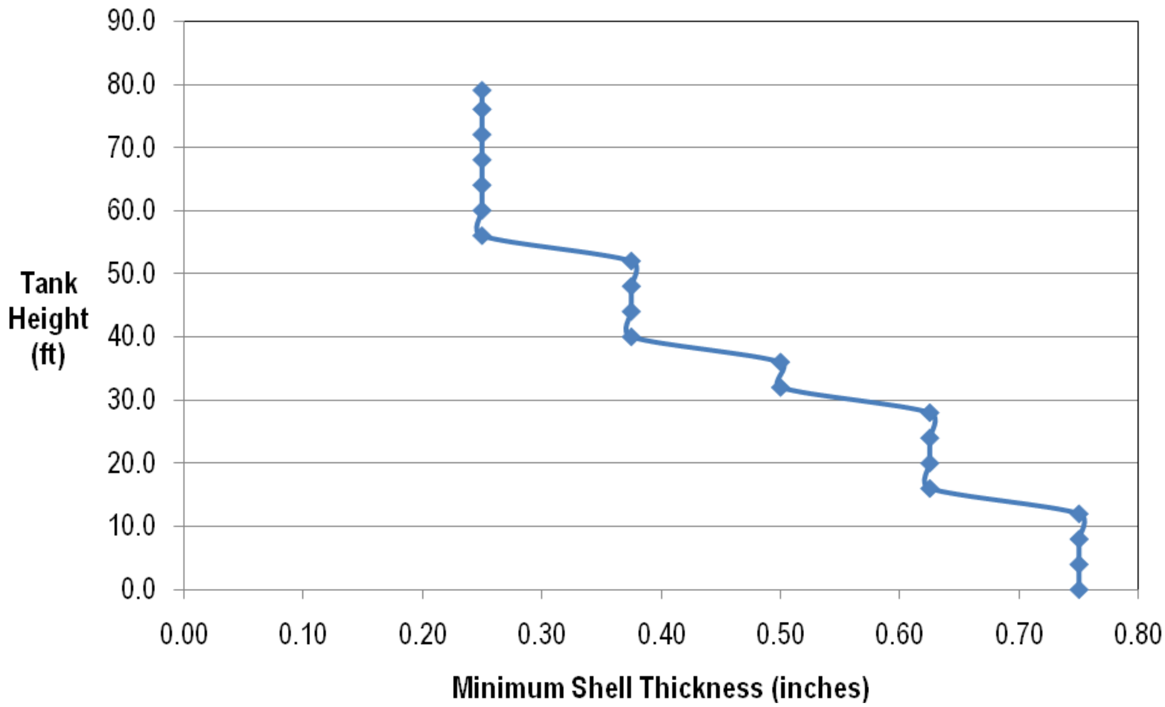

Figure 7.2 Minimum Required Tank Shell Thickness as a Function of Tank Height

Shell Compression

In addition to gravity loads acting on the shell of a tank at its base during an earthquake, the shell will be subjected to additional compression caused by seismic overturning forces. Once again, because the shell thicknesses were not available for this evaluation, the minimum thickness required to meet the allowable stress limit for buckling was determined. The shell thickness at the base should be at least 5/8-inch thick plus any corrosion allowance to avoid excessive buckling stress. Evaluation of the shell compression assumes that the tank does not have stability problems with the foundation, which can greatly increase compressive load demands to the tank shell.

Soil Bearing

The ringwall footing is a shallow foundation system that is located below the shell of the tank. During an earthquake, seismic forces will apply an overturning moment on the tank as a whole. Given the height of the tank and the high operating water level, the overturning moment is relatively large and is estimated to be in excess of 70,000,000 ft-lb. The primary reactions and forces that counterbalance overturning effects are soil bearing on the leading edge of the footing and the weight of the tank and a portion of its contents on the opposite side or trailing side. Assuming that no net uplift occurs, the estimated maximum soil-bearing load on the footing exceeds 12,000 pounds per square foot (psf). The allowable soil bearing noted in the 1993 Geotechnical Report prepared for the 1993 expansion indicates an allowable soil bearing pressure that varies from 2,700 psf to 13,300 psf, depending on the soil conditions below the footing. The noted allowable pressures are typically associated with structural backfill and bedrock, respectively. Upon review of the 1968 drawings, it appears that the soils near the tank were cut down. This may imply that the tank is founded on hard native soils and possibly bedrock. The 1993 geotechnical investigation did not drill any soil borings in the vicinity of the tank that can be used to confirm the underlying soil type. It is recommended that the geotechnical report prepared for the original construction be reviewed, if it is available, to confirm soil conditions at the tank. Once again, this evaluation assumes that the tank does not have stability problems at the foundation, which can significantly increase the bearing load to the soil.

Tank Stability

As noted previously, seismic overturning forces will act on the tank. To prevent collapse or otherwise catastrophic failure, the tank will need to have sufficient counterbalancing forces, which are typically comprised of the weight of the tank and a limited portion of the water load over the outermost edge of the tank. Unfortunately, the inherent flexibility and lack of strength of the bottom shell does not allow most of the water weight to be mobilized for resisting overturning effects. Refer to Figure 7.3 for a simple free-body diagram of the forces and reactions involved. When the overturning moment at the base of the tank cannot be sufficiently counterbalanced by the weight of the tank and a portion of its contents along with soil bearing on the leading edge of the footing, the tank is considered to be unstable. For this evaluation, it was determined that the tank has an insufficient counterbalance weight, which will significantly increase the estimated soil bearing load on the leading edge and possibly lead to collapse of the tank that may occur in the form of shell and base buckling. Estimated demand and available counterbalancing weights are summarized in Table 7.5.

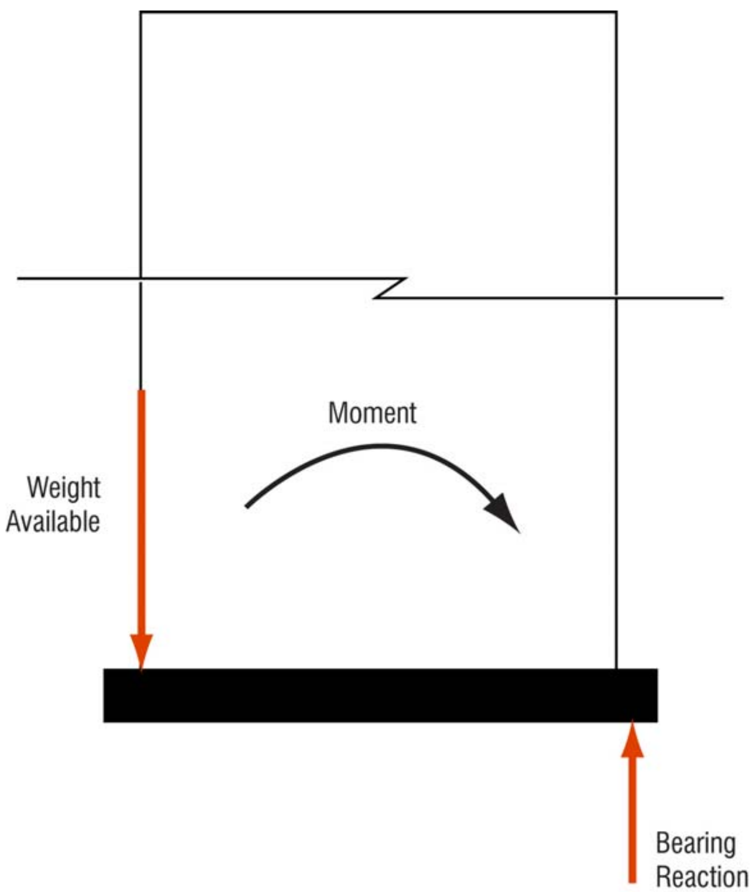

Figure 7.3 Free-Body Diagram of the Overturning Moment and Resisting Forces Caused By Seismic Loading on the Tank

The overturning condition summarized in Table 7.5 is the worst-case or maximum effect that occurs. In three dimensions, the overturning force on the tank shell will dissipate to zero going around the shell. Design practice does not recommend exceeding stability at any point along the footing. A preliminary-type finite element analysis on the ringwall footing was performed to take into account force distributions in three dimensions. Results suggest the net uplift is large enough to indicate that the tank foundation is unstable.

Table 7.5 Estimated Demand and Available Counter Balancing Weights for Tank Stability Analysis

Description	Value(1)
Weight of Tank Shell	1,600 plf
Weight of Tank Roof	150 plf
Weight of Footing	1,400 plf
Weight of Water Above Footing	11,300 plf
Weight of Backfill Above Footing	500 plf
Total Available Counter Weight	14,950 plf
Overturning Uplift Force	42,000 plf
Ratio of Uplift to Counter Weight	2.8

Note
1. plf= pounds per lineal foot of footing

Anchor Bolts

The anchor bolts are estimated to have a maximum load demand of nearly 120,000 pounds under seismic loading due to overturning of the tank. The anchor bolts are 2-inch diameter and are embedded into the ringwall footing to within 4 inches of the subgrade. The end of each anchor bolt is provided with an end bearing plate that is 1-inch thick and 8 inches square. Assuming the steel used for the anchor bolts is ASTM A36 steel with a yield strength of 36,000 psi, capacity of the bolt in tension is approximately 68,000 pounds. Therefore, the bolt was found to have an excessive load demand that is about 80 percent higher than the allowable capacity. Furthermore, ability of the concrete footing to withstand pullout forces is limited to approximately 60,000 pounds as determined in accordance with Appendix D of ACI 350-06. The lack of anchor capacity is significant and can lead to tank failure. Based on the aspect ratio of the tank and the seismic load demands, AWWA D100-05 requires that the tank be mechanically anchored.

Proposed Concepts to Address Potential Stability Concerns

While the tank shell stresses could not be conclusively evaluated due to lack of information, it is clear that the tank has significant stability concerns related to anchorage of the tank and ability of the tank to remain stable during a large earthquake. To address these deficiencies, five potential mitigation concepts are examined.

- Concept 1: Installation of a new underpinned footing with additional tank anchors and soil/rock anchors drilled down into existing bedrock. This retrofit will need to be applied around the entire perimeter of the tank and would require removal of the tank from service. To attempt to install rock anchors and underpinned footings below the existing foundation is not advisable. Installation of new anchors will likely require access to the existing footing because of the size of the loads involved. Means for providing a temporary backwash water supply will need to be secured. Such temporary service may not be available or practical and may rule-out the feasibility of this alternative.

- Concept 2: Replace the existing tank foundation by constructing a new properly designed foundation complete with piles and or soil/rock anchors as required. If the existing tank is found to have materials that can meet anticipated seismic load demands with due consideration for corrosion, the existing welded steel tank could be dismantled and re-built on top of a new foundation. Again, this alternative will require provision of a temporary backwash service.

- Concept 3: Replace the existing tank and foundation with a new tank constructed on top of a properly designed foundation. The new tank and foundation can be constructed while the existing tank is in service, thus eliminating a need for any temporary backwash service. There are different types of tanks, such as welded steel, prestressed concrete, or cast-in-place concrete, which could be evaluated to determine which type is most suitable for the site, use, reliability, and life expectancy. Sites adjacent to on the north, east, and west sides of the tank are possible locations that should be evaluated if this concept is explored further.

- Concept 4: Replace the existing tank with a pumped backwash system. A new pump station would be needed to handle full backwash flows (approximately 23,000 gpm). The pump station would need to pump out of the Clearwell to provide adequate backwash volume. A constant head box could be installed to protect filter underdrains from being over pressurized.

- Concept 5: Reduce the operating level in the tank and supplement the necessary pressure with new pumping equipment. To be effective, reduction in the operating level will need to be proportional to the degree of maximum overstresses to get the load demands down to a level that the existing structure can reasonably tolerate. It is estimated that the water level reduction will need to be approximately 50 percent, which would provide adequate pressure to backwash the filters and adequate volume to provide storage of approximately two filter backwash volumes Of course, this alternative will reduce the available head pressure from the Washwater Tank, which could impact the utility water system. The cost presented assumes that additional storage to offset the reduced volume is not required. However, it is assumed that new pumps will need to be provided to accommodate the head pressure reduction associated with the utility water system. This alternative should be able to be accomplished with minimal disruption to the existing backwash service.

It is assumed that the backwash operation will still require a tall tank to achieve the necessary water pressure to accommodate the process. However, if pressure can be obtained in an alternative manner that is economically feasible, it is recommended that any tank replacement be reduced in height to avoid the excessively large seismic load demands that can be generated by a large earthquake. Mass that is significantly elevated above grade will almost always result in large load demands on the structure and its foundation.

Additionally, with any retrofit or replacement concept, consideration for provision of a temporary backwash service (likely 6 months) during construction is paramount and may dictate which alternative is selected. The shell thicknesses should be verified prior to selecting a course of action to determine if any deficiencies exist.

Estimated project costs for each of the five concepts are presented in Table 7.6 below. The costs for temporary backwash service were estimated for assumed 6-month duration and are based on quotes from suppliers.

Table 7.6 Estimated Project Costs for Five Potential Mitigation Concepts for the Washwater Tank

Concept No.	Concept Description	Project Cost
1	Retrofit the existing tank foundation	$1,500,000
2	Replace the existing tank foundation and re-build the existing steel tank	$1,300,000
3	Replace the existing tank with a new tank and foundation	$1,300,000
4	Pumped backwash with constant head box	$2,000,000
5	Reduce the operating level by 40 percent	$0

Risk

A probabilistic analysis of seismic risk factors associated with the existing Washwater Tank, foundation and related structural components was performed. Findings are presented as an aid to the SFID/SDWD's planning and budgeting processes. We note, however, that it is impossible to predict the timing, location or severity of earthquakes, or to state with certainty how a particular structure will perform in a hypothetical future seismic event. The information provided here should not be considered a prediction or forecast that future seismic events will occur with the frequency or severity reflected in the assumptions underlying the analysis. Carollo Engineers expressly disclaims any such prediction, forecast or guarantee.

The overturning forces acting on the welded steel backwash tank were determined in accordance with AWWA D100-05 using various seismic load input. The base analysis for establishing a means of comparison assumed the prescribed seismic load demands set forth in AWWA D100-05, which correspond to seismic forces generated by an earthquake with lateral accelerations that have a 10 percent probability of being exceeded in a 50 year time period. Alternatively stated, this level of seismic shaking is equivalent to an earthquake having a mean return period of 475 years. This level of shaking is consistent with the seismic design criteria associated with a life safety performance standard that nearly all building codes and structural guides establish as the minimum criteria for new design.

Generally, structures have some measure of redundancy, overstrength, and/or ductility beyond the capacities determined in accordance with the structural code. This is because the performance level for the structure is intended to be at a life safety standard, which is intended to ensure that the structure does not threaten the life of occupants or adjacent personnel or facilities. However, with stability concerns, the structure will not find additional weight or ties to help offset the uplift. Beyond the estimated available resistance to uplift, the behavior/performance of the structure becomes uncertain.

An analysis of the overturning forces revealed that the 475-year seismic uplift demand is approximately 77,000 lbs for each tank anchor. In order for the anchor bolts to resist this demand without tank instability, the tank and foundation must have sufficient weight or other passive means available to resist the overturning forces. The total available weight is limited to approximately 40,000 lbs per anchor, which implies that the anchor loads exceed the available capacity by a factor of nearly 2.0. It was determined that the available load resistance is capable of resisting seismic forces associated with an earthquake having a return period of 77 years or having accelerations that have a 48 percent probability of being exceeded in a 50 year period (12 percent probability of exceedances in a 10 year period).

Furthermore, one may elect to reduce the operating level in the tank as a strategy to reduce risk. The seismic forces associated with the foundation uplift capacity for reduced operating levels down to 66 percent were "back-calculated." At this level, it was determined that the tank foundation has sufficient capacity to develop resistance to the overturning forces.

The associated risk levels are summarized in Table 7.7. The "SF" in the table represents the "safety factor." This is simply the ratio of the capacity to the demand. A value greater than 1.0 implies that the capacity exceeds the demand. These risk levels represent the seismic acceleration that the foundation can resist at various liquid levels. The table reports the probability of these seismic accelerations being exceeded for 50-year and 10-year periods to assist SFID/SDWD in gauging the risk. Each probability reported is associated with a hypothetical mean return period. The probabilities for the different seismic acceleration levels were derived from relationships set forth in ASCE 41, "Seismic Rehabilitation of Existing Buildings." The risks are presented in the format of probability because one cannot reasonably predict when an earthquake will occur, where it will occur, and how big it will be. The probabilistic approach is the most prevalent way to analyze seismic risk for individual structures, because this approach considers all known sources, locations, and maximum potential magnitudes. Seeking to understand what "magnitude" earthquake a structure can survive, while it seems tempting to speculate about, is fraught with too many unknowns that make an analysis costly and unreliable. Earthquake magnitudes are related to unique events that generate ground accelerations at a site that are highly dependent upon the epicenter of the earthquake, the depth of the focus, the path to the site, the magnitude of the earthquake, and the type of earthquake, to name a few. Deterministic studies can be conducted; however, they take a particular hypothetical or historic event as the basis for determining ground acceleration. These types of studies are relatively expensive, typically involve a seismologist or qualified geologist, and are rarely conducted for individual structures. Deterministic studies are typically used to understand how a community or portfolio of buildings spread out over a region are impacted by a specific hypothetical event.

Table 7.7 Summary of Risk Levels Associated with Development of Foundation Anchorage

Tank Operating Level	Safety Factor @ 475-yr Event	Return Period @ SF = 1.0	Probability of Exceedance in 50 Years	Probability of Exceedance in 10 Years
100%	0.52	77	47.6%	12.1%
90%	0.67	122	33.6%	7.9%
80%	0.78	178	24.5%	5.5%
70%	0.93	374	12.5%	2.6%
66%	1.00	475	10.0%	2.1%
60%	1.15	> 475	< 10%	< 2%

Although AWWA D100-05 requires that welded steel tanks used for producing water have an added importance factor that varies from 1.25 to 1.50, depending on the criticality of the structure and its function in providing potable water, the importance factor used in this risk analysis was assumed equal to 1.00. Provision of importance factors greater than 1.00 are intended to boost the performance of a structure for any given seismic input. It can also be equivalently interpreted as having a capacity to resist larger earthquakes.

Conclusions and Recommendations - Seismic Evaluation

The following items represent our conclusions and recommendations for consideration in defining capital improvement projects related to the seismic evaluation at the WFP:

1. Resolve the apparent stability concerns with the Washwater Tank. SFID/SDWD should resolve this item immediately.
2. SFID/SDWD should move forward making the improvements recommended in Table 7.8.
3. Seismic upgrades to the existing clearwell presented in the Malcolm Pirnie report should be addressed.

Table 7.8 Other Notable Structural Deficiencies, Recommended Fixes, and Estimated Costs

Item	Description	Recommendation	Estimated Project Cost	Appendix H Figure
1	The small propane tank that is located to the northwest of the chemical storage area is missing anchorage and has one damaged anchor bolt.	To comply with the 2010 California Building Code for seismic anchorage, the anchorage for the propane tank needs to be provided. It appears that the tank will need to be lifted to do the work.	$5,000	Figures H.4 thru H.5
2	The sludge collector mechanisms do not appear to have any visible seismic restraint system. The mechanism rides along the top of a rail beam to collect sludge from the sedimentation basins. The wheel does not appear to have any additional grip around the rail flange or other means to prevent derailment or unseating of the mechanism.	It is recommended that the mechanism be retrofited with a rail-beam-wheel system that is capable of maintaining stability of the equipment during an earthquake.	$75,000	Figures H.6 thru H.7
3	The pipe gallery south of the of the Flocculation Basins and the Operations Building Basement have conduit and small diameter pipe runs that are supported from the ceiling with Unistrut and small diameter vertical rods. These supports do not have any lateral bracing to resist seismic loading. The small diameter rods are not designed to provide lateral support.	The 2010 California Building Code requires seismic bracing for conduit and pipe distributions that weigh more than 5 lb/ft. Bracing can be provided by addition of Unistrut braces that can be epoxy anchored to the existing concrete walls and slab and with the addition of stiffeners to the vertical rods.	$15,000	Figures H.8 thru H.9
4	The large diameter elevated pipe in the lower basement of the Operations Building lacks seismic bracing. This pipe is set relatively high above the floor and can experience large stresses and displacements during a major earthquake.	Add seismic bracing at intervals that do not exceed 15 feet. Bracing may be comprised of steel straps with steel angle struts anchored to the existing concrete walls and or slab above.	$15,000	Figure H.10
5	Recent report on the clearwell by Malcolm Pirnie provided a list of seismic upgrades to the clearwell.	Make improvements to the clearwell as outlined in the Malcolm Pirnie report.	$600,000	-

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A key component of the JFMP is establishment of a practical implementation program that effectively matches the practical ability to accumulate funds with the timely implementation of the most critical projects. This section describes the process used to prioritize projects identified in the JFMP and presents the recommended 10 year CIP for the Joint Facilities.

PROJECT PRIORITIZATION PROCESS

To accommodate a wide range of near and long term raw water and treatment system needs, the JFMP identified 28 potential projects with a total project cost of approximately $87.5 million (2012 dollars). Table 8.1 provides a summary of the identified potential projects, a brief project description, estimated total capital cost, associated cost per acre-foot to implement, and anticipated project benefits. The unit cost was calculated by annualizing the project cost for 20 years at five percent interest. In addition, a change in operating and maintenance cost was also calculated. Annualized costs were normalized to an annual water production of 19,124 AF (which include 5,700 AF from local sources). The annual production rate is consistent with the 2010 Urban Water Management Plan.

A project prioritization process was established to help define the relative importance of each project, and to develop an implementation program that spreads the projects over the 10-year planning horizon.

The project prioritization process included the following steps:

- Evaluation categories (described in Table 8.2) were developed that reflect attributes that are critical to overall system performance.
- The evaluation categories were weighted to establish the relative importance of each category to overall system performance.
- Priority rating factors (PRF) were developed that reflect a project's anticipated impact on each evaluation category.
- Each project was scored by multiplying the project's priority rating factor by the evaluation category weighting for each category.

The project's potential impact on reduced operation and maintenance cost was considered in the prioritization score. The ability to fund the capital project was included in the development of the capital improvement program described later in this section.

Table 8.3 provides an example calculation spreadsheet. The spreadsheet summarizes the prioritization factor weighting descriptions as they relate to each weighted evaluation criteria. A summary of the ranking for each project is shown in Table 8.4. Detailed results of the scoring for each project are presented in Appendix J. The prioritization scoring approach provides a general indication of relative importance of a project and a method for stimulating discussion about the impact and need for various projects. A slightly higher priority score does not indicate that one project must take precedence over another. *Though the prioritization scoring was an important factor in the determination of relative project importance, some subjectivity was required in the interpretation of data and the establishment of the implementation plan presented later in this chapter.*

RECOMMENDED 10-YEAR CAPITAL IMPROVEMENT PROGRAM FOR THE JOINT FACILITIES

Based on project rankings and an assessment of project need, a recommended 10 Year Joint Facilities CIP was prepared as shown on Table 8.5.

In addition to project ranking, several factors were key in determining project priorities within the CIP. These factors include impact of the project on health and safety, regulatory compliance, financial benefits, and end of useful life determination (for equipment needing replacement). Impact of these drivers is evidenced when reviewing the recommended CIP. In the first four years, 14 projects totaling about $19.1 million dollars are recommended for implementation. Four of these 14 projects total $8.8 million dollars and address health and safety: new San Dieguito Pump Station (SDPS); electrical distribution improvements; clearwell seismic improvements; and the washwater tank. Three projects totaling $2.65 million address siltation, mounding, and inlet flow at SDR. Two other projects totaling $4.75 million provide long-term financial benefits to the Joint Facilities: the new 30-inch parallel pipeline from Cielo Pump Station to SDR and a new high voltage substation at WFP. One project totaling $0.4 million improves plant process control. The remaining recommended projects within the first four years total about $2.5 million and address regulatory compliance issues and initiation of the hydroelectric project.

Individual projects are represented in the CIP with a design phase (preliminary and final) and a construction phase (bidding and construction). Design is generally shown as approximately 10 percent of the overall project cost. Some smaller projects are shown in the CIP to occur in one year because it was determined that the project could realistically be completed in this time period, such as the SDR Pretreatment Enhancements.

Table 8.1 Summary of Potential Joint Facilities Projects

Project No.	Recommended Improvement	Project Description	Preliminary Cost Estimate: Estimated Project Cost ($)	Preliminary Cost Estimate: Project + O&M Unit Cost ($/AF)	Project Benefits
Joint Facilities					
1	New 15 MGD San Dieguito Pump Station (SDPS)	Replace existing SDPS with new facilities and add handrail on the dam.	$4,200,000	$15.92	Increase reliability and safety by replacing a facility that is past its useful life.
2	New 30-inch Parallel Pipeline from Cielo Pump Station (CPS) to SDR	Parallel existing 18-inch line with a new 30-inch line, move valves out of street, replace pump station (PS) isolation valves.	$4,150,000	$4.47	Replace pumped conveyance with gravity conveyance from Cielo PS to SDR, increase functionality and reliability.
3	Install Permanent Chlorine Dioxide Generation	Replace the existing California Department of Public Health (CDPH) "pilot approved" system with a permanent system.	$1,300,000	$5.45	Increase operational reliability of a necessary chemical system.
4	Electrical Distribution Improvements	Upgrade plant power distribution system.	$2,400,000	$10.05	Increase reliability, redundancy, and safety by replacing aging equipment.
5	SDR Pretreatment Enhancements	Enhance existing system to handle flow increase from Lake Hodges to SDR.	$150,000	$0.63	Increase SDR lake management capacities to correspond with increases in flow through SDR.
6	Chemical Storage and Feed Improvements	Provide additional chemical feed points at various points throughout the plant, upgrade polyaluminum chloride (PACL) tank and chlorinators, provide spare chemical tank, and increase reliability of utility water to the chemical systems.	$305,000	$1.28	Provide operational flexibility to improve treated water quality and increase functionality and reliability of the chemical storage and feed systems.
7	Clearwell Seismic Improvements	Provide seismic upgrades to the clearwell.	$700,000	$2.93	Increase safety and reliability.
8	SDR Siltation Basins	Install basins to reduce urban runoff sediment deposits.	$350,000	$1.47	Reduce maintenance and increase water quality of SDR.
9	Washwater Tank	Retrofit/Replace the existing tank.	$1,500,000	$6.28	Bring tank into compliance with seismic standards.
10	High Voltage Substation	Construct new electrical substation.	$600,000	$0.43	Reduce electrical costs and improve reliability.
11	SDR Sediment Mound Reduction	Lower current mound elevation.	$1,000,000	$4.19	Improve aesthetics of inflow through SDR.
12	SCADA Upgrades	Replace outdated equipment	$400,000	$1.68	Improve plant control system.
13	SDR Inlet Channel Modifications	Improve channel configuration.	$1,300,000	$5.45	Improve conveyance of inflow through SDR.
14	Replace or Upgrade Hydroelectric Facility	Replace or refurbish existing facility.	$7,600,000	$31.84	Increase cost effectiveness of the facility.
15	Mechanical Dewatering and Filter Waste Washwater Improvements	Increase mechanical dewatering capacity and improve residuals management.	$6,330,000	$51.92	Eliminate solids discharge to SDR by dewatering solids onsite and improve quality of filter waste washwater.
16	Reline or replace 15-inch Drain Line to SDR	Reline or replace existing pipeline. Future inspection of pipeline will dictate reline or replacement.	$2,000,000	$8.38	Increase reliability by refurbishing or replacing an aging pipeline.
17	Natural Treatment Wetlands	Install wetlands to improve the quality of urban runoff.	$750,000	$3.14	Increase water quality of SDR.
18	Reline Existing 30-inch SDPS Force Main to Plant or Construct New 30-inch Line	Reline or replace existing pipeline. Future inspection of pipeline will dictate reline or replacement.	$4,500,000	$18.85	Inrease reliability by refurbishing or replacing an aging pipeline.
19	New Flocculators	Replace existing flocculators and connect to standby power.	$1,000,000	$4.19	Increase functionality and reliability by replacing aging equipment.
20	New Sludge Collection Equipment	Replace existing sludge collection equipment.	$1,500,000	$6.28	Increase functionality and reliability by replacing aging equipment.
21	SDR Vegetation Removal	Remove nuisance vegetation in and adjacent to SDR.	$750,000	$3.14	Increase aesthetics of SDR.
		SUBTOTAL	$42,785,000	$188	
22	Pre-ozonation	Provide a 1,300 ppd ozone system.	$10,200,000	$69.50	Ozone "pays for itself' by increasing local water supply from 5,700 to 8,600 AF/yr.
23	Ozone Pilot Testing	Initial testing to verify efficacy of ozone.	$500,000	$2.09	Confirm efficacy of ozone.
24	Construct New Third Floc/Sed Basin	Construct a third floc/sed basin adjacent to existing.	$6,200,000	$25.97	Increase reliable pretreatment capacity above 30 mgd.
25	Filter Improvements	Rehab filter underdrains, surface wash, launders, electrical, and control.	$5,800,000	$24.30	Increase useful life.
26	Ultraviolet (UV) Disinfection	Add UV disinfection upstream of clearwell.	$5,300,000	$23.09	Provides enhanced disinfection if required by change in raw water quality or future regulations.
27	Reline/Rehabilitate Old 54-inch Treated Water Line	Rehabilitate the old 54-inch treated water line from the plant to near SDPS. Future inspection of pipeline will dictate reline or replacement.	$7,500,000	$31.42	Increase reliability by refurbishing an aging pipeline.
28	SDR Volume Enhancement through Dredging or Outlet Elevation Modifications	Increase SDR storage through dredging or raising the water level.	$5,000,000	$20.94	Increase storage capacity of SDR.
		SUBTOTAL	$40,500,000	$197	
		TOTAL	$83.3 M	$385	

Table 8.2 Evaluation Categories

Weight	Category	Description
10	Regulatory Compliance and/or Flow-Pressure Objectives	This category was used to assess the relative impact a project has on SFID/SDWD's ability to comply with mandatory regulations and/or performance criteria established to protect health and safety. This category includes water treatment quality objectives as well as flow and pressure objectives for the distribution system.
10	Staff Safety and Working Environment	This category was used to assess the improvement in safety and working environment for staff if the project is implemented.
9	Reliability - Remaining Useful Life, Condition, Accessibility	This category relates to the replacement or rehabilitation of existing assets. There must be a high level of confidence that facilities will operate, as intended, when called upon. Reliability concerns could stem from asset age, condition, or the ability to access the asset to determine its status or facilitate repair or maintenance. This evaluation category is used to assess the improvement in reliability if the project were implemented. Note that it is assumed that the critical nature of the asset is captured within the intent of other evaluation categories (such as a projects impact on regulatory and staff health and safety impacts).
8	Operation and Maintenance (O&M) Cost Efficiency	Redundant components for the Joint Facilities are important to minimize service interruption and relieve the burden on customers during planned and unexpected system shutdowns.
8	Redundancy - Joint Facilities	This category assesses the impact of the cost effectiveness realized through reduction in labor, energy, chemicals, or other operation and maintenance cost elements. Projects with a relatively short payback period would be considered as cost effective and would receive a higher rating.
7	Increased Local Water Usage	Local water offers the lowest cost supply. In addition, it lessens reliance on imported water. This category assesses a projects impact on our ability to increase the volume of local water use (relative to current usage values).
7	Water Quality Enhancement and Taste and Odor (T&O) Control	In addition to providing water that meets regulatory standards for public health and safety, the aesthetic attributes of the water needs to meet the satisfaction of customer. This category considers a project's potential impact on reduction of taste and odor complaints that periodically arise due to a variety of conditions.
6	Enhanced Operational Control	Ideally, the joint facilities provide the features needed to enable operational flexibility, and the ability to adjust and optimize system performance. This category considers a project's impact on operational flexibility and control.

The potential capital projects not included in the 10-year recommended CIP are listed below. Rationale for their exclusion follows.

- Pre-ozonation
- Ozone Pilot Testing
- Construct New Third Floc/Sed Basin
- Filter Improvements
- UV Disinfection
- Reline/Rehabilitate Old 54-inch Treated Water Line
- SDR Volume Enhancement through Dredging or Outlet Elevation Modifications

Pre-ozonation and its ancillary ozone pilot study were not included because ozone becomes cost effective if the annual local water supply could be consistently increased from 5,700 to 8,600 AF/yr. A third floc/sed basin becomes necessary when maximum day production reliably increases over 30 mgd. Maximum day demands have been slowly declining over the last several years, and it is not anticipated that production will exceed 30 mgd in the next ten years. Improvements to the filters and the old 54-inch treated water line are based on the end of their useful life. It is not anticipated that these components will need to be replaced in the next ten years. Installation of UV disinfection is based on potential future regulations for enhanced disinfection not achievable with the current treatment scheme. This is not anticipated to occur in the next ten years. SDR volume enhancement, i.e., increasing the current storage capacity of SDR, is not necessary for pre-conditioning of Lake Hodges water at projected flows during the planning horizon. Similar to a third floc/sed basin, this project should be revisited if maximum day demands begin to reliably increase above 30 mgd.

ASSOCIATED COST OF WATER INCREASE

Table 8.6 shows the cost impact of the recommended 10-year CIP with respect to the current cost to treat raw water supplies at the WFP. The costs shown in Table 8.6 are all based on 2012 values. Costs for the raw water supplies result from adding the base case O&M cost per AF with a unit cost for the recommended Joint Facilities CIP that includes both amortized capital and O&M costs.

For comparison purposes, Table 8.6 also includes an estimated cost assuming an all imported treated water supply scenario. The cost of imported treated water is based upon 2012 values with no projected increases. If the Districts were to rely totally on imported treated water, storage facilities would need to be constructed to accommodate regularly scheduled annual maintenance on the imported treated water system. A minimum of 10 days of treated water storage is required to accommodate system maintenance. Therefore, in addition to the purchase price of imported treated water, the amortized capital ($135 million for 30 years at 5%) to construct a 180 million gallon (MG) storage facility must be added to the purchase cost of imported treated water.

Table 8.6 Comparison of Increased Costs to Treat Raw Water Supplies to 100 Percent Treated CWA Water Costs[1]

	Estimated Cost of Water per AF[2] ($/AF)	
	Raw Water Supplies[3]	100% Treated CWA
Base Case O&M Cost per AF (per Table ES.2)	953	1,185
Estimated Capital Improvement Costs per AF		
Treated Water Storage[4]	0	458
Recommended Joint Facilities 10-year CIP[5]	188	0
Estimated Total Cost per AF (O&M plus amortized project cost)	**1,141**	**1,643**

Notes
1. Based on average annual demand of 19,124 AF/yr.
2. All costs based on 2012 dollars.
3. Assumes 30 percent local water on an annual basis.
4. Includes the cost for a 180 million gallon storage facility ($135 million amortized for 30 years at 5%).
5. As shown in Table ES.3, unit costs for each capital project included both amortized capital and O&M costs. Amorization terms for all projects were 20 years at 5%.

Table 8.3 Prioritization Rating Factor Descriptions and Example

CIP Evaluation Categories and Weights		Prioritization Rating Factors (PRF) and Definitions				New 15 mgd SDPS	
Evaluation Criteria	Category Weight	3	2	1	0	PRF	Score
Regulatory Compliance and/or Flow-Pressure Objectives	10	Project is critical to achieving compliance, or is a prerequisite project to a project critical to achieving compliance	Project will moderately improve ability to achieve compliance	Project may have a low level of impact on the ability to achieve compliance.	Project has no impact on ability to achieve compliance.	3	30
Staff Safety and Working Environment	10	Project could significantly reduce the risk of an accident, or would improve the work environment to the point where the protection of the employee's health would be significantly improved.	Project could have a moderate impact on the reduction accident risk or moderate improvement of the work environment.	Project may have a low level of impact on the ability to reduce accidents or improve the work environment.	Project has no impact on ability to improve staff safety and work environment.	3	30
Reliability - Remaining Useful Life, Condition, Accessibility	9	Project would substantially improve reliability of a current unreliable asset.	Project would improve the reliability of a moderately reliable asset, or the project would enable better access to the existing asset to facilitate regular monitoring and/or maintenance.	Project may further improve the reliability of an asset that is currently considered reliable.	Project has no impact on improving the reliability of an existing asset.	3	27
Operation and Maintenance (O&M) Cost Efficiency	8	Provides significant O&M savings.	Provides moderate O&M savings.	Project may result in a low level of O&M savings.	Project will provide no O&M savings.	2	16
Redundancy - Joint Facilities	8	Project provides redundant improvements that are critical to the Joint Facility should the primary system component fail to operate. Effected system users would be unreasonably burdened by the loss of the primary system component.	Project provides redundant system improvements that may not be critical to the treatment of water but would reduce a potentially unreasonable burden on the effected system users.	Project provides redundant system improvements that would reduce the impact on system users. However, the impact to users could most probably be reasonable.	Project has no impact on redundancy.	2	16
Increased Local Water Usage	7	Project substantially improves our ability to increase local water use.	Project moderately improves our ability to increase local water use.	Project may have a lower level impact on our ability to increase local water use.	Project will not increase local water usage.	1	7
Water Quality Enhancement and Taste and Odor (T&O) Control	7	Project would substantially improve product water aesthetics and significantly reduce T&O complaints.	Project would result in moderate aesthetic improvements and potentially reduce certain T&O complaints.	Project may have a limited impact on product water aesthetics and a relatively low impact on T&O complaints.	Project has no impact on water quality aesthetics.	0	0
Enhanced Operational Control	6	Project substantially increases system flexibility and/or operational control.	Project moderately increases system flexibility and/or operational control.	Project may result in some increase in system flexibility and/or operational control.	Project has no impact on system flexibility and/or operational control.	2	12
Total Score						138	

Table 8.4 Ranking Summary for Recommended Capital Improvements Projects for the Joint Facilities

Project Description	Priority Ranking	Total Project Cost
New 15 MGD San Dieguito Pump Station (SDPS)	138	$4,200,000
Install Permanent Chlorine Dioxide Generation	125	$1,300,000
Electrical Distribution Improvements	121	$2,400,000
Chemical Storage and Feed Improvements	101	$305,000
High Voltage Substation	32	$600,000
New 30-inch Parallel Pipeline from Cielo Pump Station (CPS) to SDR	128	$4,150,000
SDR Pretreatment Enhancements	105	$150,000
Clearwell Seismic Improvements	93	$700,000
SDR Siltation Basins	72	$350,000
Washwater Tank	60	$1,500,000
SDR Sediment Mound Reduction	58	$1,000,000
SCADA Upgrades	74	$400,000
SDR Inlet Channel Modifications	58	$1,300,000
Replace or Upgrade Hydroelectric Facility	117	$7,600,000
Mechanical Dewatering and Filter Waste Washwater Improvements	133	$6,330,000
Reline or replace 15-inch Drain Line to SDR	75	$2,000,000
Natural Treatment Wetlands	67	$750,000
Reline Existing 30-inch SDPS Force Main to Plant or Construct New 30-inch Line	66	$4,500,000
New Flocculators	57	$1,000,000
New Sludge Collection Equipment	57	$1,500,000
SDR Vegetation Removal	7	$750,000
Pre-ozonation	82	$10,200,000
Ozone Pilot Testing	82	$500,000
Construct New Third Floc/Sed Basin	62	$6,200,000
Filter Improvements	29	$5,800,000
Ultraviolet (UV) Disinfection	54	$5,300,000
Reline/Rehabilitate Old 54-inch Treated Water Line	34	$7,500,000
SDR Volume Enhancement through Dredging or Outlet Elevation Modifications	36	$5,000,000

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Table 8.5 Recommended 10-Year Capital Improvement Program for the Joint Facilities

		Costs in Thousands of Dollars										
Project Description	Total Project Cost	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	Total
New 15 MGD SDPS	$4,200,000	$400	$1,520	$2,280								$4,200
Install Permanent Chlorine Dioxide Generation	$1,300,000	$130	$470	$700								$1,300
Electrical Distribution Improvements	$2,400,000	$240	$860	$1,300								$2,400
Chemical Storage and Feed Improvements	$305,000	$55	$250									$305
High Voltage Substation	$600,000	$60	$220	$320								$600
New 30-inch Parallel Pipeline from CPS to SDR	$4,150,000		$400	$1,500	$2,250							$4,150
SDR Pretreatment Enhancements	$150,000		$150									$150
Clearwell Seismic Improvements	$700,000		$700									$700
SDR Siltation Basins	$350,000		$40	$120	$190							$350
Washwater Tank	$1,500,000		$200	$520	$780							$1,500
SDR Sediment Mound Reduction	$1,000,000		$100	$360	$540							$1,000
SCADA Upgrades	$400,000		$200	$200								$400
SDR Inlet Channel Modifications	$1,300,000			$150	$1,150							$1,300
Replace or Upgrade Hydroelectric Facility	$7,600,000				$750	$2,740	$4,110					$7,600
Mechanical Dewatering and Filter Waste Washwater Improvements	$6,330,000					$600	$2,290	$3,440				$6,330
Reline or Replace 15-inch Drain Line to SDR	$2,000,000							$200	$720	$1,080		$2,000
Natural Treatment Wetlands	$750,000							$80	$270	$400		$750
Reline Existing 30-inch SDPS Force Main to Plant or Construct New 30-inch Line	$4,500,000									$500	$4,000	$4,500
New Flocculators	$1,000,000									$100	$900	$1,000
New Sludge Collection Equipment	$1,500,000									$150	$1,350	$1,500
SDR Vegetation Removal	$750,000									$80	$670	$750
Total	$42,800,000	$885	$5,110	$7,450	$5,660	$3,340	$6,400	$3,720	$990	$2,310	$6,920	$42,800

APPENDIX A:
Base Case Model Summaries

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Model Inputs

DESCRIPTION	UNITS	MODEL INPUTS	100% CWA[1]	100% SDR[1]	30/70 (SDR/CWA)[1]	2007-08 Average	2009-10 Average	100% Lake Hodges[1]	100% CWA Treated[1]	Future Scenario (5,700 ac-ft)[1]
			Base Case Inputs							
FLOWS										
San Dieguito Pump Station	MGD	5.1	0	17.1	5.1	6.4	8.3	0	0.0	5.1
Cielo Pump Station to SDR	MGD	5.1	0	17.1	5.1	6.4	8.3	0	0.0	5.1
Cielo Pump Station to Plant	MGD	0.0	0	0	0	1	0.8	17.1	0.0	0.0
CWA Raw Water	MGD	12.0	17.1	0	12	11.4	6.2	0	0.0	12.0
CWA Treated Water	MGD	0.0	0	0	0	0.4	0.3	0	17.1	0.0
					17.1	19.2	15.6	17.1	17.1	17.1
RAW WATER QUALITY										
Turbidity	NTU	4.0	1.5	5.5	4	3.6	4.2	6	0.0	4.0
TOC	mg/L	5.5	2.5	9	5.5	6	7.4	11	0.0	5.5
pH	-	8.2	8.3	8	8.2	7.4	7.5	7.9	7.5	8.2
Temperature	°C	20.4	20.4	20.4	20.4	20.1	20.7	20.4	15.8	20.4
CHEMICALS										
Chlorine Dioxide										
Cielo Pipeline	mg/L	0.0	0	0	0	0	0	0	0	0
SDPS Pipeline	mg/L	0.0	0	0	0	0	0	0	0	0
Plant Inluent	mg/L	0.6	0.5	1	0.6	1.1	1.2	1	0	0.6
Settled Water	mg/L	0.0	0	0	0	0	0	0	0	0
Chlorine										
Plant Inluent	mg/L	7.5	3.5	11	7.5	5.5	6.3	11	0	7.5
Settled Water	mg/L	0.0	0	0	0	0	0	0	0	0
Filtered Water	mg/L	0.0	0	0	0	0	0	0	0	0
Ammonia										
Plant Influent	mg/L	1.3	0.7	1.8	1.3	0.8	0.8	1.8	0	1.3
Filtered Water	mg/L	0.0	0	0	0	0	0	0	0	0
PACL										
Plant Influent	mg/L	20.4	15	68	20.4	42.9	49.8	68	0	20.4
Settled Water	mg/L	0.0	0	0	0	0	0	0	0	0
Backwash Recovery System	mg/L	0.0	0	0	0	0	0	0	0	0
Cationic Polymer										
Plant Influent	mg/L	1.0	0.5	3.4	1	1.4	2	3.4	0	1.0
Settled Water	mg/L	0.0	0	0	0	0	0	0	0	0
Caustic										
Settled Water	mg/L	0.0	0	0	0	0	0	0	0	0
Filtered Water	mg/L	8.0	8	8	8	8	8.1	8	0	8.0
Anionic Polymer										
Settled Water	mg/L	0.0	0	0	0	0	0	0	0	0
Sludge Aid										
Centrifuge	lb/dry ton	10.0	10	10	10	10	10	10	0	10
Polymer - Actiflo System										
Backwash Recovery System	mg/L	0.0	0	0	0	0	0	0	0	0

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Model Inputs

SOLIDS										
Solids Removed in Sedimentation Basins	%	75%	75%	75%	75%	75%	75%	75%	75%	75%
Mechanical Dewatering System (On/Off)		OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
% Solids Conc. From Sed. Basins	%	3%	3%	3%	3%	3%	3%	3%	3%	3%
% Solids from Actiflo	%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Average Sludge Flow from Actiflo	gpm	20.0	20	20	20	20	20	20	20	20
% Solids from Thickener	%	5%	5%	5%	5%	5%	5%	5%	5%	5%
% Solids from Centrifuge	%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Sludge Aid	lb/ton	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Actiflow System (On/Off)		OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Actiflo VT Pump (On/Off)		OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Hydroturbines (On/Off)		ON	ON	ON	ON	ON	ON	ON	OFF	ON
Contract Solids Management		ON	ON	ON	ON	ON	ON	ON	OFF	ON
TOC REMOVALS										
Sedimentation	%	27%	27%	27%	27%	27%	27%	27%	27%	27%
Filtration	%	5%	5%	5%	5%	5%	5%	5%	5%	5%

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Pump Input Information

Name	TDH (ft)	Efficiency (%)
Cielo Pump Station	318	75%
San Dieguito Pump Station	358	75%
Hydroelectric Turbines	335	80%
Backwash Pumps	82	75%
Washwater Recovery Pumps	88	75%
Dewatering Feed Pumps	19	75%

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Model Input Costs

CATEGORY	UNITS		COST
WATER COSTS[1]			
Imported Raw	$/ac-ft	$	699.00
Imported Treated	$/ac-ft	$	924.00
Lake Hodges	$/ac-ft	$	52.00
ELECTRICAL COSTS			
Pump Electrical Cost[2]	$/kwh	$	0.10
Turbine Production Costs[2]	$/kwh	$	0.10
Base Plant Electrical Costs[3]	$/Day	$	125.00
Plant Electrical Costs[4]	$/AF	$	40.00
Misc. Plant Electrical Costs[4]	$/MG	$	122.76
Actiflo™ Electrical Costs[5]	$/Day	$	70.00
Dewatering Electrical Costs[5]	$/Day	$	75.00
CHEMICAL COSTS [6]			
Chlorine	$/lb	$	0.25
Ammonia (30%)	$/lb	$	0.14
PACl	$/lb	$	0.32
Cationic Polymer (coagulant aid)	$/lb	$	0.34
Caustic (50%)	$/lb	$	0.20
Anionic Polymer	$/lb	$	0.81
Chlorine Dioxide[7]	$/lb	$	1.10
Sludge Aid	$/lb	$	1.75
Sodium Chlorite (31%)	$/lb	$	0.71
Polymer (Actiflo)	$/lb	$	0.80
SLUDGE DISPOSAL COSTS[8]			
Landfilling	$/ton	$	47.25
Transportation	$/truck	$	260
Truck Capacity	Tons		18
% Solids Transported	%		70%
Cost/truck	$/truck	$	1,110.50
Cost/ton	$/ton	$	61.69
Cost/dry ton	$/dry ton	$	88.13
CONTRACT SOLIDS MANAGEMENT[9]			
Frequency	#/year		6
Cost/Time	$	$	33,000
Cost/Year	$	$	198,000
Daily Cost	$	$	542
Annual Solids	dry tons		650
Unit Cost	$/dry ton	$	304.62

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Model Input Costs

PLANT LABOR COSTS[3]			
Administration	$/yr	$	366,802
Operations	$/yr	$	847,456
Maintenance	$/yr	$	488,010
Lab	$/yr	$	117,008
Total	$/yr	$	1,819,276
Daily Cost	$	$	4,984.32
Employees	#		12
Cost per Employee	$/day	$	415.36
PLANT MAINTENANCE[3]			
Mechanical Maintenance	$/yr	$	45,320
E, I & C Maintenance	$/yr	$	5,408
Grounds Maintenance	$/yr	$	11,124
Compliance	$/yr	$	5,099
Lake Management Monitoring	$/yr	$	51,191
Plant Maintenance	$/yr	$	192,404
Plant Utilities	$/yr	$	64,878
E, I & C Maintenance	$/yr	$	135,136
Safety	$/yr	$	49,028
Building & Grounds Maintenance	$/yr	$	67,568
Service Contracts	$/yr	$	65,261
Laboratory	$/yr	$	104,030
Administrative	$/yr	$	582,981
Total	$/yr	$	1,379,428
CAPITAL IMPROVEMENTS[3]			
Annual Improvements	$/yr	$	2,500,000
IMPORTED SUPPLY FIXED COST[3]			
SFID			
Capacity Reserve Charge	$/yr	$	364,839
Readiness to Serve	$/yr	$	460,698
Customer Service	$/yr	$	379,819
Emergency Storage	$/yr	$	815,205
Infrastructure Access	$/yr	$	314,997
Subtotal		$	2,335,558

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Model Input Costs

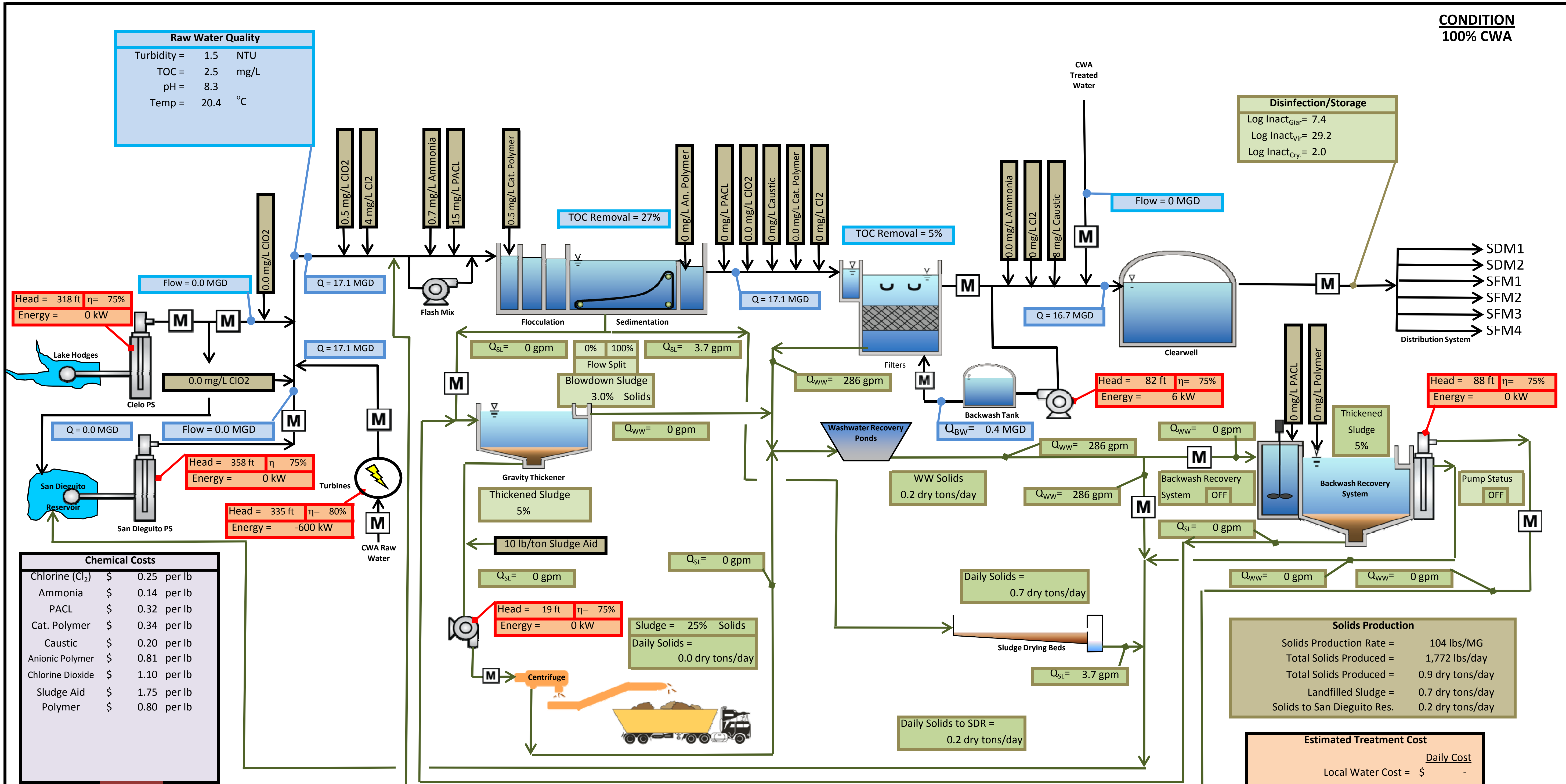
SDWD			
Emergency Service Charge	$/yr	$	397,393
MWD Capacity Reservation	$/yr	$	122,514
MWD Readiness to Serve	$/yr	$	152,560
CWA Service Charge	$/yr	$	204,070
Infrastructure Access Charge	$/yr	$	372,000
Subtotal		$	1,248,537
Total	$/yr	$	3,584,095
IMPORTED SUPPLY FIXED COST - 100% TREATED WATER[3]			
SFID			
Capacity Reserve Charge	$/yr	$	521,199
Readiness to Serve	$/yr	$	658,140
Customer Service	$/yr	$	542,599
Emergency Storage	$/yr	$	1,164,578
Infrastructure Access	$/yr	$	449,996
Subtotal		$	3,336,512
SDWD			
Emergency Service Charge	$/yr	$	567,705
MWD Capacity Reservation	$/yr	$	175,021
MWD Readiness to Serve	$/yr	$	217,943
CWA Service Charge	$/yr	$	291,528
Infrastructure Access Charge	$/yr	$	372,000
Subtotal		$	1,624,197
Total	$/yr	$	4,960,709

NOTES:
1. Based on 2012 costs (including transportation).
2. Current rate supplied by plant staff.
3. Calculated based on Costs provided by the District.
4. Cost utilized in District's current model.
5. Estimated based on equipment loads associated with the process.
6. Current chemical costs.
7. Calculated based on 1 lb. of of ClO_2 requiring 0.53 lbs. of Cl_2 and 0.41 gallons of 31% Chlorite.
8. Values supplied by plant staff.
9. Based on 2011 contract costs, option assists in reducing solids going to SDR.

PROCESS EVALUATION MODEL

R. E. BADGER WATER FILTRATION PLANT

CONDITION
100% CWA



Chemical Costs

Chlorine (Cl_2)	$	0.25	per lb
Ammonia	$	0.14	per lb
PACL	$	0.32	per lb
Cat. Polymer	$	0.34	per lb
Caustic	$	0.20	per lb
Anionic Polymer	$	0.81	per lb
Chlorine Dioxide	$	1.10	per lb
Sludge Aid	$	1.75	per lb
Polymer	$	0.80	per lb

Solids Production

Solids Production Rate =	104 lbs/MG
Total Solids Produced =	1,772 lbs/day
Total Solids Produced =	0.9 dry tons/day
Landfilled Sludge =	0.7 dry tons/day
Solids to San Dieguito Res.	0.2 dry tons/day

Estimated Treatment Cost

		Daily Cost
Local Water Cost =	$	-
Imported Raw Water Costs =	$	46,504
CWA Treated Water Costs =	$	-
Chemical =	$	1,154
Power =	$	2,238
Hydroturbines Income =	$	(1,440)
Solids Disposal =	$	601
Labor Costs =	$	4,984
Maint./CIP Costs =	$	3,779
Total Treatment Cost =	**$**	**57,821**
$/ac-ft =	**$**	**1,102**

Chemical Feed Dosages - Pretreatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Cielo ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
SDR ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Influent ClO_2	0.5 mg/L	4.2 lbs/MG	$4.57/MG	$ 78.14
Cl_2	3.5 mg/L	29.2 lbs/MG	$7.30/MG	$ 124.79
Ammonia	0.7 mg/L	5.8 lbs/MG	$0.82/MG	$ 13.98
PACL	15.0 mg/L	125.1 lbs/MG	$40.03/MG	$ 684.55
Cat. Polymer	0.5 mg/L	4.2 lbs/MG	$1.42/MG	$ 24.24

Chemical Feed Dosages - Settled Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
PACL	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Caustic	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cat. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
An. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -

Chemical Feed Dosages - Finished Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
Ammonia	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Caustic	8.0 mg/L	67 lbs/MG	$13.34/MG	$ 228.11

Chemical Feed Dosages - Residuals Treatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Sludge Aid	10.0 lb/ton	0.0 lbs/MG	$0.00/MG	$ -
PACL	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Polymer	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -

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SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
100% CWA

WATER PURCHASE COSTS	VOLUME MG	UNIT COST $/AC-FT	DAILY COST $
CWA Raw (Imported)	17.1	$ 699.00	$ 36,685
Lake Hodges (Local)	0.0	$ 52.00	$ -
CWA Treated Water	0	$ 924.00	$ -
TOTAL ($/AC-FT)			**$ 699**

IMPORTED SUPPLY FIXED COST	ANNUAL COST $	DAILY COST $
SFID	$ 2,335,558.00	$ 6,399
SDWD	$ 1,248,537.00	$ 3,421
TOTAL ($/AC-FT)		**$ 187**

ELECTRICAL COSTS	VOLUME MG	UNIT COST $/MG	DAILY COST $
Cielo Pump Station	0.0	$ 133.20	$ -
San Dieguito Pump Station	0.0	$ 149.95	$ -
Backwash Pump	0	$ 34.35	$ 14
Base Energy Cost (per day)		$ 125.00	$ 125
Plant Energy Costs	17.1	$ 122.76	$ 2,099
Actiflo System			
Cost (per day)	-	$ 70.00	$ -
Vertical Turbine Pumps	0	$ 36.86	$ -
Dewatering			
Cost (per day)	-	$ 75.00	$ -
Pumping Costs	0	$ 7.96	$ -
Hydroturbines	17.1	$ 84.19	$ (1,440)
TOTAL ($/AC-FT)			**$ 15**

CHEMICAL COSTS	VOLUME MG	UNIT COST $/MG	DAILY COST $
Chlorine Dioxide			
Cielo Pipeline	0.0	$ -	$ -
SDPS Pipeline	0.0	$ -	$ -
Plant Inluent	17.1	$ 4.57	$ 78
Settled Water	17.1	$ -	$ -
Chlorine			
Plant Inluent	17.1	$ 7.30	$ 125
Settled Water	17.1	$ -	$ -
Filtered Water	17.1	$ -	$ -

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
100% CWA

Ammonia			
Plant Influent	17.1	$ 0.82	$ 14
Filtered Water	17.1	$ -	$ -
PACL			
Plant Influent	17.1	$ 40.03	$ 685
Settled Water	17.1	$ -	$ -
Backwash Recovery System	0	$ -	$ -
Cationic Polymer			
Plant Influent	17.1	$ 1.42	$ 24
Settled Water	17.1	$ -	$ -
Caustic			
Settled Water	17.1	$ -	$ -
Filtered Water	17.1	$ 13.34	$ 228
Anionic Polymer			
Settled Water	17.1	$ -	$ -
Sludge Aid			
Centrifuge	0.0 dry tons	$17.50/dry ton	$ -
Polymer - Actiflo System			
Backwash Recovery System	0	$ -	$ -
TOTAL ($/AC-FT)			**$ 22**

RESIDUAL MANAGEMENT COSTS	AMOUNT Dry Tons	UNIT COST $/Dry Ton	DAILY COST $
Solids Disposal (Centrifuge)	0	$ 88.13	$ -
Contract Solids Management (Drying Beds)	0.66		$ 542
Solids Disposal (Drying Beds)	0.66	$ 88.13	$ 59
TOTAL ($/AC-FT)			**$ 11**

LABOR COSTS	FULL-TIME EMPLOYEES	UNIT COST $/Employee/Day	DAILY COST $
Plant	12	$ 415	$ 4,984
Actiflo	1	$ 415	$ -
Mechanical Dewatering	1	$ 415	$ -
TOTAL ($/AC-FT)			**$ 95**

MAINTENANCE COSTS		ANNUAL COST $	DAILY COST $
Plant Maintenance	-	$ 1,379,428	$ 3,779.3
TOTAL ($/AC-FT)			**$ 72**

CAPITAL IMPROVEMENTS	CAPITAL COST	ANNUAL COST $	DAILY COST $
180 MG Storage Facility (100% Treated CWA Option)	$ -	$ -	$ -
TOTAL ($/AC-FT)			**$ -**

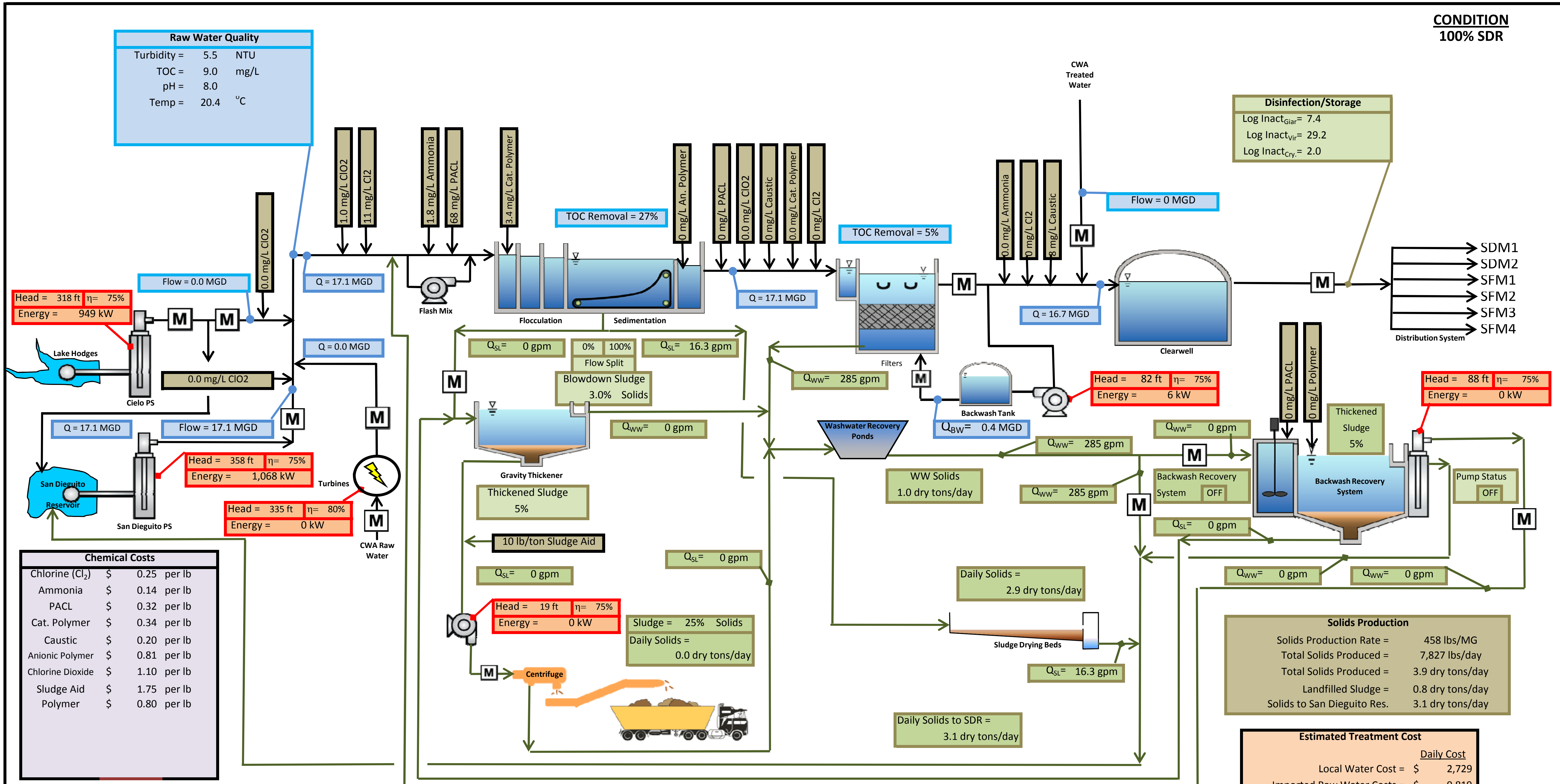
SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
100% CWA

SUMMARY COSTS

CATEGORY	**DAILY COST $**	**COST $/AC-FT**
Water Purchase Costs	$ 36,685	$ 699
Imported Supply Fixed Costs	$ 9,819	$ 187
Power Costs	$ 2,238	$ 43
Power Generation	$ (1,440)	$ (27)
Chemical	$ 1,154	$ 22
Solids Management	$ 601	$ 11
Labor	$ 4,984	$ 95
Maintenance	$ 3,779	$ 72
Subtotal	*$ 57,821*	*$ 1,102*
Capital Improvements	$ -	$ -
TOTAL COST	**$ 57,821**	**$ 1,102**

PROCESS EVALUATION MODEL

R. E. BADGER WATER FILTRATION PLANT



Chemical Costs

Chlorine (Cl_2)	$	0.25	per lb
Ammonia	$	0.14	per lb
PACL	$	0.32	per lb
Cat. Polymer	$	0.34	per lb
Caustic	$	0.20	per lb
Anionic Polymer	$	0.81	per lb
Chlorine Dioxide	$	1.10	per lb
Sludge Aid	$	1.75	per lb
Polymer	$	0.80	per lb

Solids Production

Solids Production Rate =	458 lbs/MG
Total Solids Produced =	7,827 lbs/day
Total Solids Produced =	3.9 dry tons/day
Landfilled Sludge =	0.8 dry tons/day
Solids to San Dieguito Res.	3.1 dry tons/day

Estimated Treatment Cost

		Daily Cost
Local Water Cost =	$	2,729
Imported Raw Water Costs =	$	9,819
CWA Treated Water Costs =	$	-
Chemical =	$	4,081
Power =	$	7,080
Hydroturbines Income =	$	-
Solids Disposal =	$	612
Labor Costs =	$	4,984
Maint./CIP Costs =	$	3,779
Total Treatment Cost =	**$**	**33,085**
$/ac-ft =	**$**	**631**

Chemical Feed Dosages - Pretreatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Cielo ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
SDR ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Influent ClO_2	1.0 mg/L	8.3 lbs/MG	$9.14/MG	$ 156.28
Cl_2	11.0 mg/L	91.7 lbs/MG	$22.94/MG	$ 392.19
Ammonia	1.8 mg/L	15.3 lbs/MG	$2.14/MG	$ 36.60
PACL	68.0 mg/L	567.1 lbs/MG	$181.48/MG	$ 3,103.28
Cat. Polymer	3.4 mg/L	28.4 lbs/MG	$9.64/MG	$ 164.86

Chemical Feed Dosages - Settled Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
PACL	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Caustic	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cat. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
An. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -

Chemical Feed Dosages - Finished Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
Ammonia	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Caustic	8.0 mg/L	67 lbs/MG	$13.34/MG	$ 227.87

Chemical Feed Dosages - Residuals Treatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Sludge Aid	10.0 lb/ton	0.0 lbs/MG	$0.00/MG	$ -
PACL	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Polymer	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -

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SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
100% SDR

WATER PURCHASE COSTS	VOLUME MG	UNIT COST $/AC-FT	DAILY COST $
CWA Raw (Imported)	0.0	$ 699.00	$ -
Lake Hodges (Local)	17.1	$ 52.00	$ 2,729
CWA Treated Water	0	$ 924.00	$ -
TOTAL ($/AC-FT)			**$ 52**

IMPORTED SUPPLY FIXED COST	ANNUAL COST $	DAILY COST $
SFID	$ 2,335,558.00	$ 6,399
SDWD	$ 1,248,537.00	$ 3,421
TOTAL ($/AC-FT)		**$ 187**

ELECTRICAL COSTS	VOLUME MG	UNIT COST $/MG	DAILY COST $
Cielo Pump Station	17.1	$ 133.20	$ 2,278
San Dieguito Pump Station	17.1	$ 149.95	$ 2,564
Backwash Pump	0	$ 34.35	$ 14
Base Energy Cost (per day)		$ 125.00	$ 125
Plant Energy Costs	17.1	$ 122.76	$ 2,099
Actiflo System			
Cost (per day)	-	$ 70.00	$ -
Vertical Turbine Pumps	0	$ 36.86	$ -
Dewatering			
Cost (per day)	-	$ 75.00	$ -
Pumping Costs	0	$ 7.96	$ -
Hydroturbines	0.0	$ 84.19	$ -
TOTAL ($/AC-FT)			**$ 135**

CHEMICAL COSTS	VOLUME MG	UNIT COST $/MG	DAILY COST $
Chlorine Dioxide			
Cielo Pipeline	0.0	$ -	$ -
SDPS Pipeline	17.1	$ -	$ -
Plant Inluent	17.1	$ 9.14	$ 156
Settled Water	17.1	$ -	$ -
Chlorine			
Plant Inluent	17.1	$ 22.94	$ 392
Settled Water	17.1	$ -	$ -
Filtered Water	17.1	$ -	$ -

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
100% SDR

Ammonia					
Plant Influent	17.1	$	2.14	$	37
Filtered Water	17.1	$	-	$	-
PACL					
Plant Influent	17.1	$	181.48	$	3,103
Settled Water	17.1	$	-	$	-
Backwash Recovery System	0	$	-	$	-
Cationic Polymer					
Plant Influent	17.1	$	9.64	$	165
Settled Water	17.1	$	-	$	-
Caustic					
Settled Water	17.1	$	-	$	-
Filtered Water	17.1	$	13.34	$	228
Anionic Polymer					
Settled Water	17.1	$	-	$	-
Sludge Aid					
Centrifuge	0.0 dry tons		$17.50/dry ton	$	-
Polymer - Actiflo System					
Backwash Recovery System	0	$	-	$	-
TOTAL ($/AC-FT)				**$**	**78**

RESIDUAL MANAGEMENT COSTS	**AMOUNT Dry Tons**		**UNIT COST $/Dry Ton**		**DAILY COST $**
Solids Disposal (Centrifuge)	0	$	88.13	$	-
Contract Solids Management (Drying Beds)	2.93			$	542
Solids Disposal (Drying Beds)	0.79	$	88.13	$	69
TOTAL ($/AC-FT)				**$**	**12**

LABOR COSTS	**FULL-TIME EMPLOYEES**		**UNIT COST $/Employee/Day**		**DAILY COST $**
Plant	12	$	415	$	4,984
Actiflo	1	$	415	$	-
Mechanical Dewatering	1	$	415	$	-
TOTAL ($/AC-FT)				**$**	**95**

MAINTENANCE COSTS			**ANNUAL COST $**		**DAILY COST $**
Plant Maintenance	-	$	1,379,428	$	3,779.3
TOTAL ($/AC-FT)				**$**	**72**

CAPITAL IMPROVEMENTS		**CAPITAL COST**		**ANNUAL COST $**		**DAILY COST $**
180 MG Storage Facility (100% Treated CWA Option)	$	-	$	-	$	-
TOTAL ($/AC-FT)					**$**	**-**

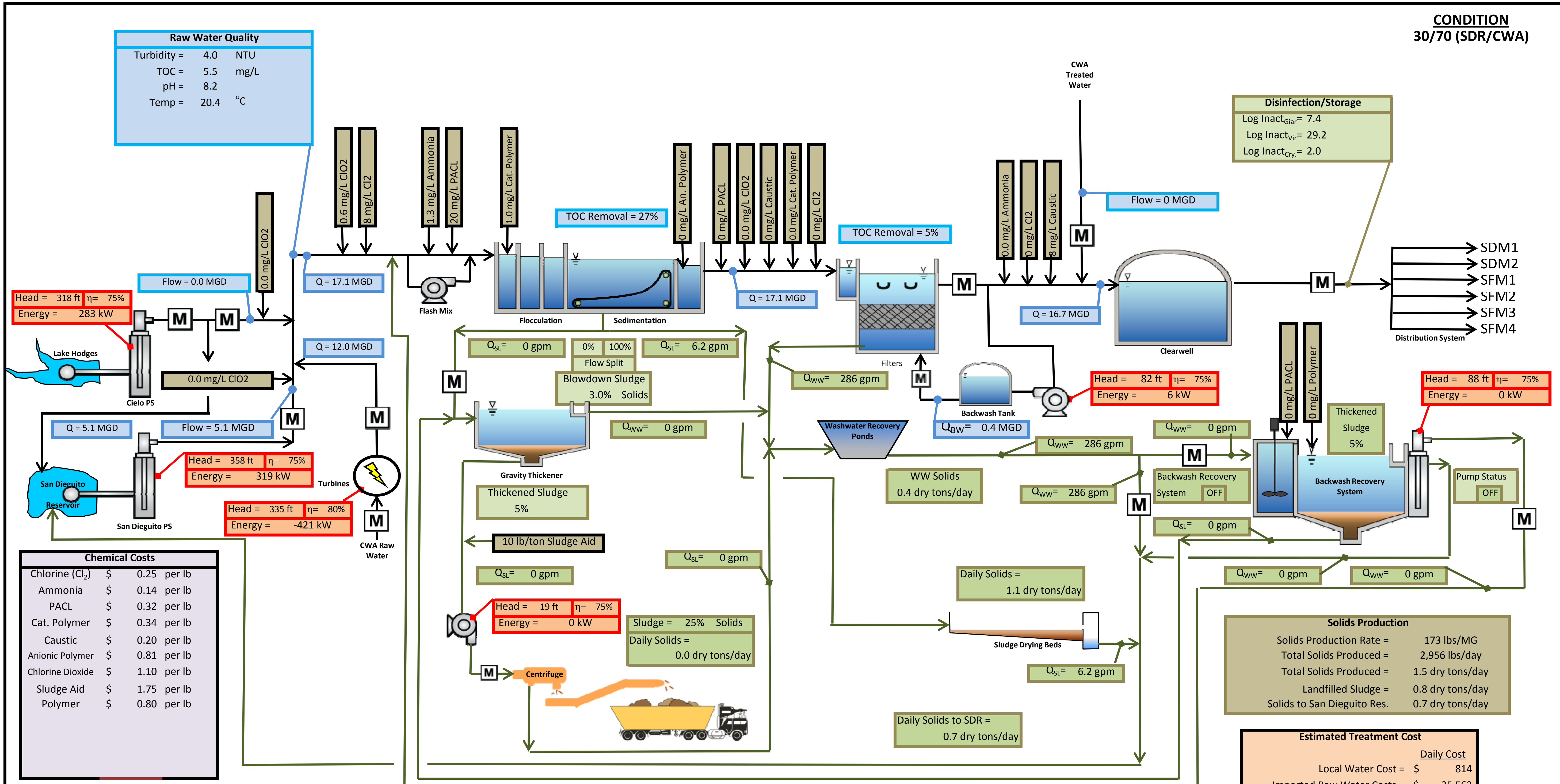
SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
100% SDR

SUMMARY COSTS

CATEGORY	DAILY COST $	COST $/AC-FT
Water Purchase Costs	$ 2,729	$ 52
Imported Supply Fixed Costs	$ 9,819	$ 187
Power Costs	$ 7,080	$ 135
Power Generation	$ -	$ -
Chemical	$ 4,081	$ 78
Solids Management	$ 612	$ 12
Labor	$ 4,984	$ 95
Maintenance	$ 3,779	$ 72
Subtotal	*$ 33,085*	*$ 631*
Capital Improvements	$ -	$ -
TOTAL COST	**$ 33,085**	**$ 631**

PROCESS EVALUATION MODEL

R. E. BADGER WATER FILTRATION PLANT



Chemical Costs			
Chlorine (Cl_2)	$	0.25	per lb
Ammonia	$	0.14	per lb
PACL	$	0.32	per lb
Cat. Polymer	$	0.34	per lb
Caustic	$	0.20	per lb
Anionic Polymer	$	0.81	per lb
Chlorine Dioxide	$	1.10	per lb
Sludge Aid	$	1.75	per lb
Polymer	$	0.80	per lb

Solids Production	
Solids Production Rate =	173 lbs/MG
Total Solids Produced =	2,956 lbs/day
Total Solids Produced =	1.5 dry tons/day
Landfilled Sludge =	0.8 dry tons/day
Solids to San Dieguito Res.	0.7 dry tons/day

Estimated Treatment Cost		Daily Cost
Local Water Cost =	$	814
Imported Raw Water Costs =	$	35,563
CWA Treated Water Costs =	$	-
Chemical =	$	1,594
Power =	$	3,682
Hydroturbines Income =	$	(1,010)
Solids Disposal =	$	612
Labor Costs =	$	4,984
Maint./CIP Costs =	$	3,779
Total Treatment Cost =	**$**	**50,018**
$/ac-ft =	**$**	**953**

Chemical Feed Dosages - Pretreatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Cielo ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
SDR ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Influent ClO_2	0.6 mg/L	5.0 lbs/MG	$5.48/MG	$ 93.77
Cl_2	7.5 mg/L	62.6 lbs/MG	$15.64/MG	$ 267.40
Ammonia	1.3 mg/L	10.4 lbs/MG	$1.46/MG	$ 24.96
PACL	20.4 mg/L	170.1 lbs/MG	$54.44/MG	$ 930.98
Cat. Polymer	1.0 mg/L	8.3 lbs/MG	$2.84/MG	$ 48.49

Chemical Feed Dosages - Settled Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
PACL	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Caustic	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cat. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
An. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -

Chemical Feed Dosages - Finished Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
Ammonia	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Caustic	8.0 mg/L	67 lbs/MG	$13.34/MG	$ 228.06

Chemical Feed Dosages - Residuals Treatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Sludge Aid	10.0 lb/ton	0.0 lbs/MG	$0.00/MG	$ -
PACL	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Polymer	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -

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SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
30/70 (SDR/CWA)

WATER PURCHASE COSTS	VOLUME MG	UNIT COST $/AC-FT	DAILY COST $
CWA Raw (Imported)	12.0	$ 699.00	$ 25,744
Lake Hodges (Local)	5.1	$ 52.00	$ 814
CWA Treated Water	0	$ 924.00	$ -
TOTAL ($/AC-FT)			**$ 506**

IMPORTED SUPPLY FIXED COST	ANNUAL COST $	DAILY COST $
SFID	$ 2,335,558.00	$ 6,399
SDWD	$ 1,248,537.00	$ 3,421
TOTAL ($/AC-FT)		**$ 187**

ELECTRICAL COSTS	VOLUME MG	UNIT COST $/MG	DAILY COST $
Cielo Pump Station	5.1	$ 133.20	$ 679
San Dieguito Pump Station	5.1	$ 149.95	$ 765
Backwash Pump	0	$ 34.35	$ 14
Base Energy Cost (per day)		$ 125.00	$ 125
Plant Energy Costs	17.1	$ 122.76	$ 2,099
Actiflo System			
Cost (per day)	-	$ 70.00	$ -
Vertical Turbine Pumps	0	$ 36.86	$ -
Dewatering			
Cost (per day)	-	$ 75.00	$ -
Pumping Costs	0	$ 7.96	$ -
Hydroturbines	12.0	$ 84.19	$ (1,010)
TOTAL ($/AC-FT)			**$ 51**

CHEMICAL COSTS	VOLUME MG	UNIT COST $/MG	DAILY COST $
Chlorine Dioxide			
Cielo Pipeline	0.0	$ -	$ -
SDPS Pipeline	5.1	$ -	$ -
Plant Inluent	17.1	$ 5.48	$ 94
Settled Water	17.1	$ -	$ -
Chlorine			
Plant Inluent	17.1	$ 15.64	$ 267
Settled Water	17.1	$ -	$ -
Filtered Water	17.1	$ -	$ -

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
30/70 (SDR/CWA)

Ammonia			
Plant Influent	17.1	$ 1.46	$ 25
Filtered Water	17.1	$ -	$ -
PACL			
Plant Influent	17.1	$ 54.44	$ 931
Settled Water	17.1	$ -	$ -
Backwash Recovery System	0	$ -	$ -
Cationic Polymer			
Plant Influent	17.1	$ 2.84	$ 48
Settled Water	17.1	$ -	$ -
Caustic			
Settled Water	17.1	$ -	$ -
Filtered Water	17.1	$ 13.34	$ 228
Anionic Polymer			
Settled Water	17.1	$ -	$ -
Sludge Aid			
Centrifuge	0.0 dry tons	$17.50/dry ton	$ -
Polymer - Actiflo System			
Backwash Recovery System	0	$ -	$ -
TOTAL ($/AC-FT)			**$ 30**

RESIDUAL MANAGEMENT COSTS	AMOUNT Dry Tons	UNIT COST $/Dry Ton	DAILY COST $
Solids Disposal (Centrifuge)	0	$ 88.13	$ -
Contract Solids Management (Drying Beds)	1.11		$ 542
Solids Disposal (Drying Beds)	0.79	$ 88.13	$ 69
TOTAL ($/AC-FT)			**$ 12**

LABOR COSTS	FULL-TIME EMPLOYEES	UNIT COST $/Employee/Day	DAILY COST $
Plant	12	$ 415	$ 4,984
Actiflo	1	$ 415	$ -
Mechanical Dewatering	1	$ 415	$ -
TOTAL ($/AC-FT)			**$ 95**

MAINTENANCE COSTS		ANNUAL COST $	DAILY COST $
Plant Maintenance	-	$ 1,379,428	$ 3,779.3
TOTAL ($/AC-FT)			**$ 72**

CAPITAL IMPROVEMENTS	CAPITAL COST	ANNUAL COST $	DAILY COST $
180 MG Storage Facility (100% Treated CWA Option)	$ -	$ -	$ -
TOTAL ($/AC-FT)			**$ -**

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
30/70 (SDR/CWA)

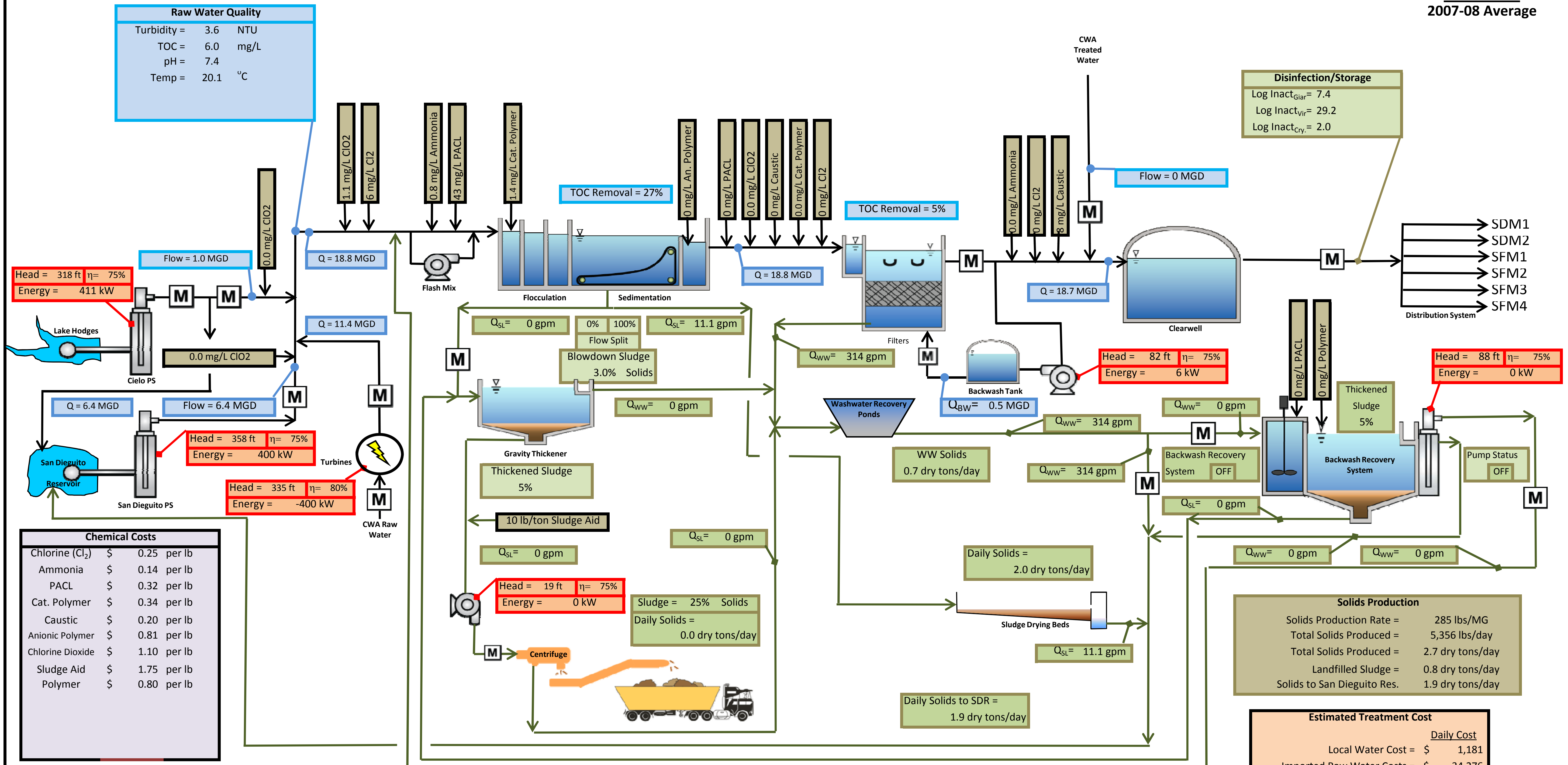
SUMMARY COSTS

CATEGORY	DAILY COST $	COST $/AC-FT
Water Purchase Costs	$ 26,558	$ 506
Imported Supply Fixed Costs	$ 9,819	$ 187
Power Costs	$ 3,682	$ 70
Power Generation	$ (1,010)	$ (19)
Chemical	$ 1,594	$ 30
Solids Management	$ 612	$ 12
Labor	$ 4,984	$ 95
Maintenance	$ 3,779	$ 72
Subtotal	*$ 50,018*	*$ 953*
Capital Improvements	$ -	$ -
TOTAL COST	**$ 50,018**	**$ 953**

PROCESS EVALUATION MODEL

R. E. BADGER WATER FILTRATION PLANT

CONDITION
2007-08 Average



Chemical Costs			
Chlorine (Cl_2)	$	0.25	per lb
Ammonia	$	0.14	per lb
PACL	$	0.32	per lb
Cat. Polymer	$	0.34	per lb
Caustic	$	0.20	per lb
Anionic Polymer	$	0.81	per lb
Chlorine Dioxide	$	1.10	per lb
Sludge Aid	$	1.75	per lb
Polymer	$	0.80	per lb

Solids Production	
Solids Production Rate =	285 lbs/MG
Total Solids Produced =	5,356 lbs/day
Total Solids Produced =	2.7 dry tons/day
Landfilled Sludge =	0.8 dry tons/day
Solids to San Dieguito Res.	1.9 dry tons/day

Estimated Treatment Cost		
		Daily Cost
Local Water Cost =	$	1,181
Imported Raw Water Costs =	$	34,276
CWA Treated Water Costs =	$	1,134
Chemical =	$	2,900
Power =	$	4,394
Hydroturbines Income =	$	(960)
Solids Disposal =	$	612
Labor Costs =	$	4,984
Maint./CIP Costs =	$	3,779
Total Treatment Cost =	**$**	**52,301**
$/ac-ft =	**$**	**888**

Chemical Feed Dosages - Pretreatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Cielo ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
SDR ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Influent ClO_2	1.1 mg/L	9.2 lbs/MG	$10.05/MG	$ 189.00
Cl_2	5.5 mg/L	45.9 lbs/MG	$11.47/MG	$ 215.59
Ammonia	0.8 mg/L	6.7 lbs/MG	$0.93/MG	$ 17.56
PACL	42.9 mg/L	357.8 lbs/MG	$114.49/MG	$ 2,152.44
Cat. Polymer	1.4 mg/L	11.7 lbs/MG	$3.97/MG	$ 74.63

Chemical Feed Dosages - Settled Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
PACL	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Caustic	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cat. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
An. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -

Chemical Feed Dosages - Finished Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
Ammonia	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Caustic	8.0 mg/L	67 lbs/MG	$13.34/MG	$ 250.65

Chemical Feed Dosages - Residuals Treatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Sludge Aid	10.0 lb/ton	0.0 lbs/MG	$0.00/MG	$ -
PACL	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Polymer	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -

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SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
2007-08 Average

WATER PURCHASE COSTS	**VOLUME MG**	**UNIT COST $/AC-FT**	**DAILY COST $**
CWA Raw (Imported)	11.4	$ 699.00	$ 24,456
Lake Hodges (Local)	7.4	$ 52.00	$ 1,181
CWA Treated Water	0.4	$ 924.00	$ 1,134
TOTAL ($/AC-FT)			**$ 454**

IMPORTED SUPPLY FIXED COST	**ANNUAL COST $**	**DAILY COST $**
SFID	$ 2,335,558.00	$ 6,399
SDWD	$ 1,248,537.00	$ 3,421
TOTAL ($/AC-FT)		**$ 167**

ELECTRICAL COSTS	**VOLUME MG**	**UNIT COST $/MG**	**DAILY COST $**
Cielo Pump Station	7.4	$ 133.20	$ 986
San Dieguito Pump Station	6.4	$ 149.95	$ 960
Backwash Pump	0	$ 34.35	$ 16
Base Energy Cost (per day)		$ 125.00	$ 125
Plant Energy Costs	18.8	$ 122.76	$ 2,308
Actiflo System			
Cost (per day)	-	$ 70.00	$ -
Vertical Turbine Pumps	0	$ 36.86	$ -
Dewatering			
Cost (per day)	-	$ 75.00	$ -
Pumping Costs	0	$ 7.96	$ -
Hydroturbines	11.4	$ 84.19	$ (960)
TOTAL ($/AC-FT)			**$ 58**

CHEMICAL COSTS	**VOLUME MG**	**UNIT COST $/MG**	**DAILY COST $**
Chlorine Dioxide			
Cielo Pipeline	1.0	$ -	$ -
SDPS Pipeline	6.4	$ -	$ -
Plant Inluent	18.8	$ 10.05	$ 189
Settled Water	18.8	$ -	$ -
Chlorine			
Plant Inluent	18.8	$ 11.47	$ 216
Settled Water	18.8	$ -	$ -
Filtered Water	18.8	$ -	$ -

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
2007-08 Average

Ammonia			
Plant Influent	18.8	$ 0.93	$ 18
Filtered Water	18.8	$ -	$ -
PACL			
Plant Influent	18.8	$ 114.49	$ 2,152
Settled Water	18.8	$ -	$ -
Backwash Recovery System	0	$ -	$ -
Cationic Polymer			
Plant Influent	18.8	$ 3.97	$ 75
Settled Water	18.8	$ -	$ -
Caustic			
Settled Water	18.8	$ -	$ -
Filtered Water	18.8	$ 13.34	$ 251
Anionic Polymer			
Settled Water	18.8	$ -	$ -
Sludge Aid			
Centrifuge	0.0 dry tons	$17.50/dry ton	$ -
Polymer - Actiflo System			
Backwash Recovery System	0	$ -	$ -
TOTAL ($/AC-FT)			**$ 49**

RESIDUAL MANAGEMENT COSTS	**AMOUNT Dry Tons**	**UNIT COST $/Dry Ton**	**DAILY COST $**
Solids Disposal (Centrifuge)	0	$ 88.13	$ -
Contract Solids Management (Drying Beds)	2.01		$ 542
Solids Disposal (Drying Beds)	0.79	$ 88.13	$ 69
TOTAL ($/AC-FT)			**$ 10**

LABOR COSTS	**FULL-TIME EMPLOYEES**	**UNIT COST $/Employee/Day**	**DAILY COST $**
Plant	12	$ 415	$ 4,984
Actiflo	1	$ 415	$ -
Mechanical Dewatering	1	$ 415	$ -
TOTAL ($/AC-FT)			**$ 85**

MAINTENANCE COSTS		**ANNUAL COST $**	**DAILY COST $**
Plant Maintenance	-	$ 1,379,428	$ 3,779.3
TOTAL ($/AC-FT)			**$ 64**

CAPITAL IMPROVEMENTS	**CAPITAL COST**	**ANNUAL COST $**	**DAILY COST $**
180 MG Storage Facility (100% Treated CWA Option)	$ -	$ -	$ -
TOTAL ($/AC-FT)			**$ -**

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
2007-08 Average

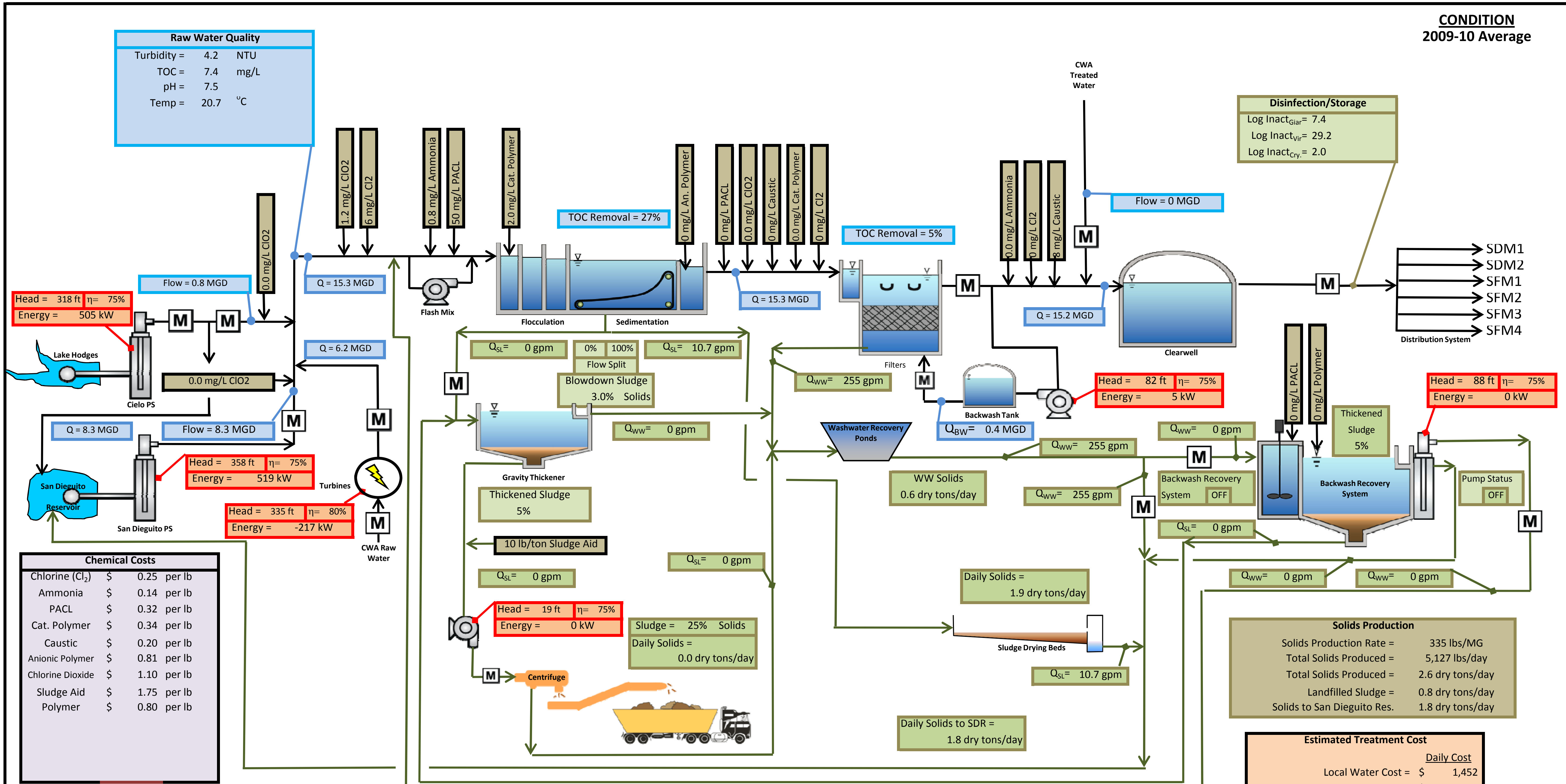
SUMMARY COSTS

CATEGORY	DAILY COST $	COST $/AC-FT
Water Purchase Costs	$ 26,772	$ 454
Imported Supply Fixed Costs	$ 9,819	$ 167
Power Costs	$ 4,394	$ 75
Power Generation	$ (960)	$ (16)
Chemical	$ 2,900	$ 49
Solids Management	$ 612	$ 10
Labor	$ 4,984	$ 85
Maintenance	$ 3,779	$ 64
Subtotal	*$ 52,301*	*$ 888*
Capital Improvements	$ -	$ -
TOTAL COST	**$ 52,301**	**$ 888**

PROCESS EVALUATION MODEL

R. E. BADGER WATER FILTRATION PLANT

CONDITION
2009-10 Average



Chemical Costs

Chlorine (Cl_2)	$	0.25	per lb
Ammonia	$	0.14	per lb
PACL	$	0.32	per lb
Cat. Polymer	$	0.34	per lb
Caustic	$	0.20	per lb
Anionic Polymer	$	0.81	per lb
Chlorine Dioxide	$	1.10	per lb
Sludge Aid	$	1.75	per lb
Polymer	$	0.80	per lb

Solids Production

Solids Production Rate =	335 lbs/MG
Total Solids Produced =	5,127 lbs/day
Total Solids Produced =	2.6 dry tons/day
Landfilled Sludge =	0.8 dry tons/day
Solids to San Dieguito Res.	1.8 dry tons/day

Chemical Feed Dosages - Pretreatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Cielo ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
SDR ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Influent ClO_2	1.2 mg/L	10.0 lbs/MG	$10.97/MG	$ 167.80
Cl_2	6.3 mg/L	52.5 lbs/MG	$13.14/MG	$ 200.97
Ammonia	0.8 mg/L	6.7 lbs/MG	$0.93/MG	$ 14.29
PACL	49.8 mg/L	415.3 lbs/MG	$132.91/MG	$ 2,033.47
Cat. Polymer	2.0 mg/L	16.7 lbs/MG	$5.67/MG	$ 86.77

Chemical Feed Dosages - Settled Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
PACL	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Caustic	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cat. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
An. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -

Chemical Feed Dosages - Finished Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
Ammonia	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Caustic	8.1 mg/L	68 lbs/MG	$13.51/MG	$ 206.51

Chemical Feed Dosages - Residuals Treatment

Sludge Aid	10.0 lb/ton	0.0 lbs/MG	$0.00/MG	$ -
PACL	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Polymer	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -

Estimated Treatment Cost

	Daily Cost
Local Water Cost =	$ 1,452
Imported Raw Water Costs =	$ 23,120
CWA Treated Water Costs =	$ 851
Chemical =	$ 2,710
Power =	$ 4,473
Hydroturbines Income =	$ (522)
Solids Disposal =	$ 612
Labor Costs =	$ 4,984
Maint./CIP Costs =	$ 3,779
Total Treatment Cost =	**$ 41,459**
$/ac-ft =	**$ 866**

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SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
2009-10 Average

WATER PURCHASE COSTS	**VOLUME MG**	**UNIT COST $/AC-FT**	**DAILY COST $**
CWA Raw (Imported)	6.2	$ 699.00	$ 13,301
Lake Hodges (Local)	9.1	$ 52.00	$ 1,452
CWA Treated Water	0.3	$ 924.00	$ 851
TOTAL ($/AC-FT)			**$ 326**

IMPORTED SUPPLY FIXED COST	**ANNUAL COST $**	**DAILY COST $**
SFID	$ 2,335,558.00	$ 6,399
SDWD	$ 1,248,537.00	$ 3,421
TOTAL ($/AC-FT)		**$ 205**

ELECTRICAL COSTS	**VOLUME MG**	**UNIT COST $/MG**	**DAILY COST $**
Cielo Pump Station	9.1	$ 133.20	$ 1,212
San Dieguito Pump Station	8.3	$ 149.95	$ 1,245
Backwash Pump	0	$ 34.35	$ 13
Base Energy Cost (per day)		$ 125.00	$ 125
Plant Energy Costs	15.3	$ 122.76	$ 1,878
Actiflo System			
Cost (per day)	-	$ 70.00	$ -
Vertical Turbine Pumps	0	$ 36.86	$ -
Dewatering			
Cost (per day)	-	$ 75.00	$ -
Pumping Costs	0	$ 7.96	$ -
Hydroturbines	6.2	$ 84.19	$ (522)
TOTAL ($/AC-FT)			**$ 83**

CHEMICAL COSTS	**VOLUME MG**	**UNIT COST $/MG**	**DAILY COST $**
Chlorine Dioxide			
Cielo Pipeline	0.8	$ -	$ -
SDPS Pipeline	8.3	$ -	$ -
Plant Inluent	15.3	$ 10.97	$ 168
Settled Water	15.3	$ -	$ -
Chlorine			
Plant Inluent	15.3	$ 13.14	$ 201
Settled Water	15.3	$ -	$ -
Filtered Water	15.3	$ -	$ -

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
2009-10 Average

Ammonia			
Plant Influent	15.3	$ 0.93	$ 14
Filtered Water	15.3	$ -	$ -
PACL			
Plant Influent	15.3	$ 132.91	$ 2,033
Settled Water	15.3	$ -	$ -
Backwash Recovery System	0	$ -	$ -
Cationic Polymer			
Plant Influent	15.3	$ 5.67	$ 87
Settled Water	15.3	$ -	$ -
Caustic			
Settled Water	15.3	$ -	$ -
Filtered Water	15.3	$ 13.51	$ 207
Anionic Polymer			
Settled Water	15.3	$ -	$ -
Sludge Aid			
Centrifuge	0.0 dry tons	$17.50/dry ton	$ -
Polymer - Actiflo System			
Backwash Recovery System	0	$ -	$ -
TOTAL ($/AC-FT)			**$ 57**

RESIDUAL MANAGEMENT COSTS	AMOUNT Dry Tons	UNIT COST $/Dry Ton	DAILY COST $
Solids Disposal (Centrifuge)	0	$ 88.13	$ -
Contract Solids Management (Drying Beds)	1.92		$ 542
Solids Disposal (Drying Beds)	0.79	$ 88.13	$ 69
TOTAL ($/AC-FT)			**$ 13**

LABOR COSTS	FULL-TIME EMPLOYEES	UNIT COST $/Employee/Day	DAILY COST $
Plant	12	$ 415	$ 4,984
Actiflo	1	$ 415	$ -
Mechanical Dewatering	1	$ 415	$ -
TOTAL ($/AC-FT)			**$ 104**

MAINTENANCE COSTS		ANNUAL COST $	DAILY COST $
Plant Maintenance	-	$ 1,379,428	$ 3,779.3
TOTAL ($/AC-FT)			**$ 79**

CAPITAL IMPROVEMENTS	CAPITAL COST	ANNUAL COST $	DAILY COST $
180 MG Storage Facility (100% Treated CWA Option)	$ -	$ -	$ -
TOTAL ($/AC-FT)			**$ -**

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
2009-10 Average

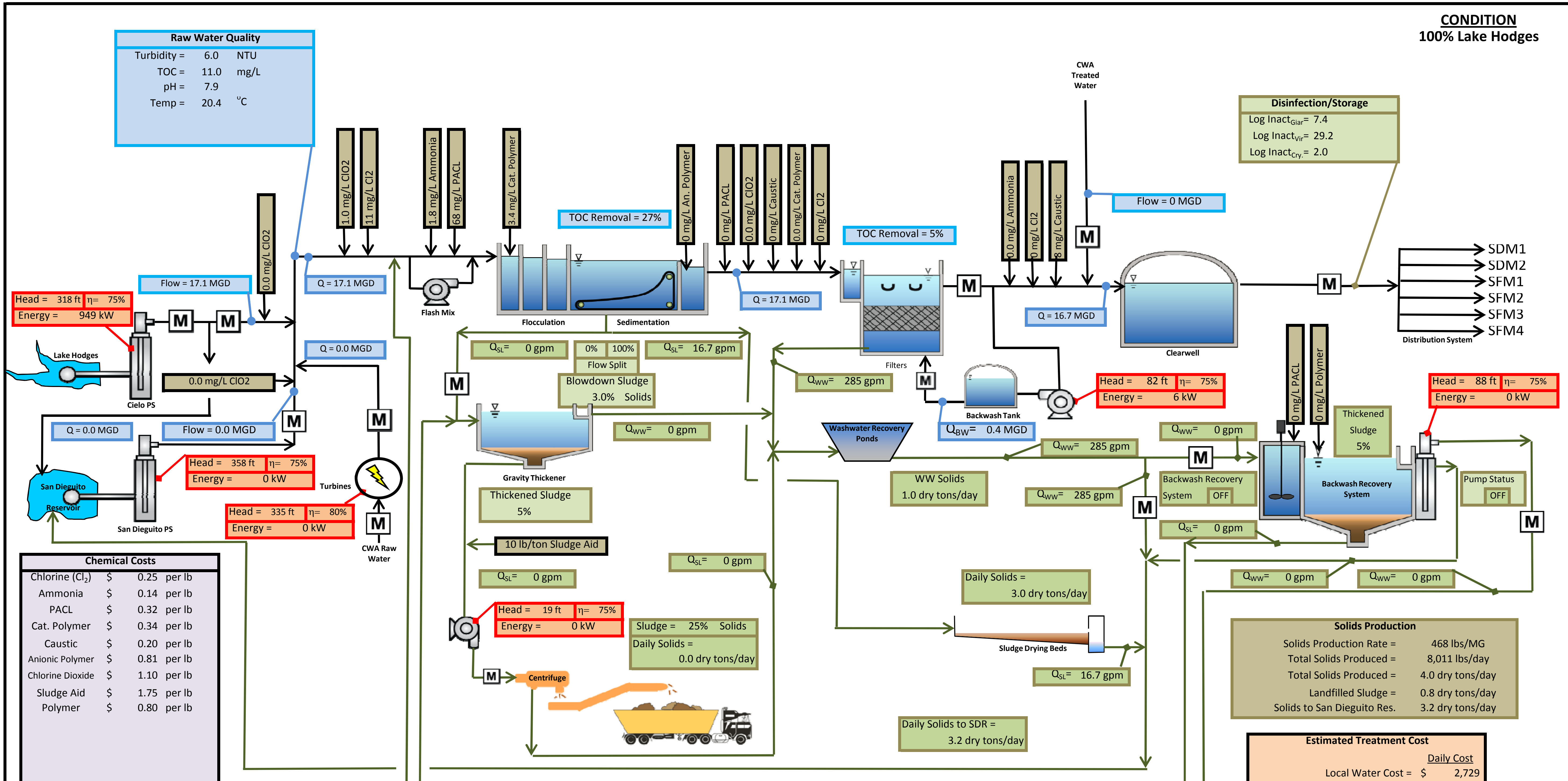
SUMMARY COSTS

CATEGORY	DAILY COST $	COST $/AC-FT
Water Purchase Costs	$ 15,604	$ 326
Imported Supply Fixed Costs	$ 9,819	$ 205
Power Costs	$ 4,473	$ 93
Power Generation	$ (522)	$ (11)
Chemical	$ 2,710	$ 57
Solids Management	$ 612	$ 13
Labor	$ 4,984	$ 104
Maintenance	$ 3,779	$ 79
Subtotal	*$ 41,459*	*$ 866*
Capital Improvements	$ -	$ -
TOTAL COST	**$ 41,459**	**$ 866**

PROCESS EVALUATION MODEL

R. E. BADGER WATER FILTRATION PLANT

CONDITION
100% Lake Hodges



Chemical Costs			
Chlorine (Cl_2)	$	0.25	per lb
Ammonia	$	0.14	per lb
PACL	$	0.32	per lb
Cat. Polymer	$	0.34	per lb
Caustic	$	0.20	per lb
Anionic Polymer	$	0.81	per lb
Chlorine Dioxide	$	1.10	per lb
Sludge Aid	$	1.75	per lb
Polymer	$	0.80	per lb

Solids Production

Solids Production Rate =	468 lbs/MG
Total Solids Produced =	8,011 lbs/day
Total Solids Produced =	4.0 dry tons/day
Landfilled Sludge =	0.8 dry tons/day
Solids to San Dieguito Res.	3.2 dry tons/day

Estimated Treatment Cost

		Daily Cost
Local Water Cost =	$	2,729
Imported Raw Water Costs =	$	9,819
CWA Treated Water Costs =	$	-
Chemical =	$	4,081
Power =	$	4,516
Hydroturbines Income =	$	-
Solids Disposal =	$	612
Labor Costs =	$	4,984
Maint./CIP Costs =	$	3,779
Total Treatment Cost =	**$**	**30,521**
$/ac-ft =	**$**	**582**

Chemical Feed Dosages - Pretreatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Cielo ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
SDR ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Influent ClO_2	1.0 mg/L	8.3 lbs/MG	$9.14/MG	$ 156.28
Cl_2	11.0 mg/L	91.7 lbs/MG	$22.94/MG	$ 392.19
Ammonia	1.8 mg/L	15.3 lbs/MG	$2.14/MG	$ 36.60
PACL	68.0 mg/L	567.1 lbs/MG	$181.48/MG	$ 3,103.28
Cat. Polymer	3.4 mg/L	28.4 lbs/MG	$9.64/MG	$ 164.86

Chemical Feed Dosages - Settled Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
PACL	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Caustic	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cat. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
An. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -

Chemical Feed Dosages - Finished Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
Ammonia	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Caustic	8.0 mg/L	67 lbs/MG	$13.34/MG	$ 227.86

Chemical Feed Dosages - Residuals Treatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Sludge Aid	10.0 lb/ton	0.0 lbs/MG	$0.00/MG	$ -
PACL	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Polymer	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
100% Lake Hodges

WATER PURCHASE COSTS	VOLUME MG	UNIT COST $/AC-FT	DAILY COST $
CWA Raw (Imported)	0.0	$ 699.00	$ -
Lake Hodges (Local)	17.1	$ 52.00	$ 2,729
CWA Treated Water	0	$ 924.00	$ -
TOTAL ($/AC-FT)			**$ 52**

IMPORTED SUPPLY FIXED COST	ANNUAL COST $	DAILY COST $
SFID	$ 2,335,558.00	$ 6,399
SDWD	$ 1,248,537.00	$ 3,421
TOTAL ($/AC-FT)		**$ 187**

ELECTRICAL COSTS	VOLUME MG	UNIT COST $/MG	DAILY COST $
Cielo Pump Station	17.1	$ 133.20	$ 2,278
San Dieguito Pump Station	0.0	$ 149.95	$ -
Backwash Pump	0	$ 34.35	$ 14
Base Energy Cost (per day)		$ 125.00	$ 125
Plant Energy Costs	17.1	$ 122.76	$ 2,099
Actiflo System			
Cost (per day)	-	$ 70.00	$ -
Vertical Turbine Pumps	0	$ 36.86	$ -
Dewatering			
Cost (per day)	-	$ 75.00	$ -
Pumping Costs	0	$ 7.96	$ -
Hydroturbines	0.0	$ 84.19	$ -
TOTAL ($/AC-FT)			**$ 86**

CHEMICAL COSTS	VOLUME MG	UNIT COST $/MG	DAILY COST $
Chlorine Dioxide			
Cielo Pipeline	17.1	$ -	$ -
SDPS Pipeline	0.0	$ -	$ -
Plant Inluent	17.1	$ 9.14	$ 156
Settled Water	17.1	$ -	$ -
Chlorine			
Plant Inluent	17.1	$ 22.94	$ 392
Settled Water	17.1	$ -	$ -
Filtered Water	17.1	$ -	$ -

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
100% Lake Hodges

Ammonia					
Plant Influent	17.1	$	2.14	$	37
Filtered Water	17.1	$	-	$	-
PACL					
Plant Influent	17.1	$	181.48	$	3,103
Settled Water	17.1	$	-	$	-
Backwash Recovery System	0	$	-	$	-
Cationic Polymer					
Plant Influent	17.1	$	9.64	$	165
Settled Water	17.1	$	-	$	-
Caustic					
Settled Water	17.1	$	-	$	-
Filtered Water	17.1	$	13.34	$	228
Anionic Polymer					
Settled Water	17.1	$	-	$	-
Sludge Aid					
Centrifuge	0.0 dry tons		$17.50/dry ton	$	-
Polymer - Actiflo System					
Backwash Recovery System	0	$	-	$	-
TOTAL ($/AC-FT)				**$**	**78**

RESIDUAL MANAGEMENT COSTS	**AMOUNT Dry Tons**		**UNIT COST $/Dry Ton**		**DAILY COST $**
Solids Disposal (Centrifuge)	0	$	88.13	$	-
Contract Solids Management (Drying Beds)	3.00			$	542
Solids Disposal (Drying Beds)	0.79	$	88.13	$	69
TOTAL ($/AC-FT)				**$**	**12**

LABOR COSTS	**FULL-TIME EMPLOYEES**		**UNIT COST $/Employee/Day**		**DAILY COST $**
Plant	12	$	415	$	4,984
Actiflo	1	$	415	$	-
Mechanical Dewatering	1	$	415	$	-
TOTAL ($/AC-FT)				**$**	**95**

MAINTENANCE COSTS			**ANNUAL COST $**		**DAILY COST $**
Plant Maintenance	-	$	1,379,428	$	3,779.3
TOTAL ($/AC-FT)				**$**	**72**

CAPITAL IMPROVEMENTS		**CAPITAL COST**		**ANNUAL COST $**		**DAILY COST $**
180 MG Storage Facility (100% Treated CWA Option)	$	-	$	-	$	-
TOTAL ($/AC-FT)					**$**	**-**

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
100% Lake Hodges

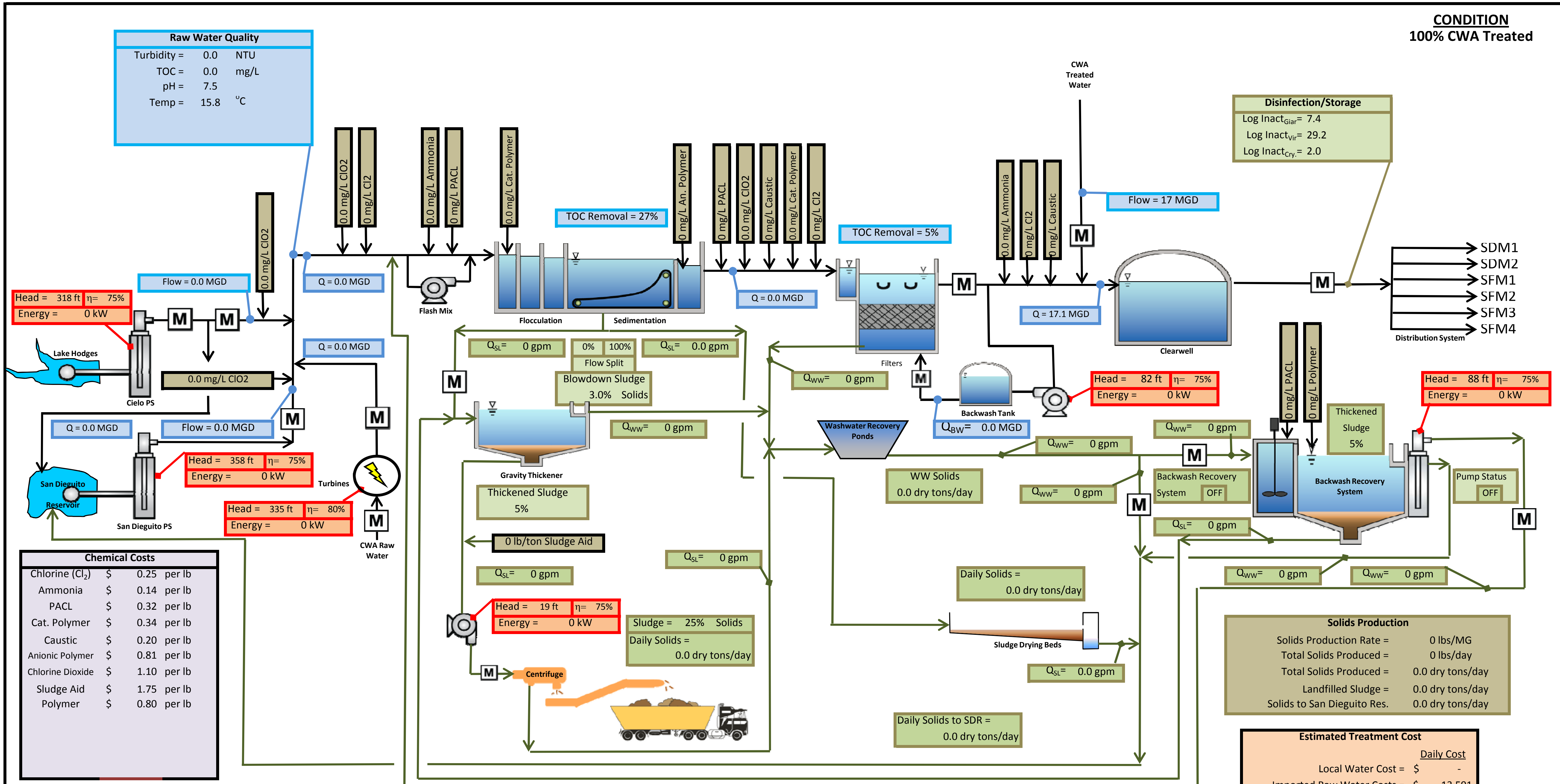
SUMMARY COSTS

CATEGORY	DAILY COST $	COST $/AC-FT
Water Purchase Costs	$ 2,729	$ 52
Imported Supply Fixed Costs	$ 9,819	$ 187
Power Costs	$ 4,516	$ 86
Power Generation	$ -	$ -
Chemical	$ 4,081	$ 78
Solids Management	$ 612	$ 12
Labor	$ 4,984	$ 95
Maintenance	$ 3,779	$ 72
Subtotal	*$ 30,521*	*$ 582*
Capital Improvements	$ -	$ -
TOTAL COST	**$ 30,521**	**$ 582**

PROCESS EVALUATION MODEL

R. E. BADGER WATER FILTRATION PLANT

CONDITION
100% CWA Treated



Chemical Costs			
Chlorine (Cl_2)	$	0.25	per lb
Ammonia	$	0.14	per lb
PACL	$	0.32	per lb
Cat. Polymer	$	0.34	per lb
Caustic	$	0.20	per lb
Anionic Polymer	$	0.81	per lb
Chlorine Dioxide	$	1.10	per lb
Sludge Aid	$	1.75	per lb
Polymer	$	0.80	per lb

Solids Production	
Solids Production Rate =	0 lbs/MG
Total Solids Produced =	0 lbs/day
Total Solids Produced =	0.0 dry tons/day
Landfilled Sludge =	0.0 dry tons/day
Solids to San Dieguito Res.	0.0 dry tons/day

Chemical Feed Dosages - Pretreatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Cielo ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
SDR ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Influent ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Ammonia	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
PACL	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cat. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -

Chemical Feed Dosages - Settled Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
PACL	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Caustic	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cat. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
An. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -

Chemical Feed Dosages - Finished Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
Ammonia	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Caustic	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -

Chemical Feed Dosages - Residuals Treatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Sludge Aid	0.0 lb/ton	#DIV/0!	#DIV/0!	#DIV/0!
PACL	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Polymer	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -

Estimated Treatment Cost

	Daily Cost
Local Water Cost =	$ -
Imported Raw Water Costs =	$ 13,591
CWA Treated Water Costs =	$ 48,493
Chemical =	$ -
Power =	$ 125
Hydroturbines Income =	$ -
Solids Disposal =	$ -
Labor Costs =	$ -
Maint./CIP Costs =	$ 24,060
Total Treatment Cost =	**$ 86,269**
$/ac-ft =	**$ 1,643**

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SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
100% CWA Treated

WATER PURCHASE COSTS	VOLUME MG	UNIT COST $/AC-FT	DAILY COST $
CWA Raw (Imported)	0.0	$ 699.00	$ -
Lake Hodges (Local)	0.0	$ 52.00	$ -
CWA Treated Water	17.1	$ 924.00	$ 48,493
TOTAL ($/AC-FT)			**$ 924**

IMPORTED SUPPLY FIXED COST	ANNUAL COST $	DAILY COST $
SFID	$ 3,336,512.00	$ 9,141
SDWD	$ 1,624,197.00	$ 4,450
TOTAL ($/AC-FT)		**$ 259**

ELECTRICAL COSTS	VOLUME MG	UNIT COST $/MG	DAILY COST $
Cielo Pump Station	0.0	$ 133.20	$ -
San Dieguito Pump Station	0.0	$ 149.95	$ -
Backwash Pump	0	$ 34.35	$ -
Base Energy Cost (per day)		$ 125.00	$ 125
Plant Energy Costs	0.0	$ 122.76	$ -
Actiflo System			
Cost (per day)	-	$ 70.00	$ -
Vertical Turbine Pumps	0	$ 36.86	$ -
Dewatering			
Cost (per day)	-	$ 75.00	$ -
Pumping Costs	0	$ 7.96	$ -
Hydroturbines	0.0	$ 84.19	$ -
TOTAL ($/AC-FT)			**$ 2**

CHEMICAL COSTS	VOLUME MG	UNIT COST $/MG	DAILY COST $
Chlorine Dioxide			
Cielo Pipeline	0.0	$ -	$ -
SDPS Pipeline	0.0	$ -	$ -
Plant Inluent	0.0	$ -	$ -
Settled Water	0.0	$ -	$ -
Chlorine			
Plant Inluent	0.0	$ -	$ -
Settled Water	0.0	$ -	$ -
Filtered Water	0.0	$ -	$ -

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
100% CWA Treated

Ammonia			
Plant Influent	0.0	$ -	$ -
Filtered Water	0.0	$ -	$ -
PACL			
Plant Influent	0.0	$ -	$ -
Settled Water	0.0	$ -	$ -
Backwash Recovery System	0	$ -	$ -
Cationic Polymer			
Plant Influent	0.0	$ -	$ -
Settled Water	0.0	$ -	$ -
Caustic			
Settled Water	0.0	$ -	$ -
Filtered Water	0.0	$ -	$ -
Anionic Polymer			
Settled Water	0.0	$ -	$ -
Sludge Aid			
Centrifuge	0.0 dry tons	$0.00/dry ton	$ -
Polymer - Actiflo System			
Backwash Recovery System	0	$ -	$ -
TOTAL ($/AC-FT)			**$ -**

RESIDUAL MANAGEMENT COSTS	AMOUNT Dry Tons	UNIT COST $/Dry Ton	DAILY COST $
Solids Disposal (Centrifuge)	0	$ 88.13	$ -
Contract Solids Management (Drying Beds)	0.00		$ -
Solids Disposal (Drying Beds)	0.00	$ 88.13	$ -
TOTAL ($/AC-FT)			**$ -**

LABOR COSTS	FULL-TIME EMPLOYEES	UNIT COST $/Employee/Day	DAILY COST $
Plant	0	$ 415	$ -
Actiflo	0	$ 415	$ -
Mechanical Dewatering	0	$ 415	$ -
TOTAL ($/AC-FT)			**$ -**

MAINTENANCE COSTS		ANNUAL COST $	DAILY COST $
Plant Maintenance	-	$ -	$ -
TOTAL ($/AC-FT)			**$ -**

CAPITAL IMPROVEMENTS	CAPITAL COST	ANNUAL COST $	DAILY COST $
180 MG Storage Facility (100% Treated CWA Option)	$ 135,000,000	$ 8,781,944	$ 24,060.1
TOTAL ($/AC-FT)			**$ 458**

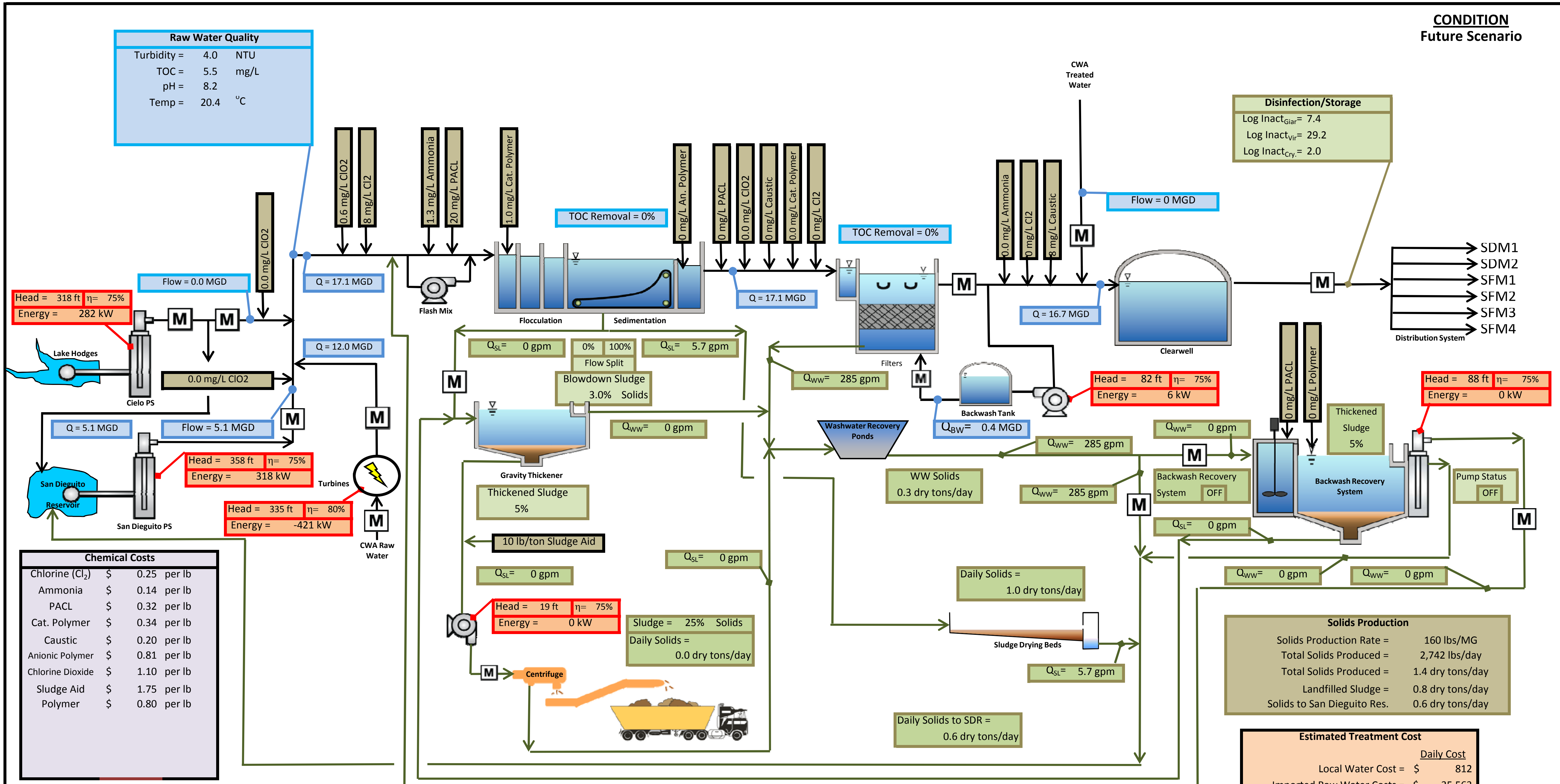
SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
100% CWA Treated

SUMMARY COSTS

CATEGORY	**DAILY COST $**	**COST $/AC-FT**
Water Purchase Costs	$ 48,493	$ 924
Imported Supply Fixed Costs	$ 13,591	$ 259
Power Costs	$ 125	$ 2
Power Generation	$ -	$ -
Chemical	$ -	$ -
Solids Management	$ -	$ -
Labor	$ -	$ -
Maintenance	$ -	$ -
Subtotal	*$ 62,209*	*$ 1,185*
Capital Improvements	$ 24,060	$ 458
TOTAL COST	**$ 86,269**	**$ 1,643**

PROCESS EVALUATION MODEL

R. E. BADGER WATER FILTRATION PLANT



Chemical Costs			
Chlorine (Cl_2)	$	0.25	per lb
Ammonia	$	0.14	per lb
PACL	$	0.32	per lb
Cat. Polymer	$	0.34	per lb
Caustic	$	0.20	per lb
Anionic Polymer	$	0.81	per lb
Chlorine Dioxide	$	1.10	per lb
Sludge Aid	$	1.75	per lb
Polymer	$	0.80	per lb

Solids Production	
Solids Production Rate =	160 lbs/MG
Total Solids Produced =	2,742 lbs/day
Total Solids Produced =	1.4 dry tons/day
Landfilled Sludge =	0.8 dry tons/day
Solids to San Dieguito Res.	0.6 dry tons/day

Estimated Treatment Cost

		Daily Cost
Local Water Cost =	$	812
Imported Raw Water Costs =	$	35,563
CWA Treated Water Costs =	$	-
Chemical =	$	1,594
Power =	$	3,678
Hydroturbines Income =	$	(1,010)
Solids Disposal =	$	612
Labor Costs =	$	4,984
Maint./CIP Costs =	$	3,779
Total Treatment Cost =	**$**	**50,012**
$/ac-ft =	**$**	**953**

Chemical Feed Dosages - Pretreatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Cielo ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
SDR ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Influent ClO_2	0.6 mg/L	5.0 lbs/MG	$5.48/MG	$ 93.71
Cl_2	7.5 mg/L	62.6 lbs/MG	$15.64/MG	$ 267.22
Ammonia	1.3 mg/L	10.8 lbs/MG	$1.52/MG	$ 25.94
PACL	20.4 mg/L	170.1 lbs/MG	$54.44/MG	$ 930.36
Cat. Polymer	1.0 mg/L	8.3 lbs/MG	$2.84/MG	$ 48.46

Chemical Feed Dosages - Settled Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
PACL	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
ClO_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Caustic	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cat. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
An. Polymer	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -

Chemical Feed Dosages - Finished Water

Chemical	Dose	Usage	Unit Cost	Daily Cost
Ammonia	0.0 mg/L	0.0 lbs/MG	$0.00/MG	$ -
Cl_2	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Caustic	8.0 mg/L	67 lbs/MG	$13.34/MG	$ 227.92

Chemical Feed Dosages - Residuals Treatment

Chemical	Dose	Usage	Unit Cost	Daily Cost
Sludge Aid	10.0 lb/ton	0.0 lbs/MG	$0.00/MG	$ -
PACL	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -
Polymer	0.0 mg/L	0 lbs/MG	$0.00/MG	$ -

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SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
Future Scenario

WATER PURCHASE COSTS	**VOLUME MG**	**UNIT COST $/AC-FT**	**DAILY COST $**
CWA Raw (Imported)	12.0	$ 699.00	$ 25,744
Lake Hodges (Local)	5.1	$ 52.00	$ 812
CWA Treated Water	0	$ 924.00	$ -
TOTAL ($/AC-FT)			**$ 506**

IMPORTED SUPPLY FIXED COST	**ANNUAL COST $**	**DAILY COST $**
SFID	$ 2,335,558.00	$ 6,399
SDWD	$ 1,248,537.00	$ 3,421
TOTAL ($/AC-FT)		**$ 187**

ELECTRICAL COSTS	**VOLUME MG**	**UNIT COST $/MG**	**DAILY COST $**
Cielo Pump Station	5.1	$ 133.20	$ 678
San Dieguito Pump Station	5.1	$ 149.95	$ 763
Backwash Pump	0	$ 34.35	$ 14
Base Energy Cost (per day)		$ 125.00	$ 125
Plant Energy Costs	17.1	$ 122.76	$ 2,098
Actiflo System			
Cost (per day)	-	$ 70.00	$ -
Vertical Turbine Pumps	0	$ 36.86	$ -
Dewatering			
Cost (per day)	-	$ 75.00	$ -
Pumping Costs	0	$ 7.96	$ -
Hydroturbines	12.0	$ 84.19	$ (1,010)
TOTAL ($/AC-FT)			**$ 51**

CHEMICAL COSTS	**VOLUME MG**	**UNIT COST $/MG**	**DAILY COST $**
Chlorine Dioxide			
Cielo Pipeline	0.0	$ -	$ -
SDPS Pipeline	5.1	$ -	$ -
Plant Inluent	17.1	$ 5.48	$ 94
Settled Water	17.1	$ -	$ -
Chlorine			
Plant Inluent	17.1	$ 15.64	$ 267
Settled Water	17.1	$ -	$ -
Filtered Water	17.1	$ -	$ -

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
Future Scenario

Ammonia			
Plant Influent	17.1	$ 1.52	$ 26
Filtered Water	17.1	$ -	$ -
PACL			
Plant Influent	17.1	$ 54.44	$ 930
Settled Water	17.1	$ -	$ -
Backwash Recovery System	0	$ -	$ -
Cationic Polymer			
Plant Influent	17.1	$ 2.84	$ 48
Settled Water	17.1	$ -	$ -
Caustic			
Settled Water	17.1	$ -	$ -
Filtered Water	17.1	$ 13.34	$ 228
Anionic Polymer			
Settled Water	17.1	$ -	$ -
Sludge Aid			
Centrifuge	0.0 dry tons	$17.50/dry ton	$ -
Polymer - Actiflo System			
Backwash Recovery System	0	$ -	$ -
TOTAL ($/AC-FT)			**$ 30**

RESIDUAL MANAGEMENT COSTS	**AMOUNT Dry Tons**	**UNIT COST $/Dry Ton**	**DAILY COST $**
Solids Disposal (Centrifuge)	0	$ 88.13	$ -
Contract Solids Management (Drying Beds)	1.03		$ 542
Solids Disposal (Drying Beds)	0.79	$ 88.13	$ 69
TOTAL ($/AC-FT)			**$ 12**

LABOR COSTS	**FULL-TIME EMPLOYEES**	**UNIT COST $/Employee/Day**	**DAILY COST $**
Plant	12	$ 415	$ 4,984
Actiflo	1	$ 415	$ -
Mechanical Dewatering	1	$ 415	$ -
TOTAL ($/AC-FT)			**$ 95**

MAINTENANCE COSTS		**ANNUAL COST $**	**DAILY COST $**
Plant Maintenance	-	$ 1,379,428	$ 3,779.3
TOTAL ($/AC-FT)			**$ 72**

CAPITAL IMPROVEMENTS	**CAPITAL COST**	**ANNUAL COST $**	**DAILY COST $**
180 MG Storage Facility (100% Treated CWA Option)	$ -	$ -	$ -
TOTAL ($/AC-FT)			**$ -**

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Treatment Cost Summary
Future Scenario

SUMMARY COSTS

CATEGORY	**DAILY COST $**	**COST $/AC-FT**
Water Purchase Costs	$ 26,556	$ 506
Imported Supply Fixed Costs	$ 9,819	$ 187
Power Costs	$ 3,678	$ 70
Power Generation	$ (1,010)	$ (19)
Chemical	$ 1,594	$ 30
Solids Management	$ 612	$ 12
Labor	$ 4,984	$ 95
Maintenance	$ 3,779	$ 72
Subtotal	*$ 50,012*	*$ 953*
Capital Improvements	$ -	$ -
TOTAL COST	**$ 50,012**	**$ 953**

APPENDIX B:
Hydraulic Model Analysis for WFP

PROJECT : Santa Fe Irrigation District - Joint Facilities Master Plan
R.E. Badger Water Filtration Plant - Hydraulic Analysis

Hydraulix BY carollo engineers

JOB # : ______ REVISION: ______ CHECKED : ______ DATE : ______ BY : MMB DATE : 3/1/2011

	Equation Ref.	HGL	EGL

Plant Flow Rate (MGD) 40
Reservoir Water Level (ft) 519.5
Filter Water Level (ft) 531.6

Filter Operation

Filter 1	Off
Filter 2	On
Filter 3	On
Filter 4	On
Filter 5	On
Filter 6	On
Number Filters in Operation	5
Flow per Filter (MGD)	8.0
Flow Filters 1 - 4 (MGD)	24.0
Flow Filters 5 - 6 (MGD)	16.0

Flow Split into Reservoir
Flow Split 61.1%
Diff HL (ft) 0.000

DOWNSTREAM CONTROL

					HGL	EGL
EGL	**=**	**519.50**			519.50	519.50
Flow	**=**	**40.00 mgd**	**=**	**61.88 cfs**		

FLOW SPLIT INTO RESERVOIR

		Headloss
Flow Split	61.1%	
Flow Into Inlet 1	24.4	0.935
Flow Into Inlet 2	15.6	0.934

INLET 2

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow 15.6 mgd = 24.1 cfs

Pipe Diameter, D	36	inch
Pipe Length, L	308	ft
Absolute Roughness, ε	0.00040	ft
Pipe velocity, v	3.41	fps
Kinematic Viscosity	1.000E-05	ft^2/sec
Reynold's Number, R	1021619	
Friction factor, f	0.0139	

Equivalent Hazen-Williams "C" = 143.1887

Friction Energy Loss, h_L 0.26 ft

MINOR PIPE LOSS HEADING

Flow, Q 15.6 mgd = 24.1 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Outlet Loss - Still Water	15.56	24.07	1.00	36	----	3.41	----	0.18	0.18
1	Butterfly Valve (Open)	15.56	24.07	0.50	36	----	3.41	----	0.18	0.09
1	22.5 ° Bend	15.56	24.07	0.15	36	----	3.41	----	0.18	0.03
1	Mitre Bend - 90 ° Deflection	15.56	24.07	1.27	36	----	3.41	----	0.18	0.23
1	Reducer	15.56	24.07	0.25	54	36	1.51	3.41	0.18	0.05
1	Tee - Thru Straight Run	15.56	24.07	0.60	36	----	3.41	----	0.18	0.11
									Sum =	0.68

	Equation Ref.	HGL	EGL
Total Energy Loss = 0.93 ft			
Upstream Condition		520.43	520.43

INLET 1

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	24.4 mgd =	37.8 cfs
Pipe Diameter, D	36 inch	
Pipe Length, L	22 ft	
Absolute Roughness, ε	0.00040 ft	
Pipe velocity, v	5.35 fps	
Kinematic Viscosity	1.000E-05 ft^2/sec	
Reynold's Number, R	1604650	
Friction factor, f	0.0135	Equivalent Hazen-Williams "C" = 140.1668
Friction Energy Loss, h_L	0.04 ft	

MINOR PIPE LOSS HEADING

Flow, Q 24.4 mgd = 37.8 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Outlet Loss - Still Water	24.44	37.81	1.00	36	----	5.35	----	0.44	0.44
1	Butterfly Valve (Open)	24.44	37.81	0.50	36	----	5.35	----	0.44	0.22
1	22.5 ° Bend	24.44	37.81	0.15	36	----	5.35	----	0.44	0.07
1	Tee - Thru Side Outlet	24.44	37.81	1.80	54	----	2.38	----	0.09	0.16
									Sum =	0.89

Total Energy Loss = 0.93 ft

	HGL	EGL
Upstream Condition	520.43	520.43

BETWEEN RESERVOIR FLOW SPLIT AND FILTER CONTOL WEIR

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	40.0 mgd =	61.9 cfs
Pipe Diameter, D	54 inch	
Pipe Length, L	760 ft	
Absolute Roughness, ε	0.00040 ft	
Pipe velocity, v	3.89 fps	
Kinematic Viscosity	1.000E-05 ft^2/sec	
Reynold's Number, R	1750846	
Friction factor, f	0.0127	Equivalent Hazen-Williams "C" = 143.2394
Friction Energy Loss, h_L	0.50 ft	

MINOR PIPE LOSS HEADING

Flow, Q 40.0 mgd = 61.9 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)

												Equation Ref.	HGL	EGL
1	Mitre Bend - 45 º Deflection	40.00	61.88	0.32	54	----	3.89	----	0.24	0.08				
1	Mitre Bend - 90 º Deflection	40.00	61.88	1.27	54	----	3.89	----	0.24	0.30				
1	Entrance Loss - Flush	40.00	61.88	0.50	----	54	----	3.89	0.24	0.12				
									Sum =	0.49				

Total Energy Loss = 0.99 ft

Upstream Condition | HGL 521.43 | EGL 521.43

FILTER CONTROL WEIR

[STRAIGHT EDGED SHARP CRESTED WEIR]

Flow 40.0 mgd = 61.9 cfs

WSE Downstream of Weir 521.43 ft
Weir Crest Elevation 521.74 ft
Downstream head, Hd -0.31 ft
Length of Weir, L 24.00 ft

WEIR IS FREE-DISCHARGING

Free Discharging Weir Computation { 6 }
Head on Weir, H 0.84 ft
Upstream WSE 522.58 ft

Submerged Weir Computation { 7 }
K NA
M NA
Increment NA ft
Upstream Head, Hu1 NA ft
F(H1) NA
F'(H1) NA
Upstream Head, Hu2 NA ft
Upstream WSE NA ft

Head over Weir *0.84 ft*

Condition Upstream of Weir | HGL 522.58 | EGL 522.58

UPSTREAM OF WEIR STRUCTURE

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow 40.0 mgd = 61.9 cfs

Pipe Diameter, D 54 inch
Pipe Length, L 10 ft
Absolute Roughness, ε 0.00040 ft
Pipe velocity, v 3.89 fps
Kinematic Viscosity 1.000E-05 ft^2/sec
Reynold's Number, R 1750846
Friction factor, f 0.0127 Equivalent Hazen-Williams "C" = 143.2394

Friction Energy Loss, h_L 0.01 ft

MINOR PIPE LOSS HEADING

Flow, Q 40.0 mgd = 61.9 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Outlet Loss - Still Water	40.00	61.88	1.00	54	----	3.89	----	0.24	0.24
									Sum =	0.2351

	Equation Ref.	HGL	EGL
Total Energy Loss = 0.24 ft			
Upstream Condition		522.82	522.82

FLOW SPLIT (NEW AND OLD FILTERS)

New Filters (5-6)	16.0
Old Filters (1-4)	24.0

NEW FILTERS

42" LINE DOWNSTREAM OF FILTERS 5 - 6

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	16.0 mgd =	24.8 cfs
Pipe Diameter, D	42 inch	
Pipe Length, L	232 ft	
Absolute Roughness, ε	0.00040 ft	
Pipe velocity, v	2.57 fps	
Kinematic Viscosity	1.000E-05 ft^2/sec	
Reynold's Number, R	900435	
Friction factor, f	0.0138	Equivalent Hazen-Williams "C" = 145.1244
Friction Energy Loss, h_L	0.09 ft	

MINOR PIPE LOSS HEADING

Flow, Q 16.0 mgd = 24.8 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Tee - Thru Side Outlet	16.00	24.75	1.80	42	----	2.57	----	0.10	0.18
4	Mitre Bend - 45 º Deflection	16.00	24.75	0.32	42	----	2.57	----	0.10	0.13
1	Increaser	16.00	24.75	0.25	42	54	2.57	1.56	0.07	0.02
									Sum =	0.33

Total Energy Loss = 0.43 ft

	HGL	EGL
Upstream Condition	523.25	523.25

INDIVIDUAL LINE FROM FILTER 5/6

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	8.0 mgd =	12.4 cfs
Pipe Diameter, D	42 inch	
Pipe Length, L	43 ft	
Absolute Roughness, ε	0.00040 ft	
Pipe velocity, v	1.29 fps	
Kinematic Viscosity	1.000E-05 ft^2/sec	
Reynold's Number, R	450218	
Friction factor, f	0.0148	Equivalent Hazen-Williams "C" = 147.7759
Friction Energy Loss, h_L	0.00 ft	

MINOR PIPE LOSS HEADING

Flow, Q 8.0 mgd = 12.4 cfs

Equation Ref.	HGL	EGL

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Wye - Thru Straight Run	8.00	12.38	0.45	42	----	1.29	----	0.03	0.01
2	Mitre Bend - 45 ° Deflection	8.00	12.38	0.32	42	----	1.29	----	0.03	0.02
1	Butterfly Valve (Open)	8.00	12.38	0.50	42	----	1.29	----	0.03	0.01
1	Entrance Loss - Flush	8.00	12.38	0.50	----	42	----	1.29	0.03	0.01
									Sum =	0.05

Total Energy Loss = 0.06 ft

Upstream Condition 523.31 523.31

FILTERED WATER CONDUIT (SQUARE PIPE)

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow 8.0 mgd = 12.4 cfs

Pipe Diameter, D	53	inch — Use equiv. diameter per Lindeberg 10th ed. Pg 17-9
Pipe Length, L	61	ft
Absolute Roughness, ε	0.00040	ft
Pipe velocity, v	0.80	fps
Kinematic Viscosity	1.000E-05	ft^2/sec
Reynold's Number, R	354768	
Friction factor, f	0.0150	Equivalent Hazen-Williams "C" = 149.206

Friction Energy Loss, h_L 0.00 ft

Condition Upstream of Pipe 523.31 523.31

24" FILTERED WATER HEADER

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow 8.0 mgd = 12.4 cfs

Pipe Diameter, D	24	inch
Pipe Length, L	5	ft
Absolute Roughness, ε	0.00040	ft
Pipe velocity, v	3.94	fps
Kinematic Viscosity	1.000E-05	ft^2/sec
Reynold's Number, R	787881	
Friction factor, f	0.0149	Equivalent Hazen-Williams "C" = 141.1647

Friction Energy Loss, h_L 0.01 ft

MINOR PIPE LOSS HEADING

Flow, Q 8.0 mgd = 12.4 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Outlet Loss - Still Water	8.00	12.38	1.00	24	----	3.94	----	0.24	0.24
0	Butterfly Valve (Open)	8.00	12.38	0.50	24	----	3.94	----	0.24	0.00
1	Mitre Bend - 90 ° Deflection	8.00	12.38	1.27	24	----	3.94	----	0.24	0.30
0	Reducer	8.00	12.38	0.25	30	24	2.52	3.94	0.24	0.00
									Sum =	0.55

Total Energy Loss = 0.55 ft

	Equation Ref.	HGL	EGL
Upstream Condition		523.87	523.87

FILTER - CONSTANT LEVEL

HEADLOSSES

24/30" Filtered Water Header		0.50
Lower Gullet		0.01
Gullet Wall		0.01
Underdrains		0.17
Filter Media		1.35 clean bed
Total	**7.7**	
Headloss for accumulation	5.7	

	Equation Ref.	HGL	EGL
Condition on Filters		531.60	531.60

UPPER GULLET WALL

[SUBMERGED ORIFICE (RECTANGULAR)] { 2 }

Flow	8.0 mgd =	12.4	cfs
Number of Ports	6		
Flow Per Port	1.3 mgd =	2.1	cfs
Port Width	3 ft		
Port Height	2.5 ft		
Discharge Coefficient, C	0.61		
Velocity through port, v	0.28 fps		
Orifice Energy Loss, h_L	0.00 ft		

	Equation Ref.	HGL	EGL
Condition Upstream of Orifice		531.60	531.60

DOWNSTREAM OF FLOW SPLITTING WEIRS

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	8.0 mgd =	12.4	cfs
Pipe Diameter, D	30 inch		
Pipe Length, L	6 ft		
Absolute Roughness, ε	0.00040 ft		
Pipe velocity, v	2.52 fps		
Kinematic Viscosity	1.000E-05 ft^2/sec		
Reynold's Number, R	630305		
Friction factor, f	0.0147	Equivalent Hazen-Williams "C" =	144.3469
Friction Energy Loss, h_L	0.00 ft		

MINOR PIPE LOSS HEADING

Flow, Q 8.0 mgd = 12.4 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Tee - Thru Side Outlet	8.00	12.38	1.80	30	----	2.52	----	0.10	0.18
1	Outlet Loss - Still Water	8.00	12.38	1.00	30	----	2.52	----	0.10	0.10
1	Entrance Loss - Flush	8.00	12.38	0.50	----	30	----	2.52	0.10	0.05
1	Butterfly Valve (Open)	8.00	12.38	0.50	30	----	2.52	----	0.10	0.05
									Sum =	0.38

Total Energy Loss = 0.38 ft

PROJECT : Santa Fe Irrigation District - Joint Facilities Master Plan
R.E. Badger Water Filtration Plant - Hydraulic Analysis

Hydraulix BY carollo engineers

JOB # :		REVISION:	
CHECKED :		BY :	MMB
DATE :		DATE :	3/1/2011

	Equation Ref.	HGL	EGL
Upstream Condition		531.98	531.98

FLOW SPLITTING WEIR - 2 PER FILTER

[STRAIGHT EDGED SHARP CRESTED WEIR]

Flow	4.0	mgd =	6.2 cfs
WSE Downstream of Weir	531.98	ft	
Weir Crest Elevation	532.23	ft	
Downstream head, Hd	-0.25	ft	
Length of Weir, L	4.00	ft	

WEIR IS FREE-DISCHARGING

Free Discharging Weir Computation { 6 }

Head on Weir, H	0.60	ft
Upstream WSE	532.83	ft

Submerged Weir Computation { 7 }

K	NA	
M	NA	
Increment	NA	ft
Upstream Head, Hu1	NA	ft
F(H1)	NA	
F'(H1)	NA	
Upstream Head, Hu2	NA	ft
Upstream WSE	NA	ft

Head over Weir *0.60 ft*

	Equation Ref.	HGL	EGL
Condition Upstream of Weir		532.83	532.83

OLD FILTERS
52" LINE DOWNSTREAM OF FILTERS 1 - 4

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	24.0	mgd =	37.1 cfs
Pipe Diameter, D	54	inch	
Pipe Length, L	128	ft	
Absolute Roughness, ε	0.00040	ft	
Pipe velocity, v	2.33	fps	
Kinematic Viscosity	1.000E-05	ft^2/sec	
Reynold's Number, R	1050508		
Friction factor, f	0.0132		Equivalent Hazen-Williams "C" = 146.1625
Friction Energy Loss, h_L	0.03	ft	

MINOR PIPE LOSS HEADING

Flow, Q 24.0 mgd = 37.1 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Tee - Thru Straight Run	24.00	37.13	0.60	54	----	2.33	----	0.08	0.05
0	Mitre Bend - 45 ° Deflection	24.00	37.13	0.32	54	----	2.33	----	0.08	0.00
0	Increaser	24.00	37.13	0.25	54	54	2.33	2.33	0.00	0.00
									Sum =	0.05

Total Energy Loss = 0.08 ft

PROJECT : Santa Fe Irrigation District - Joint Facilities Master Plan
R.E. Badger Water Filtration Plant - Hydraulic Analysis

Hydraulix by Carollo Engineers

JOB # :	**REVISION:**	**CHECKED :**	**BY :** MMB
		DATE :	**DATE :** 3/1/2011

	Equation Ref.	HGL	EGL
Upstream Condition		522.91	522.91

INDIVIDUAL LINE FROM FILTER 1&3

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow 16.0 mgd = 24.8 cfs

Pipe Diameter, D	42	inch
Pipe Length, L	29	ft
Absolute Roughness, ε	0.00040	ft
Pipe velocity, v	2.57	fps
Kinematic Viscosity	1.000E-05	ft^2/sec
Reynold's Number, R	900435	
Friction factor, f	0.0138	Equivalent Hazen-Williams "C" = 145.1244

Friction Energy Loss, h_L 0.01 ft

MINOR PIPE LOSS HEADING

Flow, Q 16.0 mgd = 24.8 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Tee - Thru Side Outlet	16.00	24.75	1.80	42	----	2.57	----	0.10	0.18
1	Tee - Thru Straight Run	16.00	24.75	0.60	54	----	1.56	----	0.04	0.02
1	Increaser	16.00	24.75	0.25	42	54	2.57	1.56	0.07	0.02
1	Mitre Bend - 90 º Deflection	16.00	24.75	1.27	42	----	2.57	----	0.10	0.13
1	Entrance Loss - Flush	16.00	24.75	0.50	----	42	----	2.57	0.10	0.05
									Sum =	0.41

Total Energy Loss = 0.42 ft

	Equation Ref.	HGL	EGL
Upstream Condition		523.32	523.32

FILTERED WATER CONDUIT (SQUARE PIPE)

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow 16.0 mgd = 24.8 cfs

Pipe Diameter, D	53	inch — Use equiv. diameter per Lindeberg 10th ed. Pg 17-9
Pipe Length, L	61	ft
Absolute Roughness, ε	0.00040	ft
Pipe velocity, v	1.60	fps
Kinematic Viscosity	1.000E-05	ft^2/sec
Reynold's Number, R	709536	
Friction factor, f	0.0138	Equivalent Hazen-Williams "C" = 147.7135

Friction Energy Loss, h_L 0.01 ft

	Equation Ref.	HGL	EGL
Condition Upstream of Pipe		523.33	523.33

24" FILTERED WATER HEADER

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow 8.0 mgd = 12.4 cfs

Pipe Diameter, D	24	inch
Pipe Length, L	5	ft
Absolute Roughness, ε	0.00040	ft

		Equation Ref.	HGL	EGL

Pipe velocity, v 3.94 fps
Kinematic Viscosity 1.000E-05 ft^2/sec
Reynold's Number, R 787881
Friction factor, f 0.0149 Equivalent Hazen-Williams "C" = 141.1647

Friction Energy Loss, h_L 0.01 ft

MINOR PIPE LOSS HEADING

Flow, Q 8.0 mgd = 12.4 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Outlet Loss - Still Water	8.00	12.38	1.00	24	----	3.94	----	0.24	0.24
0	Butterfly Valve (Open)	8.00	12.38	0.50	24	----	3.94	----	0.24	0.00
1	Mitre Bend - 90 º Deflection	8.00	12.38	1.27	24	----	3.94	----	0.24	0.30
0	Reducer	8.00	12.38	0.25	30	24	2.52	3.94	0.24	0.00
									Sum =	0.55

Total Energy Loss = 0.55 ft

Upstream Condition — HGL 523.89, EGL 523.89

FILTER - CONSTANT LEVEL

HEADLOSSES

24/30" Filtered Water Header	0.50	
Lower Gullet	0.01	
Gullet Wall	0.01	
Underdrains	0.17	
Filter Media	1.35	clean bed
Total	**7.7**	
Headloss for accumulation	5.7	

Condition on Filters — HGL 531.60, EGL 531.60

UPPER GULLET WALL

[SUBMERGED ORIFICE (RECTANGULAR)] { 2 }

Flow 8.0 mgd = 12.4 cfs

Number of Ports 6
Flow Per Port 1.3 mgd = 2.1 cfs
Port Width 3 ft
Port Height 2.5 ft
Discharge Coefficient, C 0.61
Velocity through port, v 0.28 fps

Orifice Energy Loss, h_L 0.00 ft

Condition Upstream of Orifice — HGL 531.60, EGL 531.60

DOWNSTREAM OF FLOW SPLITTING WEIRS

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow 8.0 mgd = 12.4 cfs

Pipe Diameter, D 30 inch
Pipe Length, L 6 ft
Absolute Roughness, ε 0.00040 ft
Pipe velocity, v 2.52 fps
Kinematic Viscosity 1.000E-05 ft^2/sec
Reynold's Number, R 630305

		Equation Ref.	HGL	EGL

Friction factor, f 0.0147 Equivalent Hazen-Williams "C" = 144.3469

Friction Energy Loss, h_L 0.00 ft

MINOR PIPE LOSS HEADING

Flow, Q 8.0 mgd = 12.4 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Tee - Thru Side Outlet	8.00	12.38	1.80	30	----	2.52	----	0.10	0.18
1	Outlet Loss - Still Water	8.00	12.38	1.00	30	----	2.52	----	0.10	0.10
1	Entrance Loss - Flush	8.00	12.38	0.50	----	30	----	2.52	0.10	0.05
1	Butterfly Valve (Open)	8.00	12.38	0.50	30	----	2.52	----	0.10	0.05
									Sum =	0.38

Total Energy Loss = 0.38 ft

Upstream Condition — HGL 531.98 — EGL 531.98

FLOW SPLITTING WEIR - 2 PER FILTER

[STRAIGHT EDGED SHARP CRESTED WEIR]

Flow 4.0 mgd = 6.2 cfs

WSE Downstream of Weir 531.98 ft
Weir Crest Elevation 532.23 ft
Downstream head, Hd -0.25 ft
Length of Weir, L 4.00 ft

WEIR IS FREE-DISCHARGING

Free Discharging Weir Computation { 6 }
Head on Weir, H 0.60 ft
Upstream WSE 532.83 ft

Submerged Weir Computation { 7 }
K NA
M NA
Increment NA ft
Upstream Head, Hu1 NA ft
F(H1) NA
F'(H1) NA
Upstream Head, Hu2 NA ft
Upstream WSE NA ft

Head over Weir 0.60 ft

Condition Upstream of Weir — HGL 532.83 — EGL 532.83

FILTER INFLUENT CHANNEL UPSTREAM OF FILTER INFLUENT WEIRS

[CHANNEL FRICTION LOSSES] { 5 }

Flow, Q 20.00 mgd = 30.9 cfs
Channel Width 6.30 ft
Total Channel Length 120.00
Downstream Invert El 528.00
Channel Slope 0.00%
Manning Coeff, n 0.013

Invert	Invert	Depth	Vel.	Hydr. Radius	Avg.	Friction Loss

Equation Ref.	HGL	EGL

Station	Up	Down	(ft)	(fps)	(ft)	Sf	Sf	(ft)	HGL	EGL
0.0	528.00	528.00	4.81	1.020	1.90	0.000	----	----	532.81	532.83
24.0	528.00	528.00	4.81	1.020	1.90	0.000	0.000	0.00	532.81	532.83
48.0	528.00	528.00	4.82	1.020	1.90	0.000	0.000	0.00	532.82	532.83
72.0	528.00	528.00	4.82	1.020	1.90	0.000	0.000	0.00	532.82	532.83
96.0	528.00	528.00	4.82	1.020	1.90	0.000	0.000	0.00	532.82	532.83
120.0	528.00	528.00	4.82	1.019	1.90	0.000	0.000	0.00	532.82	532.83

TOTAL ENERGY LOSS *0.00 ft*

Condition at Upstream End of Channel 532.82 532.83

FILTER INFLUENT CHANNEL

[CHANNEL FRICTION LOSSES] { 5 }

Flow, Q	40.00	mgd =	61.9 cfs
Channel Width	5.00	ft	
Total Channel Length	50.00		
Downstream Invert El	528.00		
Channel Slope	0.00%		
Manning Coeff, n	0.013		

Station	Invert Up	Invert Down	Depth (ft)	Vel. (fps)	Hydr. Radius (ft)	Sf	Avg. Sf	Friction Loss (ft)	HGL	EGL
0.0	528.00	528.00	4.73	2.618	1.64	0.000	----	----	532.73	532.83
10.0	528.00	528.00	4.73	2.616	1.64	0.000	0.000	0.00	532.73	532.84
20.0	528.00	528.00	4.73	2.615	1.64	0.000	0.000	0.00	532.73	532.84
30.0	528.00	528.00	4.74	2.613	1.64	0.000	0.000	0.00	532.74	532.84
40.0	528.00	528.00	4.74	2.612	1.64	0.000	0.000	0.00	532.74	532.84
50.0	528.00	528.00	4.74	2.610	1.64	0.000	0.000	0.00	532.74	532.85

TOTAL ENERGY LOSS *0.01 ft*

Condition at Upstream End of Channel 532.74 532.85

MINOR CHANNEL LOSS HEADING

Flow, Q 40.0 mgd = 61.9 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Width Up (ft)	Width Down (ft)	Depth (ft)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	90 Degree Bend - Long Rad	40.00	61.88	0.30	5	----	4.74	2.61	----	0.11	0.03
1	Sudden Expansion	40.00	61.88	1.00	8.00	14.00	4.74	1.63	0.93	0.03	0.03
										Sum =	0.06

Total Energy Loss = 0.06 ft

Upstream Condition 532.91 532.91

SETTLED WATER PIPELINE

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	40.0	mgd =	61.9 cfs
Pipe Diameter, D	48	inch	
Pipe Length, L	250	ft	
Absolute Roughness, ε	0.00040	ft	

			Equation Ref.	HGL	EGL

Pipe velocity, v 4.92 fps
Kinematic Viscosity 1.000E-05 ft^2/sec
Reynold's Number, R 1969702
Friction factor, f 0.0128 Equivalent Hazen-Williams "C" = 141.3945

Friction Energy Loss, h_L 0.30 ft

MINOR PIPE LOSS HEADING

Flow, Q 40.0 mgd = 61.9 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Mitre Bend - 90 ° Deflection	40.00	61.88	1.27	48	----	4.92	----	0.38	0.48
2	Mitre Bend - 45 ° Deflection	40.00	61.88	0.32	48	----	4.92	----	0.38	0.24
1	Entrance Loss - Flush	40.00	61.88	0.50	----	48	----	4.92	0.38	0.19
1	Outlet Loss - Still Water	40.00	61.88	1.00	48	----	4.92	----	0.38	0.38
									Sum =	1.28

Total Energy Loss = 1.58 ft

Upstream Condition — HGL 534.49 — EGL 534.49

SETTLED WATER WEIRS

[V-NOTCH WEIR]

Flow 10 mgd = 15.5 cfs

WSE Downstream of Weir 534.49 ft
Weir Crest Elevation 534.66 ft
Downstream head, Hd -0.17 ft

Weir Length 150.00 ft
Distance Between Notches 8.00 in
Number of Notches 225

WEIR IS FREE-DISCHARGING

Free Discharging Weir Computation { 8 }
Head on Weir, H 0.24 ft
Upstream WSE 534.90 ft

Submerged Weir Computation { 9 }
K NA
M NA
Increment NA ft
Upstream Head, Hu1 NA ft
F(H1) NA
F'(H1) NA
Upstream Head, Hu2 NA ft
Upstream WSE NA ft

Head over Weir 0.24 ft

Condition Upstream of Weir — HGL 534.90 — EGL 534.90

SEDIMENTATION BASINS

[CHANNEL FRICTION LOSSES] { 5 }

Flow, Q 20.00 mgd = 30.9 cfs
Channel Width 40.00 ft
Total Channel Length 240.00
Downstream Invert El 525.00

	Equation Ref.	HGL	EGL

Channel Slope 0.00%
Manning Coeff, n 0.013

Station	Invert Up	Invert Down	Depth (ft)	Vel. (fps)	Hydr. Radius (ft)	Sf	Avg. Sf	Friction Loss (ft)	HGL	EGL
0.0	525.00	525.00	9.90	0.078	6.62	0.000	----	----	534.90	534.90
48.0	525.00	525.00	9.90	0.078	6.62	0.000	0.000	0.00	534.90	534.90
96.0	525.00	525.00	9.90	0.078	6.62	0.000	0.000	0.00	534.90	534.90
144.0	525.00	525.00	9.90	0.078	6.62	0.000	0.000	0.00	534.90	534.90
192.0	525.00	525.00	9.90	0.078	6.62	0.000	0.000	0.00	534.90	534.90
240.0	525.00	525.00	9.90	0.078	6.62	0.000	0.000	0.00	534.90	534.90

TOTAL ENERGY LOSS 0.00 ft

Condition at Upstream End of Channel — HGL 534.90 — EGL 534.90

BAFFLE WALL #2

[SUBMERGED ORIFICE (RECTANGULAR)] { 2 }

Flow 20.0 mgd = 30.9 cfs

Number of Ports 100
Flow Per Port 0.2 mgd = 0.3 cfs
Port Width 0.67 ft
Port Height 0.67 ft
Discharge Coefficient, C 0.61
Velocity through port, v 0.70 fps

Orifice Energy Loss, h_L 0.02 ft

Condition Upstream of Orifice — HGL 534.92 — EGL 534.92

BAFFLE WALL #1

[SUBMERGED ORIFICE (RECTANGULAR)] { 2 }

Flow 20.0 mgd = 30.9 cfs

Number of Ports 80
Flow Per Port 0.3 mgd = 0.4 cfs
Port Width 0.5 ft
Port Height 0.5 ft
Discharge Coefficient, C 0.61
Velocity through port, v 1.55 fps

Orifice Energy Loss, h_L 0.10 ft

Condition Upstream of Orifice — HGL 535.02 — EGL 535.02

FLOCCULATION CHANNEL

[CHANNEL FRICTION LOSSES] { 5 }

Flow, Q 20.00 mgd = 30.9 cfs
Channel Width 20.00 ft
Total Channel Length 100.00
Downstream Invert El 525.00
Channel Slope 0.00%
Manning Coeff, n 0.013

Station	Invert Up	Invert Down	Depth (ft)	Vel. (fps)	Hydr. Radius (ft)	Sf	Avg. Sf	Friction Loss (ft)	HGL	EGL
0.0	525.00	525.00	10.02	0.154	5.00	0.000	----	----	535.02	535.02
20.0	525.00	525.00	10.02	0.154	5.00	0.000	0.000	0.00	535.02	535.02
40.0	525.00	525.00	10.02	0.154	5.00	0.000	0.000	0.00	535.02	535.02

											Equation Ref.	HGL	EGL
60.0	525.00	525.00	10.02	0.154	5.00	0.000	0.000	0.00	535.02	535.02			
80.0	525.00	525.00	10.02	0.154	5.00	0.000	0.000	0.00	535.02	535.02			
100.0	525.00	525.00	10.02	0.154	5.00	0.000	0.000	0.00	535.02	535.02			

TOTAL ENERGY LOSS *0.00 ft*

	HGL	EGL
Condition at Upstream End of Channel	535.02	535.02

MINOR CHANNEL LOSS HEADING

Flow, Q 20.0 mgd = 30.9 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Width Up (ft)	Width Down (ft)	Depth (ft)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
2	Turn Around Baffle	20.00	30.94	3.20	4.5	----	10.02	0.69	----	0.01	0.05
0	90 Degree Bend - Long Rad	20.00	30.94	0.30	4.5	----	10.49	0.66	----	0.01	0.00
										Sum =	0.05

Total Energy Loss = 0.05 ft

	HGL	EGL
Upstream Condition	535.06	535.06

[SUBMERGED ORIFICE (RECTANGULAR)] { 2 }

Flow	20.0 mgd =	30.9 cfs
Number of Ports	3	
Flow Per Port	6.7 mgd =	10.3 cfs
Port Width	4.5 ft	
Port Height	10.49 ft	
Discharge Coefficient, C	0.61	
Velocity through port, v	0.22 fps	
Orifice Energy Loss, h_L	0.00 ft	

	HGL	EGL
Condition Upstream of Orifice	535.07	535.07

FLOCCULATION BASIN INLET

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	20.0 mgd =	30.9 cfs
Pipe Diameter, D	36 inch	
Pipe Length, L	5 ft	
Absolute Roughness, ε	0.00040 ft	
Pipe velocity, v	4.38 fps	
Kinematic Viscosity	1.000E-05 ft^2/sec	
Reynold's Number, R	1313134	
Friction factor, f	0.0136	Equivalent Hazen-Williams "C" = 141.581
Friction Energy Loss, h_L	0.01 ft	

MINOR PIPE LOSS HEADING

Flow, Q 20.0 mgd = 30.9 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)

Hydraulix BY carollo engineers

PROJECT : Santa Fe Irrigation District - Joint Facilities Master Plan
R.E. Badger Water Filtration Plant - Hydraulic Analysis

CHECKED : | **BY :** MMB
JOB # : | **REVISION:** | **DATE :** | **DATE :** 3/1/2011

											Equation Ref.	HGL	EGL
1	Outlet Loss - Still Water	20.00	30.94	1.00	36	----	4.38	----	0.30	0.30			
1	Entrance Loss - Flush	20.00	30.94	0.50	----	36	----	4.38	0.30	0.15			
1	Butterfly Valve (Open)	20.00	30.94	0.50	36	----	4.38	----	0.30	0.15			
									Sum =	0.60			

Total Energy Loss = 0.60 ft

Upstream Condition — HGL 535.67 — EGL 535.67

RAW WATER INFLUENT CHANNEL

[CHANNEL FRICTION LOSSES] { 5 }

Flow, Q	40.00 mgd =	61.9 cfs
Channel Width	5.00 ft	
Total Channel Length	40.00	
Downstream Invert El	532.00	
Channel Slope	0.53%	
Manning Coeff, n	0.013	

Station	Invert Up	Invert Down	Depth (ft)	Vel. (fps)	Hydr. Radius (ft)	Sf	Avg. Sf	Friction Loss (ft)	HGL	EGL
0.0	532.00	532.00	3.47	3.566	1.45	0.001	----	----	535.47	535.67
8.0	532.04	532.00	3.43	3.610	1.45	0.001	0.001	0.00	535.47	535.67
16.0	532.08	532.04	3.39	3.655	1.44	0.001	0.001	0.00	535.47	535.68
24.0	532.13	532.08	3.34	3.702	1.43	0.001	0.001	0.01	535.47	535.68
32.0	532.17	532.13	3.30	3.750	1.42	0.001	0.001	0.01	535.47	535.69
40.0	532.21	532.17	3.26	3.799	1.41	0.001	0.001	0.01	535.47	535.69

TOTAL ENERGY LOSS *0.03 ft*

Condition at Upstream End of Channel — HGL 535.47 — EGL 535.69

MINOR CHANNEL LOSS HEADING

Flow, Q 40.0 mgd = 61.9 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Width Up (ft)	Width Down (ft)	Depth (ft)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
4	90 Degree Bend - Long Rad	40.00	61.88	0.30	5	----	3.47	3.57	----	0.20	0.24
										Sum =	0.23691

Total Energy Loss = 0.24 ft

Upstream Condition — HGL 535.93 — EGL 535.93

INFLUENT PIPELINE

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	40.0 mgd =	61.9 cfs
Pipe Diameter, D	54 inch	
Pipe Length, L	1000 ft	
Absolute Roughness, ε	0.00040 ft	
Pipe velocity, v	3.89 fps	
Kinematic Viscosity	1.000E-05 ft^2/sec	
Reynold's Number, R	1750846	
Friction factor, f	0.0127	Equivalent Hazen-Williams "C" = 143.2394

	Equation Ref.	HGL	EGL

Friction Energy Loss, h_L 0.66 ft

MINOR PIPE LOSS HEADING

Flow, Q 40.0 mgd = 61.9 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)	EGL
1	Outlet Loss - Still Water	40.00	61.88	1.00	54	----	3.89	----	0.24	0.24	536.17
1	Mitre Bend - 90 º Deflection	40.00	61.88	1.27	54	----	3.89	----	0.24	0.30	
1	Mitre Bend - 45 º Deflection	40.00	61.88	0.32	54	----	3.89	----	0.24	0.08	
2	Mitre Bend - 22.5 º Deflection	40.00	61.88	0.15	54	----	3.89	----	0.24	0.07	
1	Butterfly Valve (Open)	40.00	61.88	0.50	54	----	3.89	----	0.24	0.12	
0		40.00	61.88		54	----	3.89	----	0.24	0.00	
0		40.00	61.88		54	----	3.89	----	0.24	0.00	
									Sum =	0.80	

Total Energy Loss = 1.46 ft

	HGL	EGL
Upstream Condition	537.39	537.39

APPENDIX C:
WFP Arc Flash Study

BADGER FAULT CURRENT CALCULATION ASSUMPTIONS

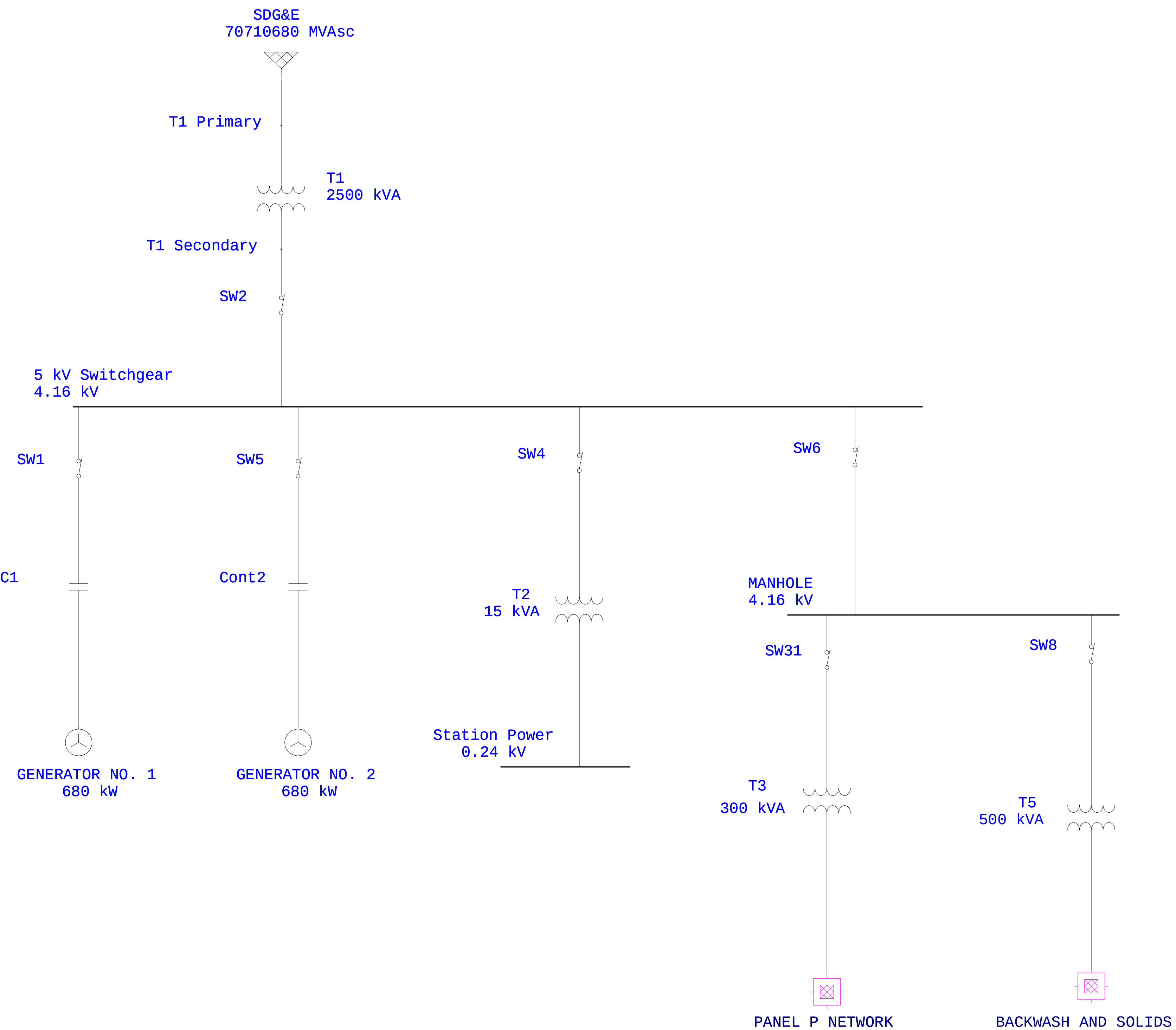
RE Badger Fault Calculation Assumptions

The following items are the assumptions that were made throughout the fault current calculation for the RE Badger Facility:

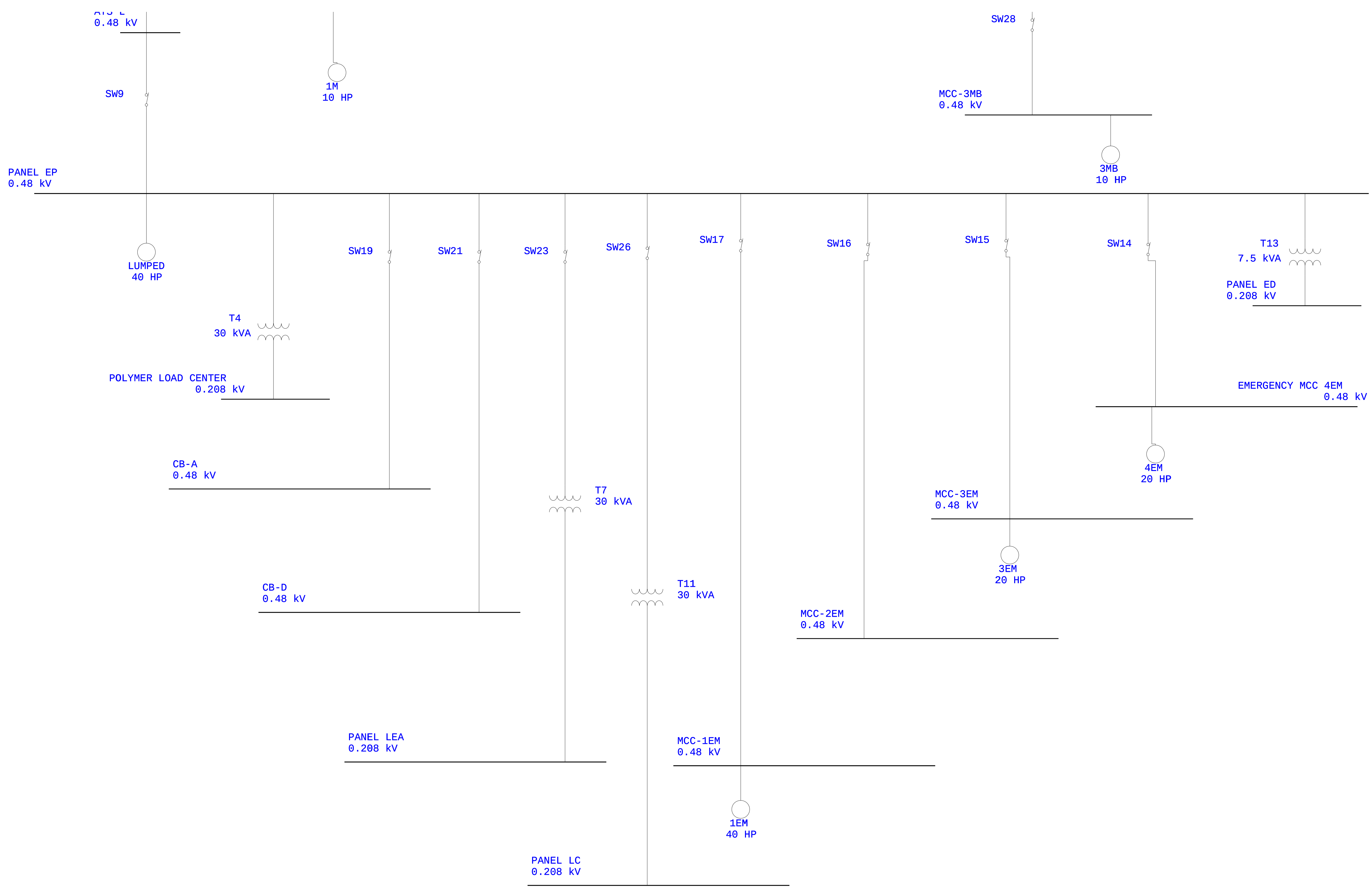
- The utility acts as an infinite source of fault current (no utility impedance).
- A typical impedance was used for the 12 kV to 4 kV transformer (5.5%).
- A typical impedance was used for the 4.16 kV Hydroelectric generators (Xd’’=19%).
- There is zero impedance from the hydroelectric generators to the 5 kV SWGR (Cable was not entered).
- The station power transformer was entered as a single phase (4.16-240) transformer based on field investigation opposed to the three phase transformer in the 93 drawings. An ETAP typical impedance was used.
- A typical impedance was used for the 500 kVA transformer (4.8%).
- A typical impedance was used for the 300 kVA transformer (4.8%).
- A typical impedance was used for the 160 kW emergency generator (Xd’’=19%).
- Cable size and distance was not used for any connection.

BADGER SYSTEM ONE-LINES

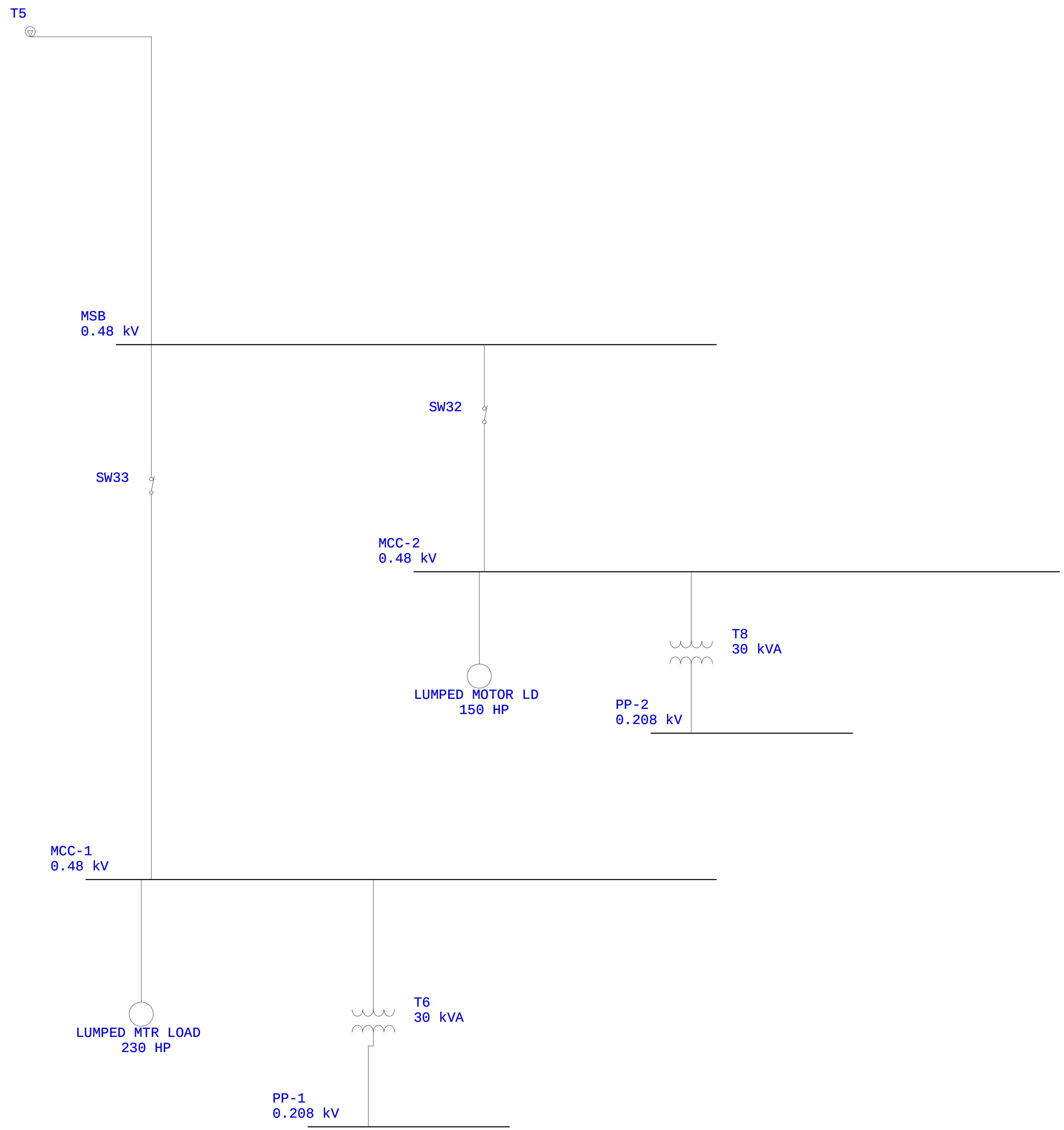
One-Line Diagram - OLV1 (Edit Mode)



One-Line Diagram - OLV1=>PANEL P NETWORK (Edit Mode)

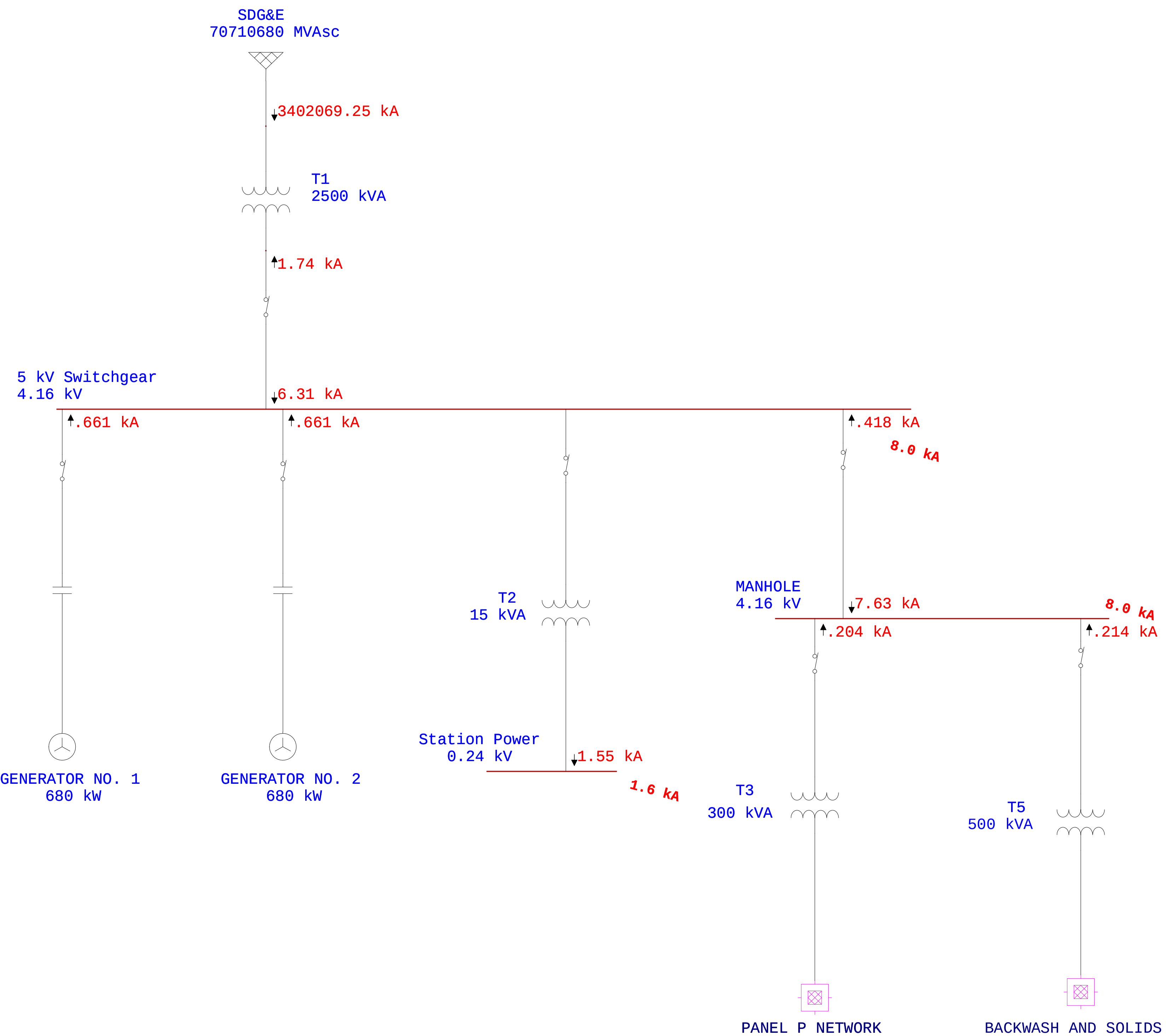

0.48 kV
SW9
1M
10 HP
SW28
MCC-3MB
0.48 kV
3MB
10 HP
PANEL EP
0.48 kV
LUMPED
40 HP
SW19
SW21
SW23
SW26
SW17
SW16
SW15
SW14
T13
7.5 kVA
PANEL ED
0.208 kV
T4
30 kVA
POLYMER LOAD CENTER
0.208 kV
EMERGENCY MCC 4EM
0.48 kV
4EM
20 HP
CB-A
0.48 kV
T7
30 kVA
MCC-3EM
0.48 kV
3EM
20 HP
CB-D
0.48 kV
T11
30 kVA
MCC-2EM
0.48 kV
PANEL LEA
0.208 kV
MCC-1EM
0.48 kV
1EM
40 HP
PANEL LC
0.208 kV

One-Line Diagram - OLV1=>BACKWASH AND SOLIDS (Edit Mode)

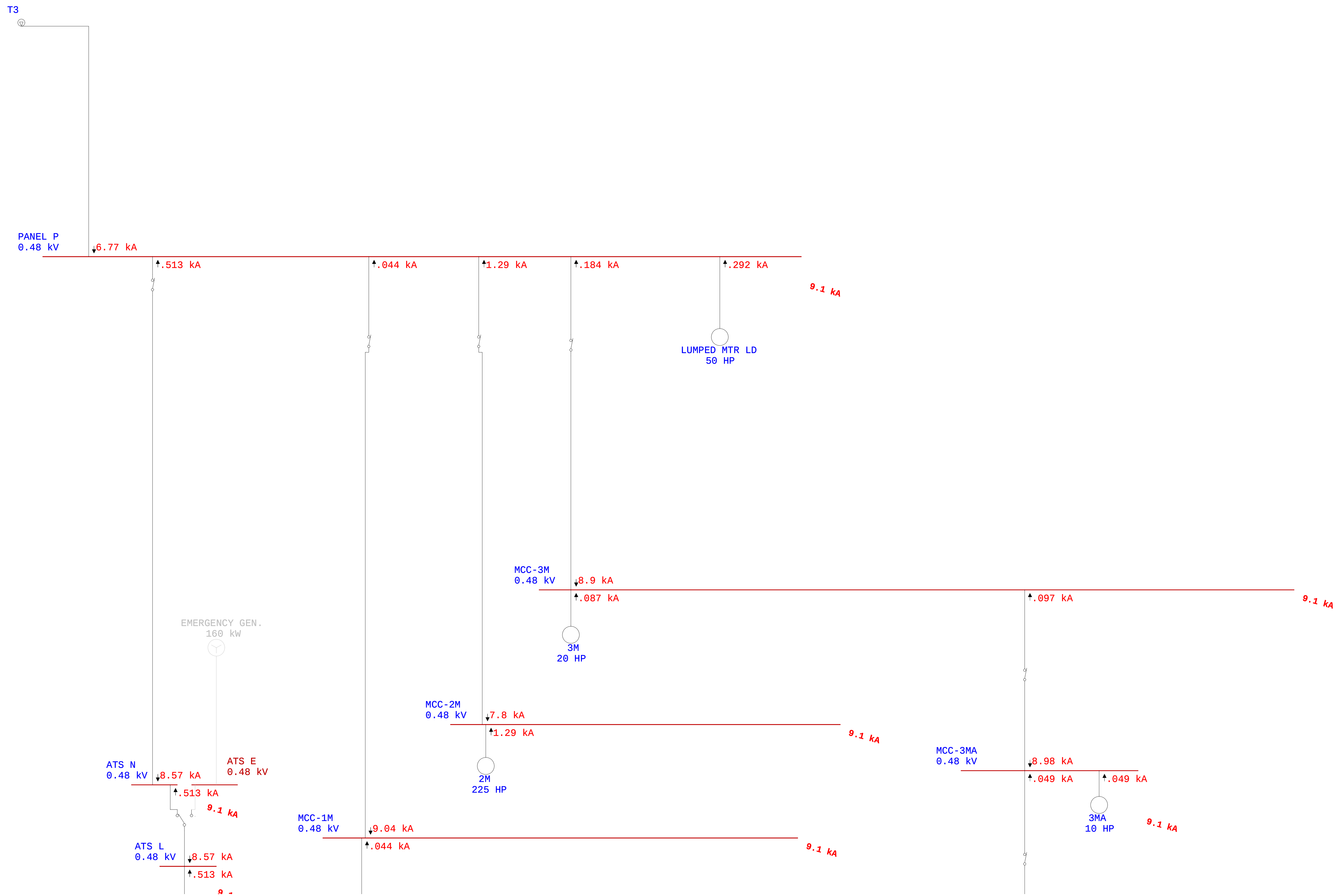


BADGER FAULT CALCULATION ONE-LINES

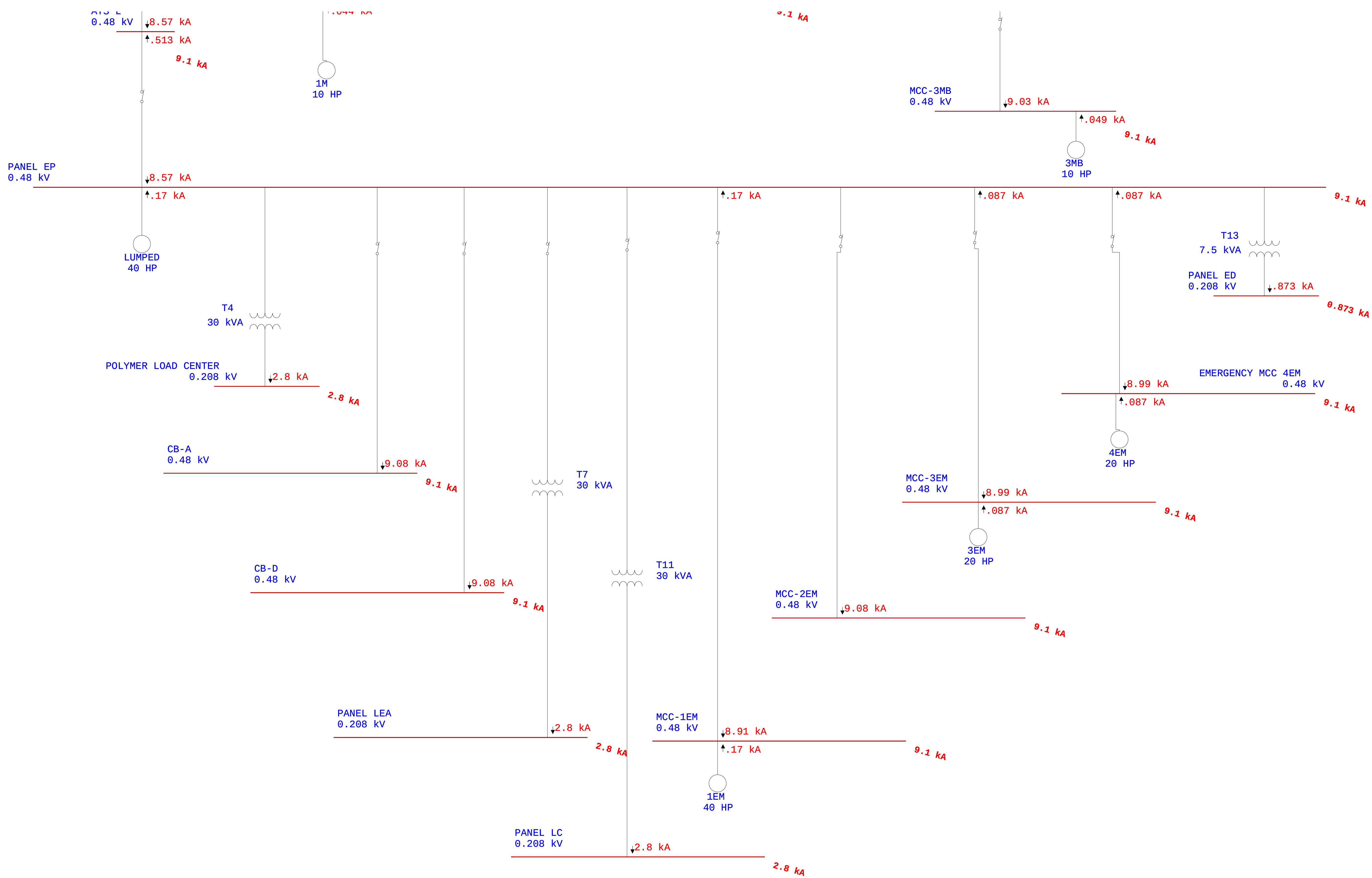
One-Line Diagram - OLV1 (Short-Circuit Analysis)



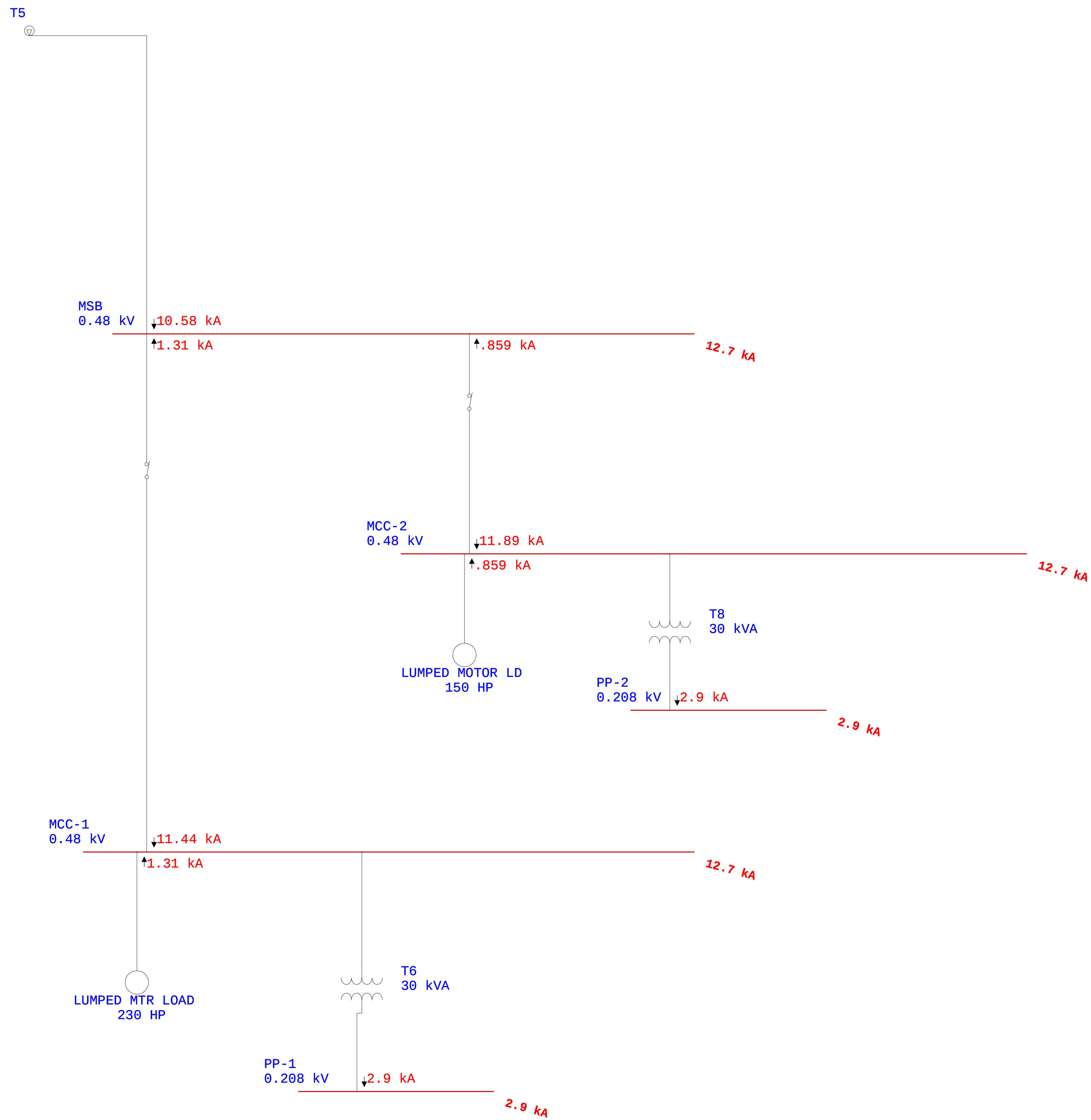
One-Line Diagram - OLV1=>PANEL P NETWORK (Short-Circuit Analysis)



One-Line Diagram - OLV1=>PANEL P NETWORK (Short-Circuit Analysis)



One-Line Diagram - OLV1=>BACKWASH AND SOLIDS (Short-Circuit Analysis)



NFPA70E ARC Flash Tables

Tasks Performed on Energized Equipment	*Hazard/Risk Category*	*Rubber Insulating Gloves*	*Insulated and Insulating Hand Tools*
Panelboards or Other Equipment Rated 240 V and Below - Note 1			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	0	N	N
Circuit breaker (CB) or fused switch operation with cover on	0	N	N
CB or fused switch operation with covers off	0	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	0	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard	1	Y	Y

General Notes (applicable to the entire table):
(a) Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.
(b) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which wok will be done, and are manufactured and tested in accordance with ASTM F 1505, *Standard Specification for Insulated and Insulating Hand Tools.*
(c) Y= yes (required), N=no (not required).
(d) For systems rated less than 1000 volts, the fault currents and upstream protective device clearing times are based on an 18 in. working distance.
(e) For systems rated 1 kV and greater, the Hazard/Risk Categories are based on a 36 in. working distance.
(f) For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (1/2 cycle fault clearing time or less), the hazard/risk category required may be reduced by one number.

Specific Notes (as referenced in the table):
1. Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time.

Tasks Performed on Energized Equipment	*Hazard/Risk Category*	*Rubber Insulating Gloves*	*Insulated and Insulating Hand*
Panelboards or Switchboards Rated >240 V and up to 600 V (with molded case or insulated case circuit breakers) - Note 1			
Perform infrared thermography and other non-contact inspections outside the Restriced Approach Boundary	1	N	N
CB or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	Y	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard or switchboard	2*	Y	Y

General Notes (applicable to the entire table):
(a) Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.
(b) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which wok will be done, and are manufactured and tested in accordance with ASTM F 1505, *Standard Specification for Insulated and Insulating Hand Tools.*
(c) Y= yes (required), N=no (not required).
(d) For systems rated less than 1000 volts, the fault currents and upstream protective device clearing times are based on an 18 in. working distance.
(e) For systems rated 1 kV and greater, the Hazard/Risk Categories are based on a 36 in. working distance.
(f) For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (1/2 cycle fault clearing time or less), the hazard/risk category required may be reduced by one number.

Specific Notes (as referenced in the table):
1. Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time.

Tasks Performed on Energized Equipment	*Hazard/Risk Category*	*Rubber Insulating Gloves*	*Insulated and Insulating Hand*
600 V Class Motor Control Centers (MCCs) - Note 2 (except as indicated)			
Perform infrared thermography and other non-contract inspections outside the restriced approach boundary	1	N	N
CB or fused switch or starter operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch or starter operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120	2*	Y	Y
Insertion or removal of individual starter "buckets" from MCC - Note 3	4	Y	N
Application of safety grounds, after voltage	2*	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit	1	N	N
Work on energized electrical conductors and circuit parts of utilizzation equipment fed	2*	Y	Y

General Notes (applicable to the entire table):
(a) Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.
(b) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which wok will be done, and are manufactured and tested in accordance with ASTM F 1505, *Standard Specification for Insulated and Insulating Hand Tools.*
(c) Y= yes (required), N=no (not required).
(d) For systems rated less than 1000 volts, the fault currents and upstream protective device clearing times are based on an 18 in. working distance.
(e) For systems rated 1 kV and greater, the Hazard/Risk Categories are based on a 36 in. working distance.
(f) For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (1/2 cycle fault clearing time or less), the hazard/risk category required may be reduced by one number.

Specific Notes (as referenced in the table):
2. Maximum of 65 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time.
3. Maximum of 42 kA short circuit current available; maximum of 0.33 sec (20 cycle) fault clearing time.

Tasks Performed on Energized Equipment	*Hazard/Risk Category*	*Rubber Insulating*	*Insulated and Insulating Hand*
600 V Class Swtichgear (with power circuit breakers or fused switches) - Note 4			
Perform infrared thermography and other non-compact inspections outside the restricted approach boundary	2	N	N
CB or fused switch operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts > 120 V, exposed	2*	Y	Y
Insertion or removal (racking) of CBs from cubicals, doors open or closed	4	N	N
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	2	N	N

General Notes (applicable to the entire table):
(a) Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.
(b) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which wok will be done, and are manufactured and tested in accordance with ASTM F 1505, *Standard Specification for Insulated and Insulating Hand Tools.*
(c) Y= yes (required), N=no (not required).
(d) For systems rated less than 1000 volts, the fault currents and upstream protective device clearing times are based on an 18 in. working distance.
(e) For systems rated 1 kV and greater, the Hazard/Risk Categories are based on a 36 in. working distance.
(f) For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (1/2 cycle fault clearing time or less), the hazard/risk category required may be reduced by one number.

Specific Notes (as referenced in the table):
4. Maximum of 35 kA short circuit current available; maximum of up to 0.5 sec (30 cycle) fault clearing time.

Tasks Performed on Energized Equipment	*Hazard/Risk Category*	*Rubber Insulating Gloves*	*Insulated and Insulating Hand*
Other 600 V Class (277 V through 600 V, nominal) Equipment - Note 2 (except as indicated)			
Lighting or small power transformers (600 V, maximum)			
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	2*	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N
Revenue meters (kW-hour, at primary voltage and current)			
Insertion or removal	2*	Y	N
Cable trough or tray cover removal or installation	1	N	N
Miscellaneous equipment cover removal or installation	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N
Insertion or removal of plug-in devices into or from busways	2*	Y	N

General Notes (applicable to the entire table):
(a) Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.
(b) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which wok will be done, and are manufactured and tested in accordance with ASTM F 1505, *Standard Specification for Insulated and Insulating Hand Tools.*
(c) Y= yes (required), N=no (not required).
(d) For systems rated less than 1000 volts, the fault currents and upstream protective device clearing times are based on an 18 in. working distance.
(e) For systems rated 1 kV and greater, the Hazard/Risk Categories are based on a 36 in. working distance.
(f) For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (1/2 cycle fault clearing time or less), the hazard/risk category required may be reduced by one number.

Specific Notes (as referenced in the table):
2. Maximum of 65 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time.

⚠ WARNING

Arc Flash and Shock Hazard Present
Appropriate PPE Required

Arc Flash Hazard Boundary	4.0 ft
Incident Energy in cal/cm^2	Refer to Table
Working Distance	Refer to Table
Shock Hazard Exposure	480 VAC
Insulating Gloves Class	Refer to Table

Shock Hazard **when covers removed**

Hazard Category
Refer to Table

Minimum PPE Requirements
Refer to Table

Limited Approach Boundary	Refer to Table
Restricted Approach Boundary	Refer to Table
Prohibited Approach Boundary	Refer to Table

Equipment **MCC-1**

07-12-2011

CIELO FAULT CURRENT

CALCULATION ASSUMPTIONS

Cielo Pump Station ETap Model Assumptions

1. **General:**
   a. As-built drawings were used to acquire the cable lengths for major feeders. The cable lengths are always rounded down to achieve the worst-case scenario
   b. All transformers of 250 kVA and below or 208V and below were used as point load in the model. NFPA does not require Arc Flash studies on system of 200 volts or less powered by transformers of 250KVA and smaller.
   c. 2 Second maximum fault clearing time.
2. **Circuit Breakers:**
   a. All information used was based on collected field data. Updated data is located on ProjectWise.
3. **Point Loads**:
   a. Load was entered as the Full Load rating of transformer
4. **Motors:**
   a. Used typical current provided by ETap based on motor HP
   b. 1800 RPM
5. **RVSS's:**
   a. Since all of the RVSS's have by-pass contactors, the RVSS starters were not modeled. This is a valid assumption because in a fault condition, the bypass contactor will not restrict the fault current contribution of the motor.
6. **Separate Enclosures:**
   a. 480V Cabinets and Panels are included in the Arc Flash calculation. This includes external RVSS's, Power Panels, Disconnects, etc.
7. **Cable:**
   a. NEC cable with Rubber 2 insulation
   b. 75 degree C
   c. 600 V
8. **Running Conditions**
   a. The arc flash labels are based on the worst case of two separate scenarios.
      i. Power provided by SDG&E
      ii. Power provided by an standard 800 kW portable generator.
      iii. Each of the above options at 70% of the available arcing fault current from the utility.
         1. SDG&E could not offer a minimum fault current, so a recommendation of 70% from a separate utility was utilized.

CIELO ORIGINAL DEVICE SETTINGS

Protective Device Settings

Fuse: Cooper

MFR:	Cooper	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	Bay-O-Net (High Ampere)	kV:	15.500	LG kA:	0.00	Asym. (Calc.)
Speed:	Other	Int. kA:	2.500	Base kV:	0.000	(Calc.)
Size:	C05	Cont. Amp:	125.000			

Fuse: S&C

MFR:	S&C	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SM-4	kV:	17.000	LG kA:	0.00	Asym. (Calc.)
Speed:	Standard	Int. kA:	12.500	Base kV:	0.000	(Calc.)
Size:	150E	Cont. Amp:	150.000			

CB: AC-2 CB

MFR:	General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SELA	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: General Electric
Model: Spectra RMS SE
Sensor: 20
Rating Plug: 20.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	Fixed	
	ST Band	Fixed	I^xt=IN
INST	Inst. Pickup	MAX	

CB: ACP-2 CB

MFR:	General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SELA	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: General Electric
Model: Spectra RMS SE
Sensor: 30
Rating Plug: 30.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	Fixed	
	ST Band	Fixed	I^xt=IN
INST	Inst. Pickup	MAX	

Protective Device Settings

CB: CB2

MFR:	General Electric	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	SKLA	Rating:	65 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.000 (Calc.)

LV Solid State Trip Device

MFR: General Electric
Model: Spectra RMS SK
Sensor: 400
Rating Plug: 400.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	Fixed	
	ST Band	Fixed	I^xt=IN
INST	Inst. Pickup	MIN	

CB: CB5

MFR:	General Electric	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	SKLA	Rating:	65 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.000 (Calc.)

LV Solid State Trip Device

MFR: General Electric
Model: Spectra RMS SK
Sensor: 600
Rating Plug: 600.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	Fixed	
	ST Band	Fixed	I^xt=IN
INST	Inst. Pickup	MIN	

Protective Device Settings

CB: CB6

MFR:	General Electric	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	SKLA	Rating:	65 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.000 (Calc.)

LV Solid State Trip Device

MFR: General Electric
Model: Spectra RMS SK
Sensor: 600
Rating Plug: 600.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	Fixed	
	ST Band	Fixed	I^xt=IN
INST	Inst. Pickup	MIN	

CB: LP2 CB

MFR:	General Electric	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	SELA	Rating:	65 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	30	Cont. Amp:	30.000	Base kV:	0.000 (Calc.)

LV Solid State Trip Device

MFR: General Electric
Model: Spectra RMS SE
Sensor: 25
Rating Plug: 25.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	Fixed	
	ST Band	Fixed	I^xt=IN
INST	Inst. Pickup	MAX	

CB: MCC-2 MAIN

MFR:	General Electric	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	SS 2500	Rating:	100 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	2500	Cont. Amp:	2500.000	Base kV:	0.000 (Calc.)

LV Solid State Trip Device

MFR: General Electric
Model: Power+ (ICCB)
Sensor: 2500 (LIG)
Rating Plug: 2500.00

		Phase Setting
Long-Time	LT Pickup	1.000
	LT Band	1
INST	Inst. Pickup	5.000

Protective Device Settings

CB: MS-2

MFR:	Siemens	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SHTD6	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	2500	Cont. Amp:	2500.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Siemens
Model: STD w/ ETU
Sensor: 2500
Rating Plug: 2500.00

	Phase Setting			Ground Setting		
Long-Time	LT Pickup	1		Ground Pickup	0.38	
	LT Band	8		Ground Band	0.5	I^xt=IN
Short-Time	ST Pickup	2.5				
	ST Band	0.1	I^xt=IN			
INST	Inst. Pickup	5				

CB: P-1 CB

MFR:	General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SKLA	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: General Electric
Model: Spectra RMS SK
Sensor: 400
Rating Plug: 400.00

	Phase Setting		
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	Fixed	
	ST Band	Fixed	I^xt=IN
INST	Inst. Pickup	MAX	

Protective Device Settings

CB: P-2 CB

MFR:	General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SKLA	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: General Electric
Model: Spectra RMS SK
Sensor: 600
Rating Plug: 600.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	Fixed	
	ST Band	Fixed	I^xt=IN
INST	Inst. Pickup	4	

CB: P-3 CB

MFR:	General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SKLA	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: General Electric
Model: Spectra RMS SK
Sensor: 600
Rating Plug: 600.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	Fixed	
	ST Band	Fixed	I^xt=IN
INST	Inst. Pickup	5	

Protective Device Settings

CB: P-4 CB

MFR:	General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SKLA	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: General Electric

Model: Spectra RMS SK

Sensor: 400

Rating Plug: 400.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	Fixed	
	ST Band	Fixed	I^xt=IN
INST	Inst. Pickup	MAX	

CIELO REVISED DEVICE SETTINGS

Protective Device Settings

CB: MCC-2 MAIN

MFR:	General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SS 2500	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	2500	Cont. Amp:	2500.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: General Electric
Model: Power+ (ICCB)
Sensor: 2500 (LIG)
Rating Plug: 2500.00

		Phase Setting
Long-Time	LT Pickup	1.000
	LT Band	1
INST	Inst. Pickup	2.500

CB: MS-2

MFR:	Siemens	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SHTD6	Rating:	100 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	2500	Cont. Amp:	2500.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: Siemens
Model: STD w/ ETU
Sensor: 2500
Rating Plug: 2500.00

		Phase Setting			Ground Setting	
Long-Time	LT Pickup	1		Ground Pickup	0.38	
	LT Band	8		Ground Band	0.5	I^xt=IN
Short-Time	ST Pickup	2.5				
	ST Band	0.1	I^xt=IN			
INST	Inst. Pickup	3				

CB: P-1 CB

MFR:	General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SKLA	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.000	(Calc.)

LV Solid State Trip Device

MFR: General Electric
Model: Spectra RMS SK
Sensor: 400
Rating Plug: 400.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	Fixed	
	ST Band	Fixed	I^xt=IN
INST	Inst. Pickup	5	

CB: P-2 CB

MFR:	General Electric	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	SKLA	Rating:	65 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.000 (Calc.)

LV Solid State Trip Device

MFR: General Electric
Model: Spectra RMS SK
Sensor: 600
Rating Plug: 600.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	Fixed	
	ST Band	Fixed	I^xt=IN
INST	Inst. Pickup	4	

CB: P-3 CB

MFR:	General Electric	Tag #:		3-Phase kA:	0.00 Asym. (Calc.)
Model:	SKLA	Rating:	65 kA, 0.48 kV	LG kA:	0.00 Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.000 (Calc.)

LV Solid State Trip Device

MFR: General Electric
Model: Spectra RMS SK
Sensor: 600
Rating Plug: 600.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	Fixed	
	ST Band	Fixed	I^xt=IN
INST	Inst. Pickup	4	

Protective Device Settings

CB: P-4 CB

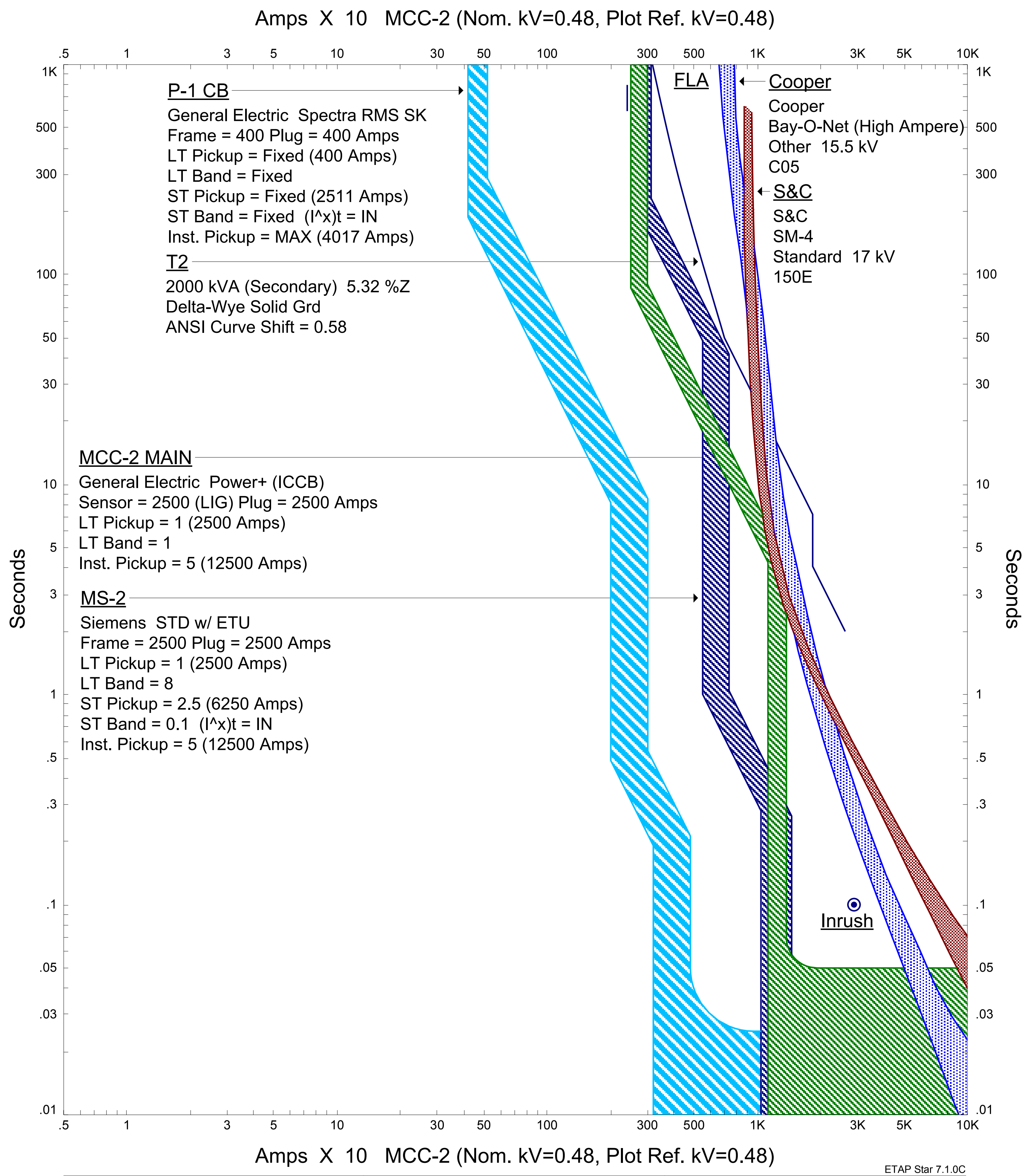
MFR:	General Electric	Tag #:		3-Phase kA:	0.00	Asym. (Calc.)
Model:	SKLA	Rating:	65 kA, 0.48 kV	LG kA:	0.00	Asym. (Calc.)
Size:	800	Cont. Amp:	800.000	Base kV:	0.000	(Calc.)

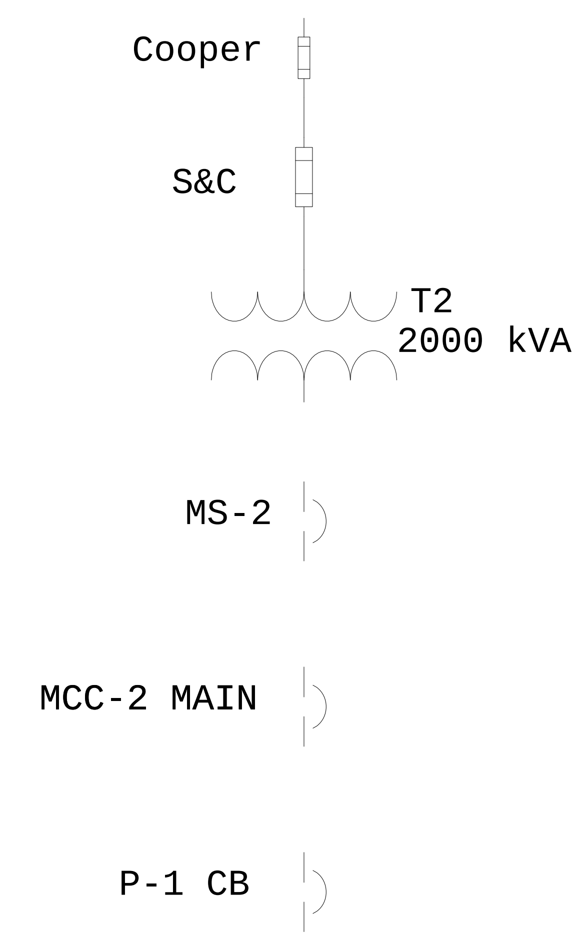
LV Solid State Trip Device

MFR: General Electric
Model: Spectra RMS SK
Sensor: 600
Rating Plug: 600.00

		Phase Setting	
Long-Time	LT Pickup	Fixed	
	LT Band	Fixed	
Short-Time	ST Pickup	Fixed	
	ST Band	Fixed	I^xt=IN
INST	Inst. Pickup	4	

CIELO ORIGINAL TIME CURRENT CURVE

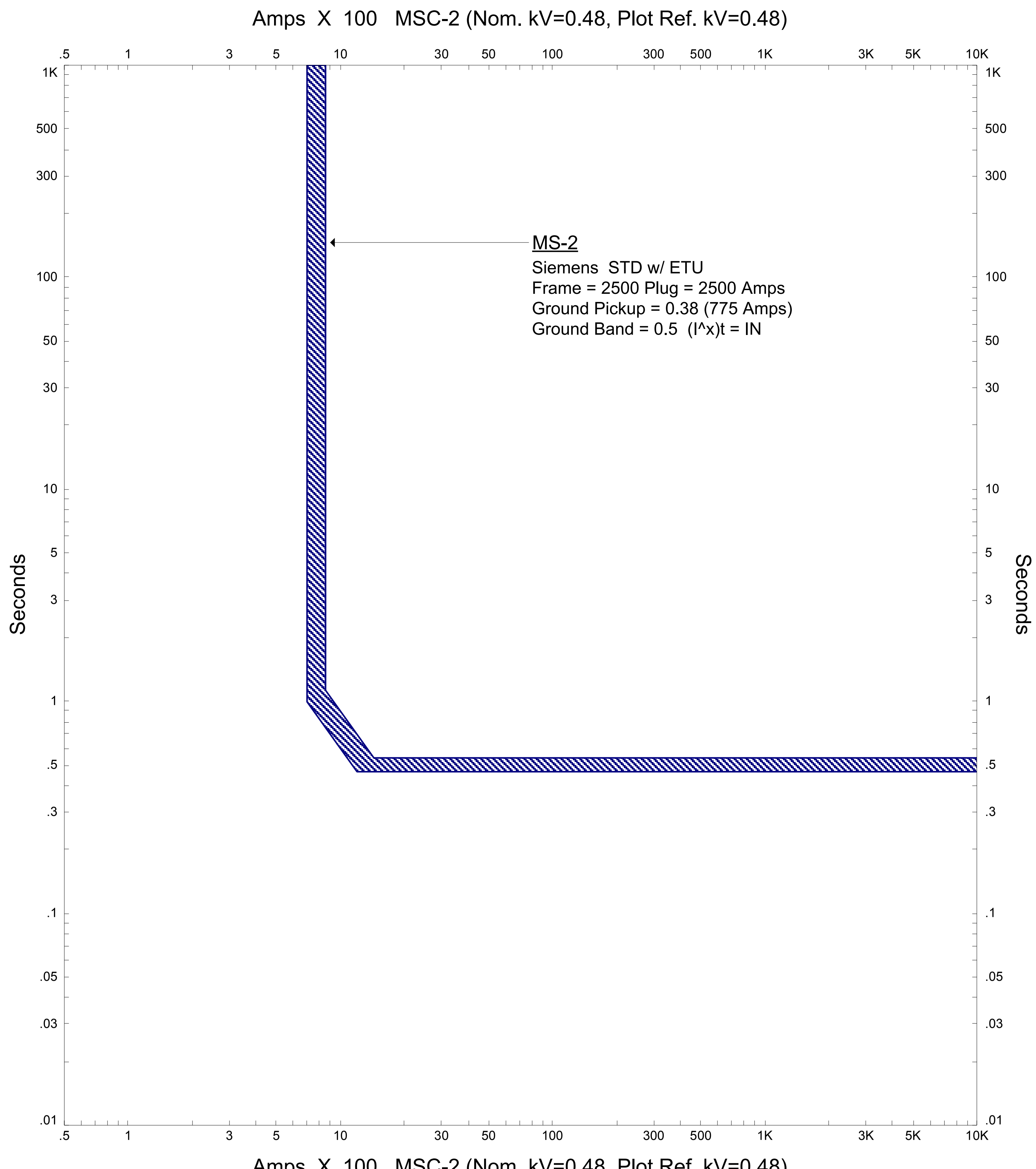


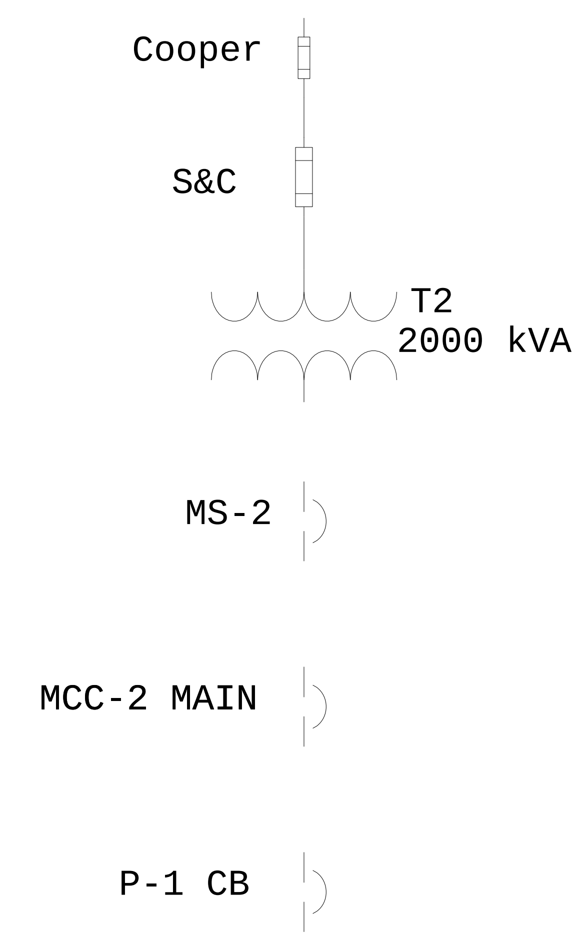


Pump 1

Project:
Location:
Contract:
Engineer:
Filename: H:\Client\SFID\Arc Flash_ETAP\Cielo PS\Cielo PS\CieloPS.OTI

Date: 05-04-2011
SN: JOHNCAROL1
Rev: Base
Fault: Phase





ETAP Star 7.1.0C

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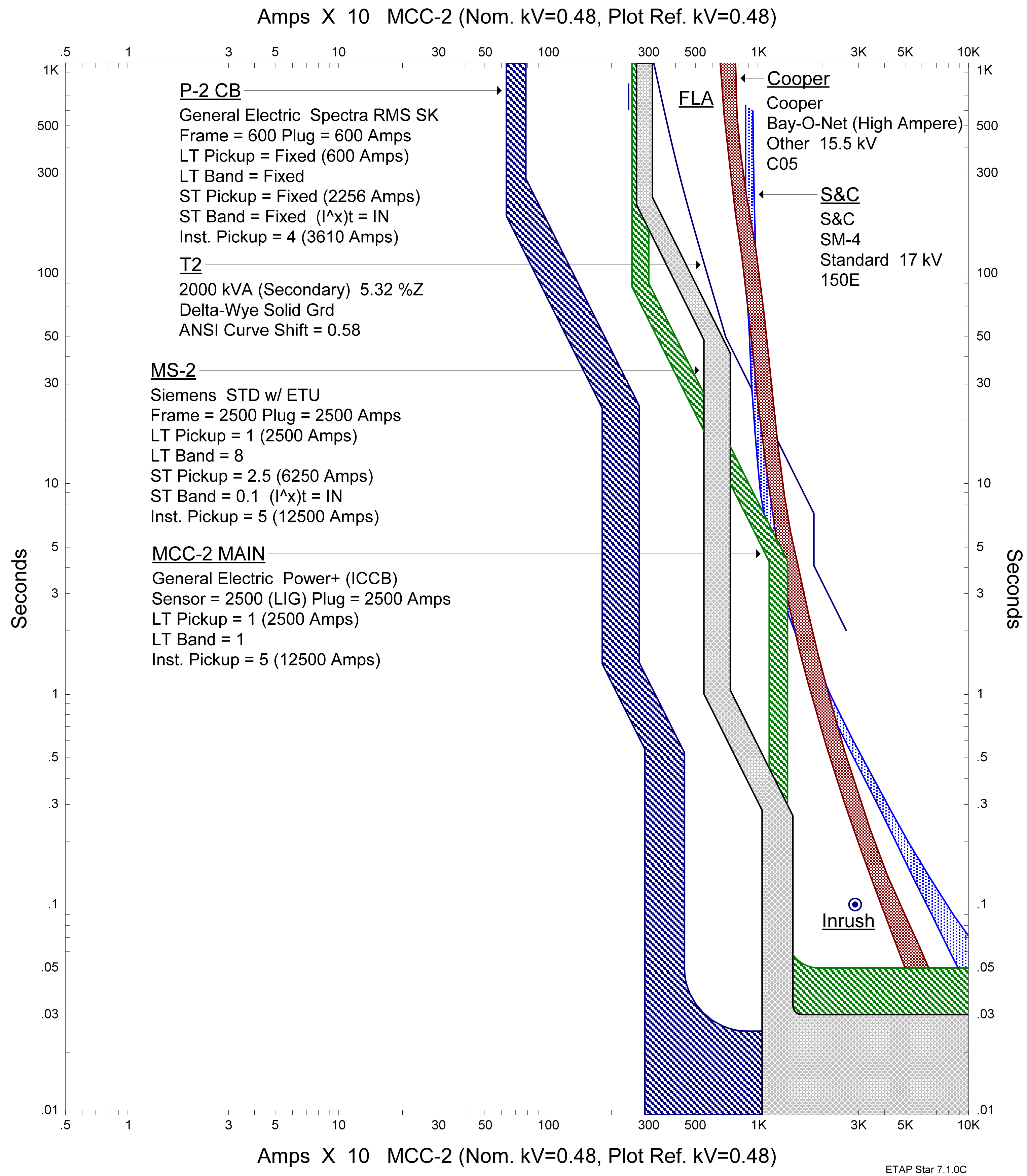

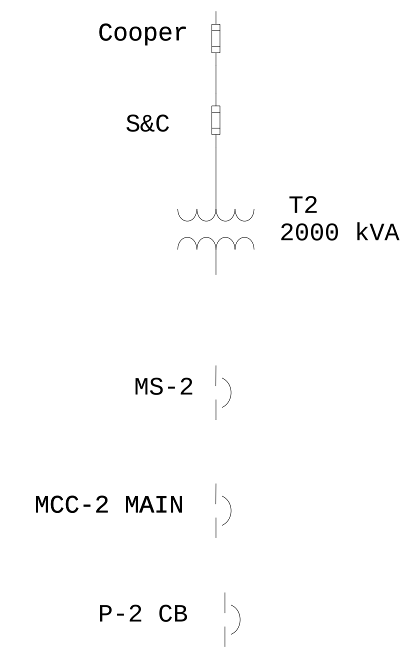

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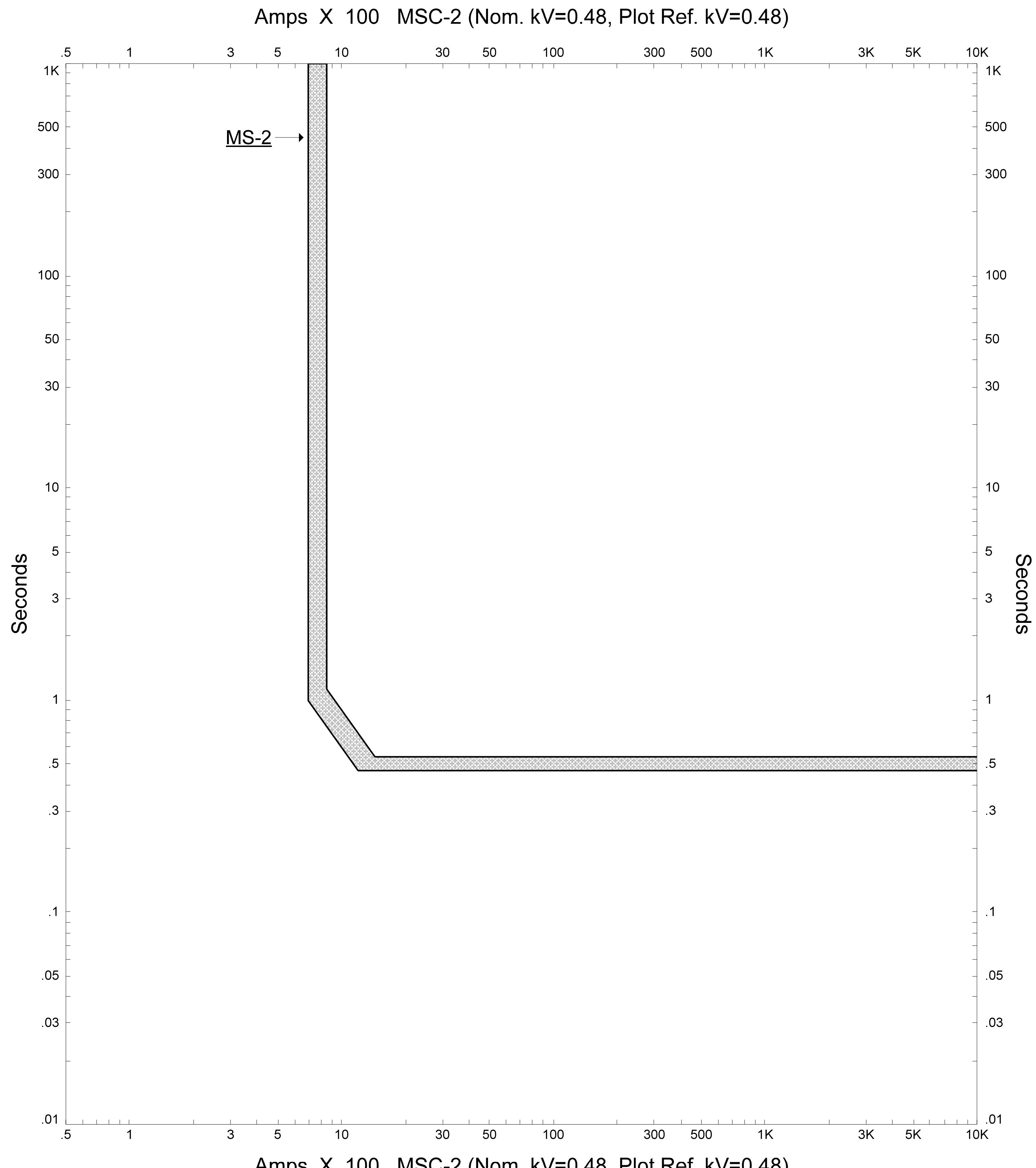
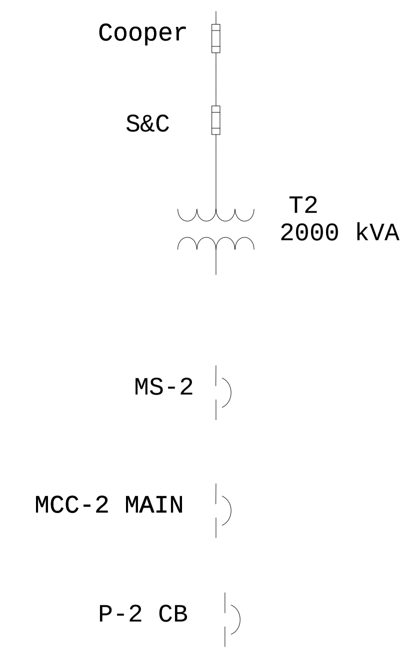
SN: JOHNCAROL1
Rev: Base
Fault: Phase





ETAP Star 7.1.0C

Pump 2

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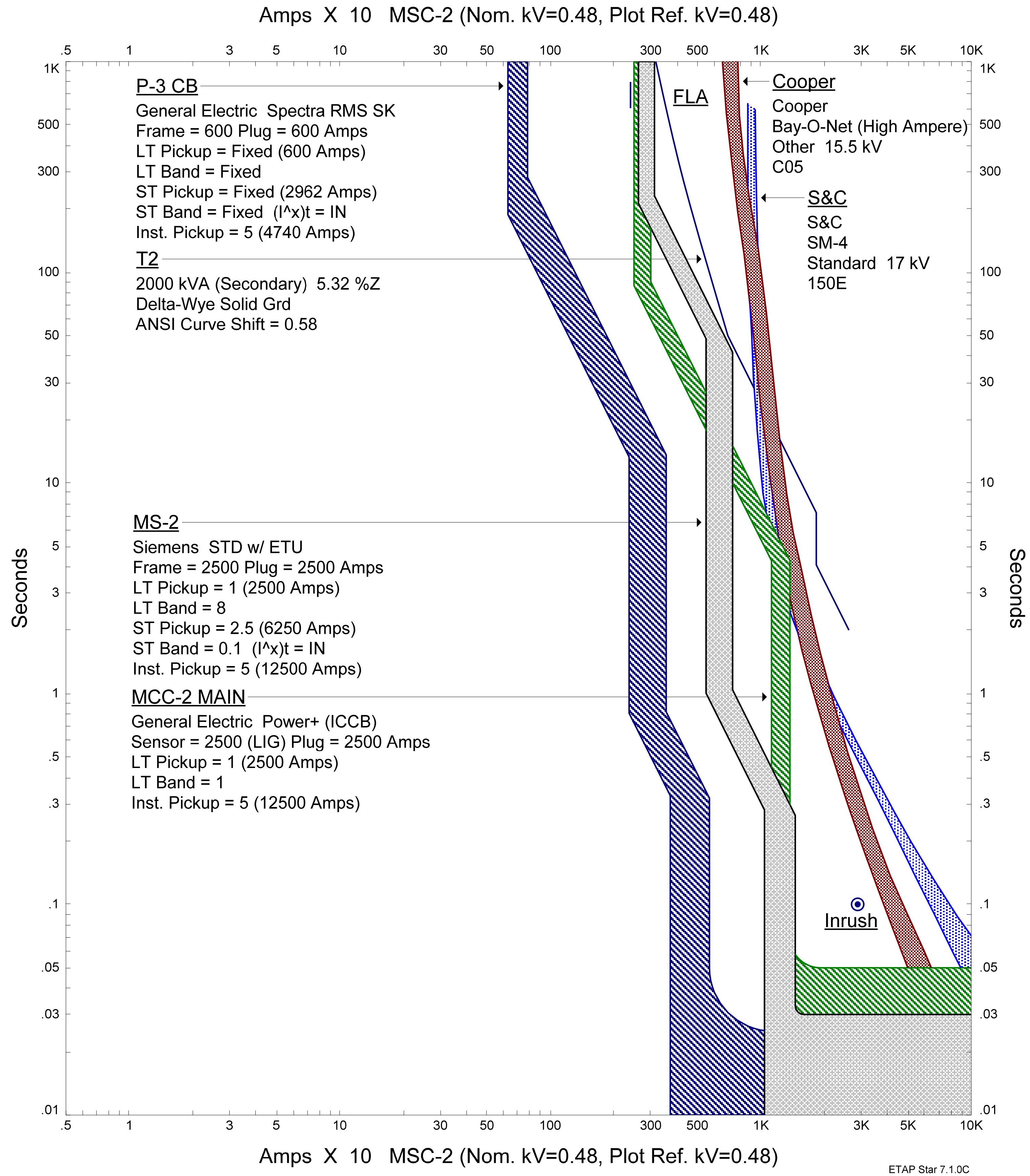
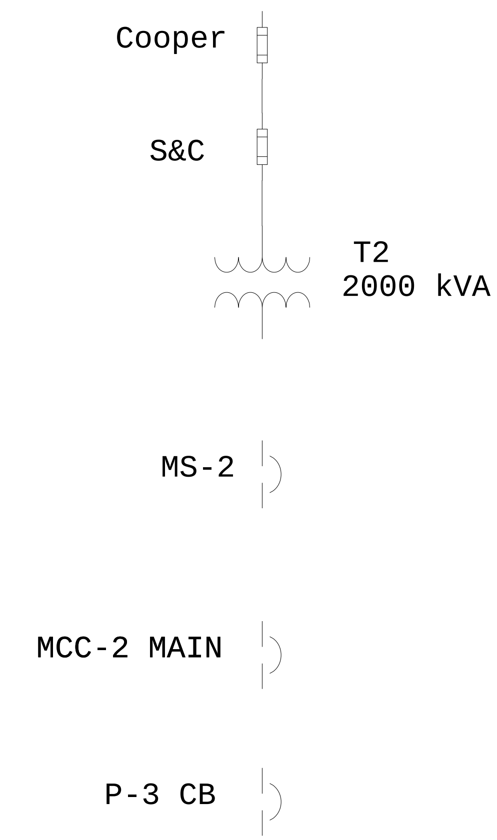
Date: 05-04-2011
SN: JOHNCAROL1
Rev: Base
Fault: Ground





Pump 3

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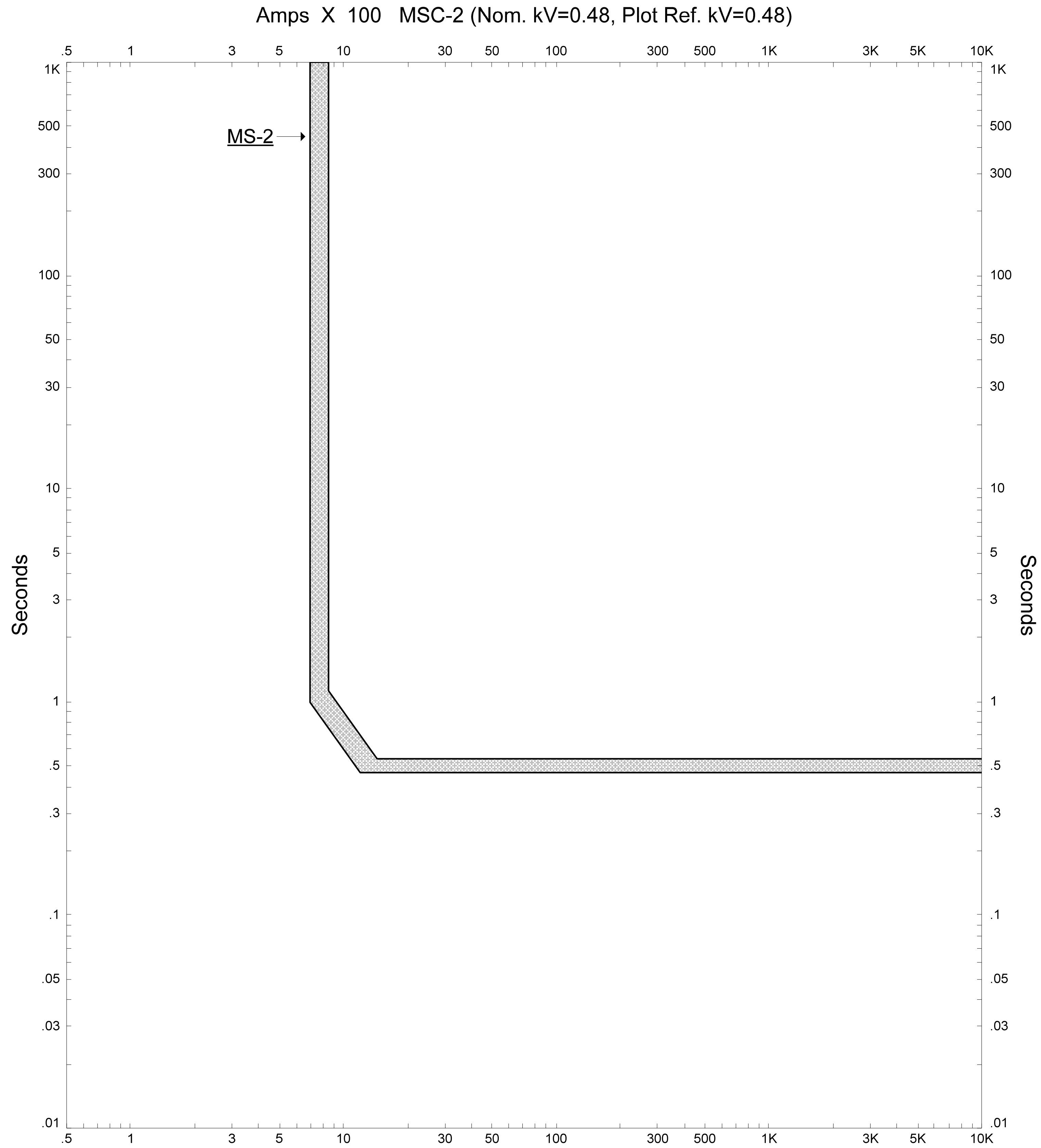
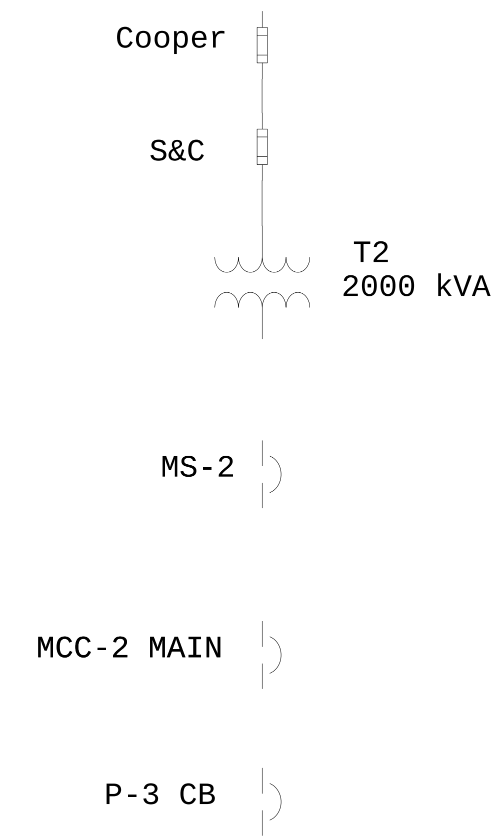
SN: JOHNCAROL1
Rev: Base
Fault: Phase





ETAP Star 7.1.0C

Pump 3

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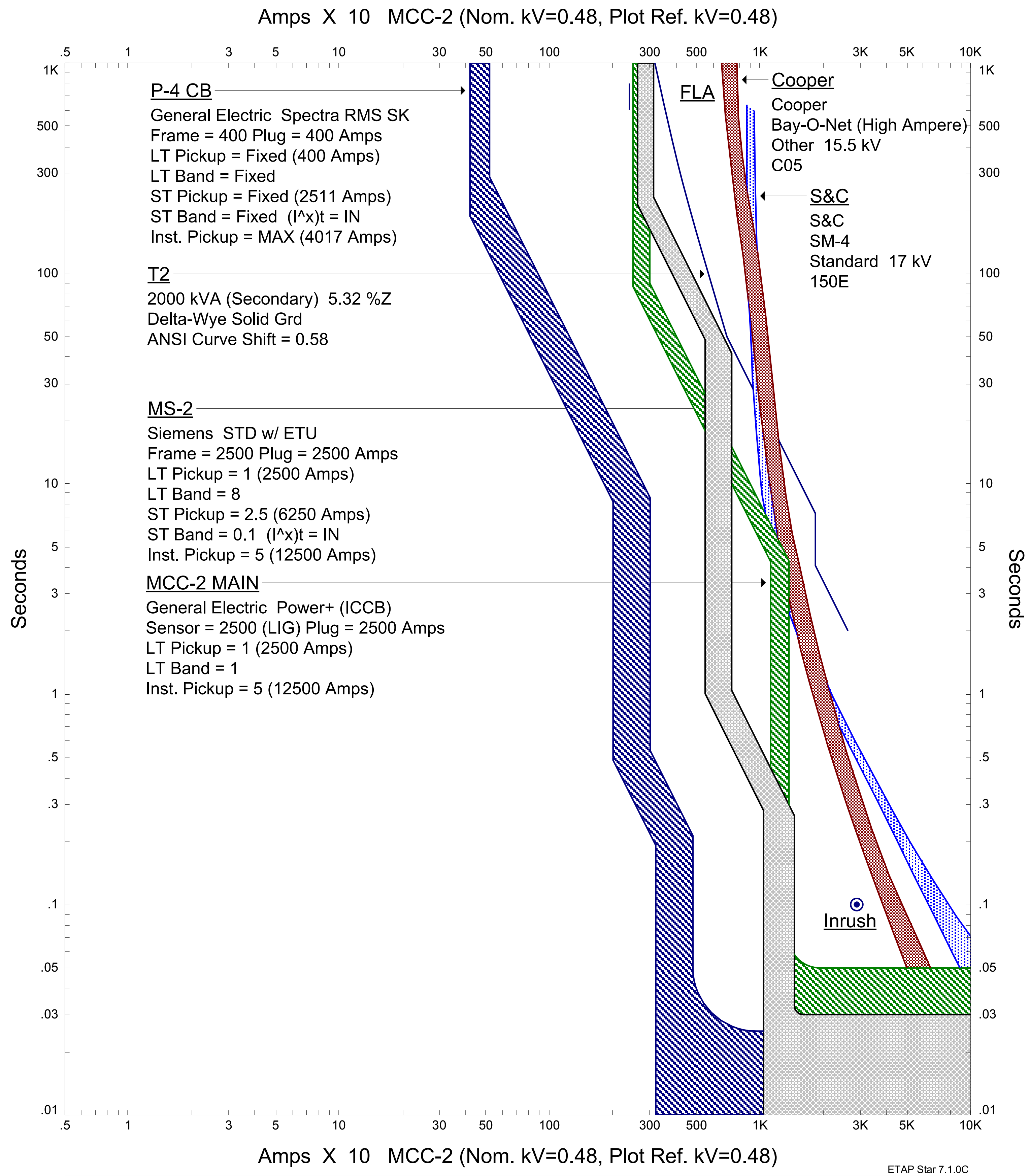
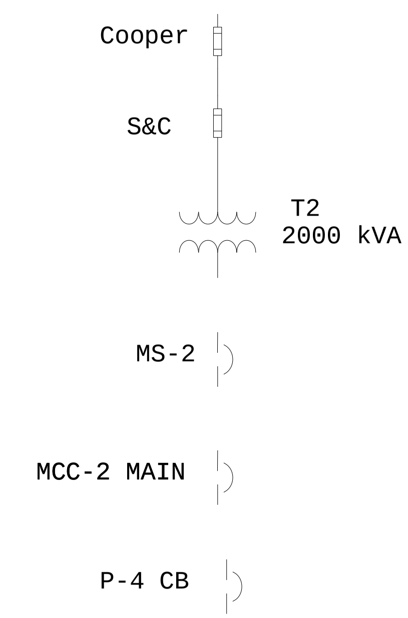
SN: JOHNCAROL1
Rev: Base
Fault: Ground





Pump 4

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Engineer:
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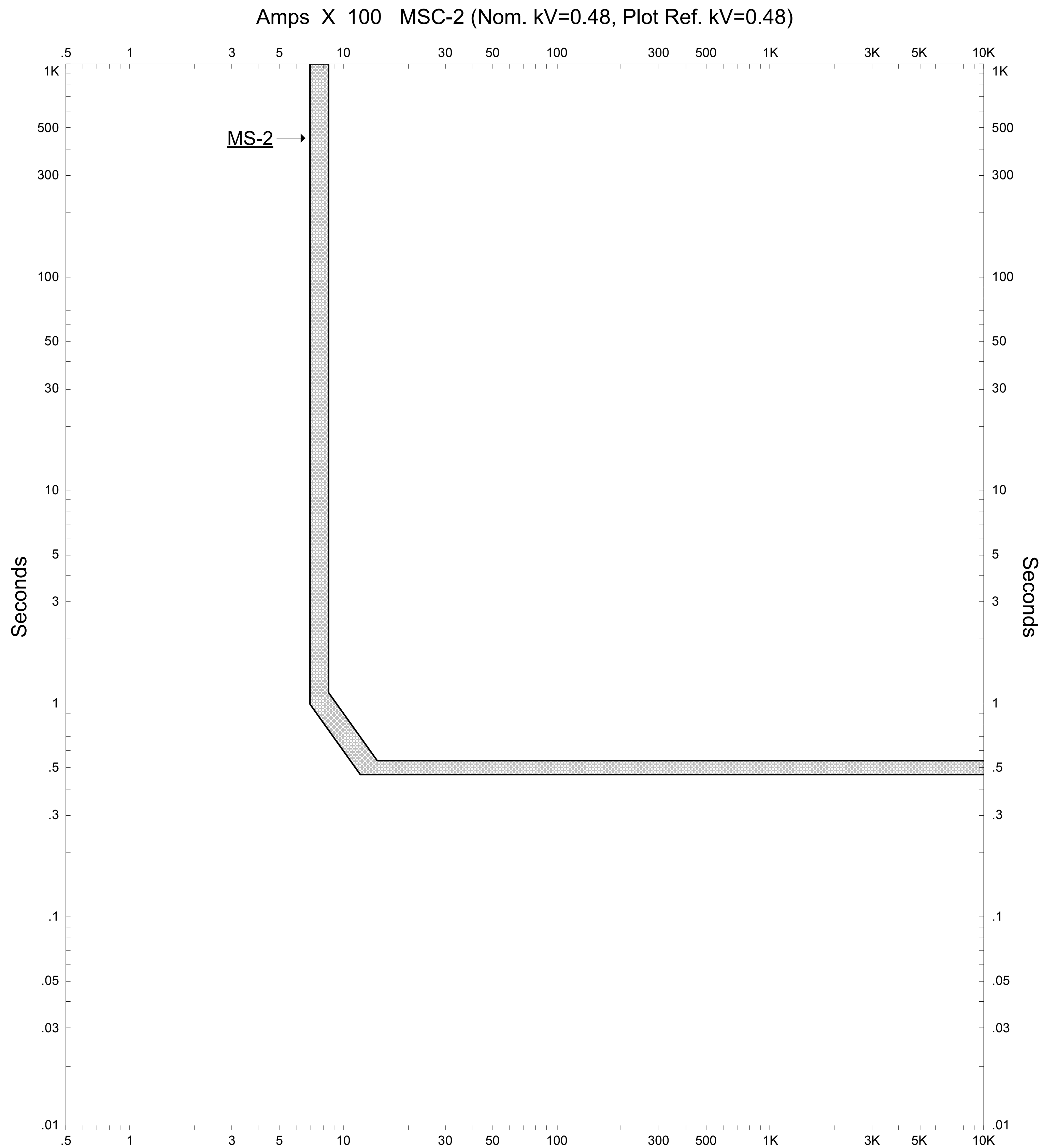
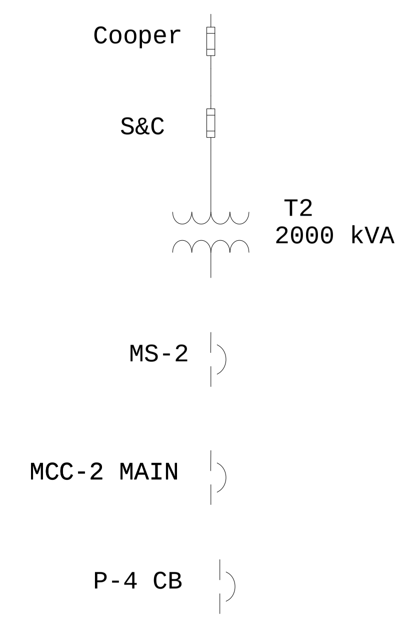
SN: JOHNCAROL1
Rev: Base
Fault: Phase



Amps X 100 MSC-2 (Nom. kV=0.48, Plot Ref. kV=0.48)



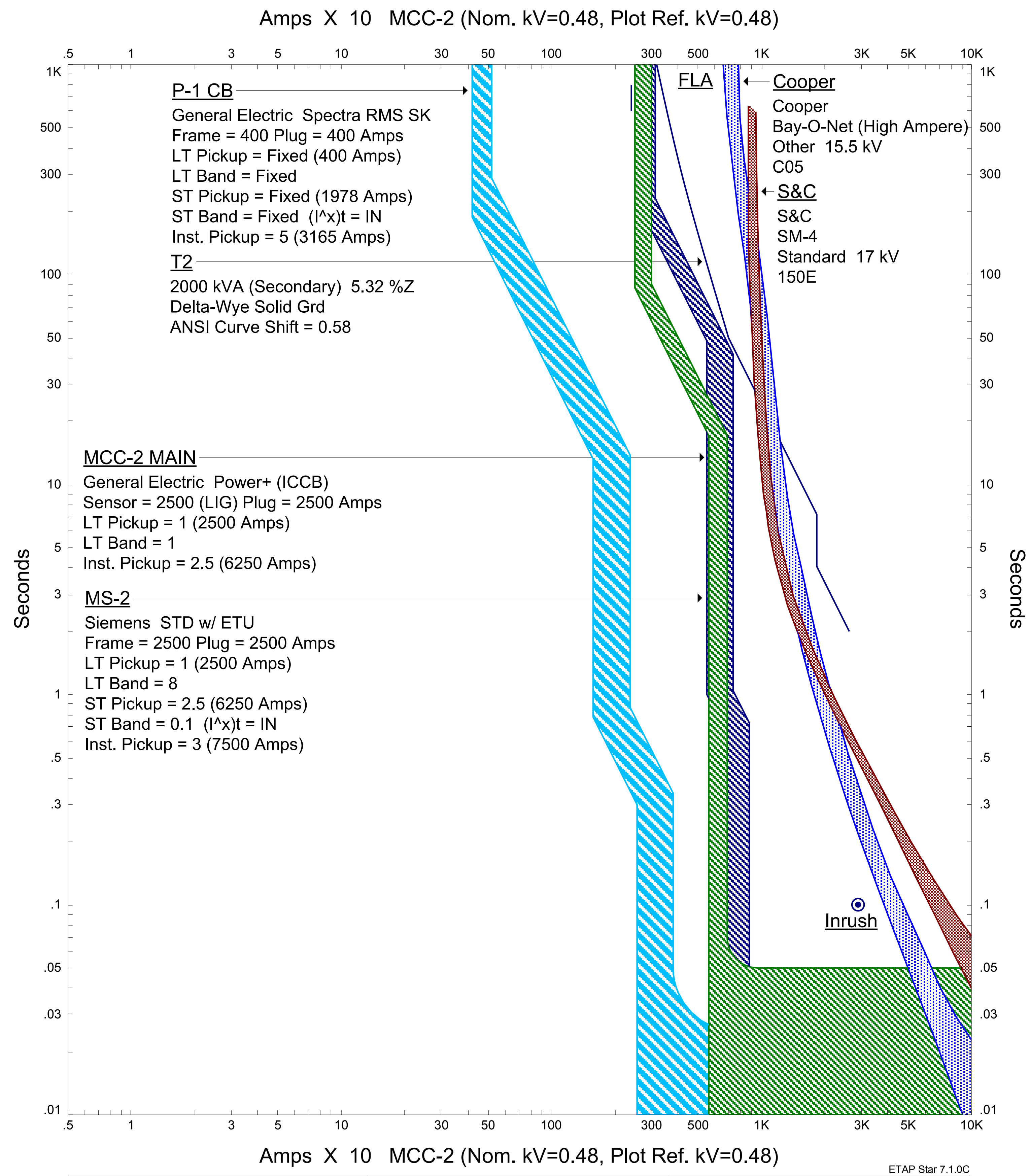
ETAP Star 7.1.0C

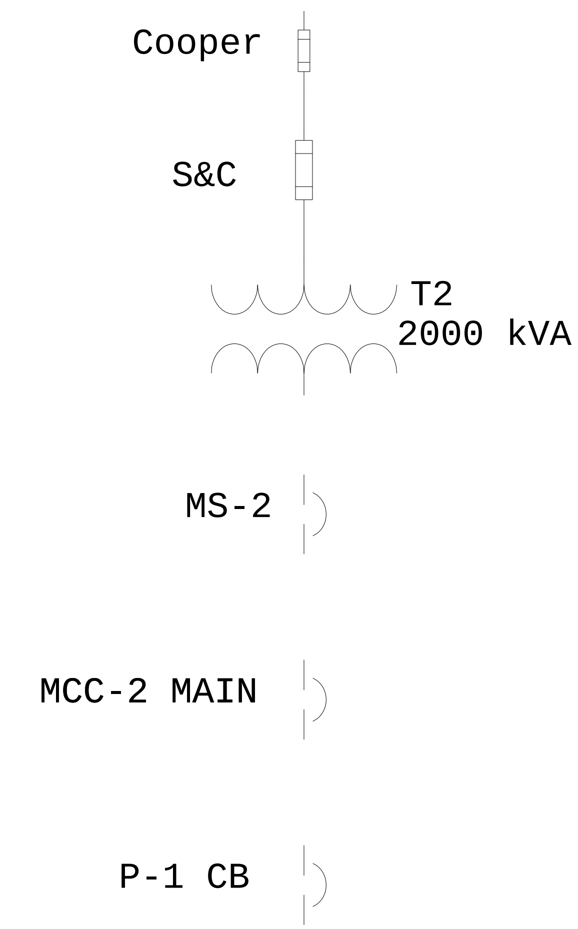
Pump 4

Project:
Location:
Contract:
Engineer:
Filename: H:\Client\SFID\Arc Flash_ETAP\Cielo PS\Cielo PS\CieloPS.OTI

Date: 05-04-2011
SN: JOHNCAROL1
Rev: Base
Fault: Ground

CIELO REVISED TIME CURRENT CURVE





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Contract:
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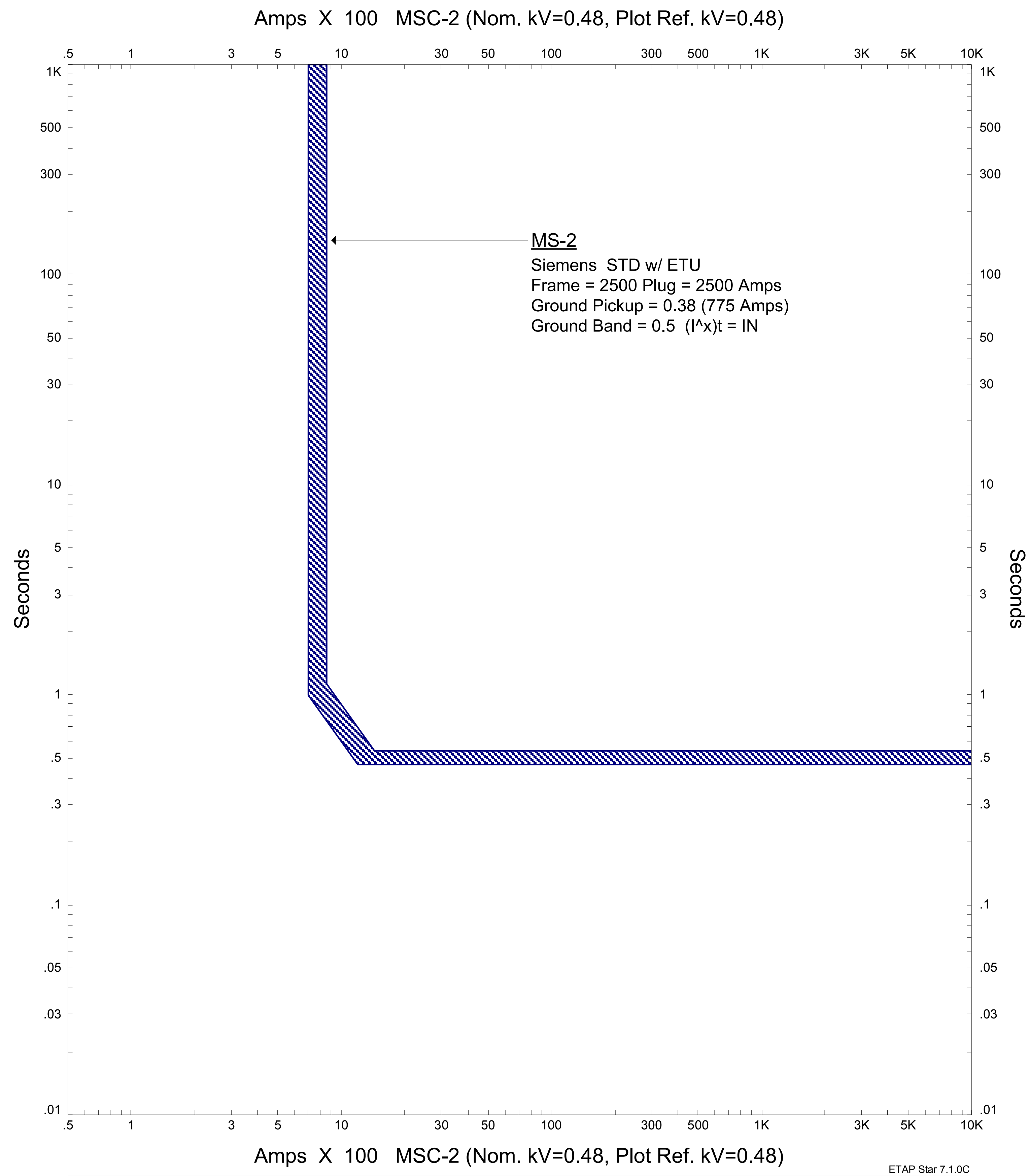
Date: 05-04-2011
SN: JOHNCAROL1
Rev: Revision 1
Fault: Phase



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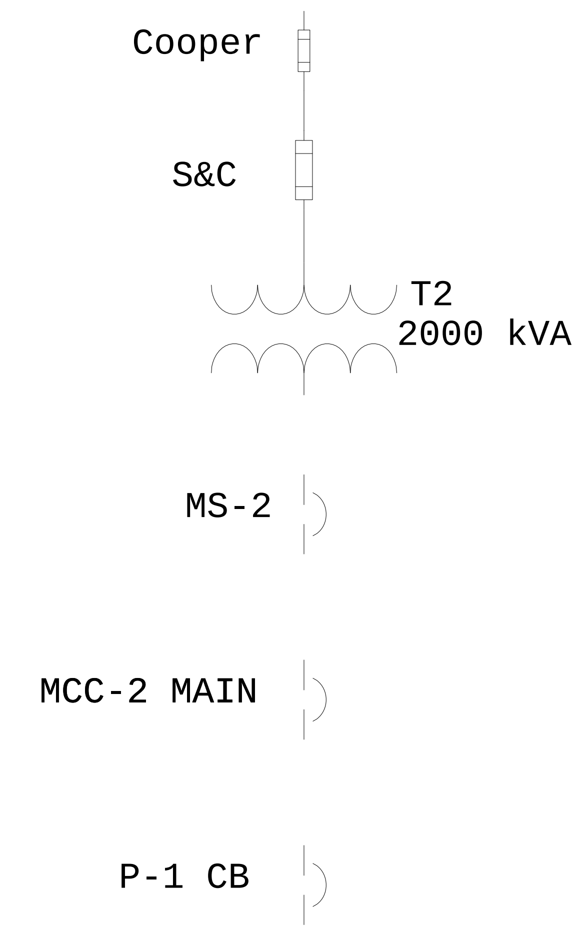
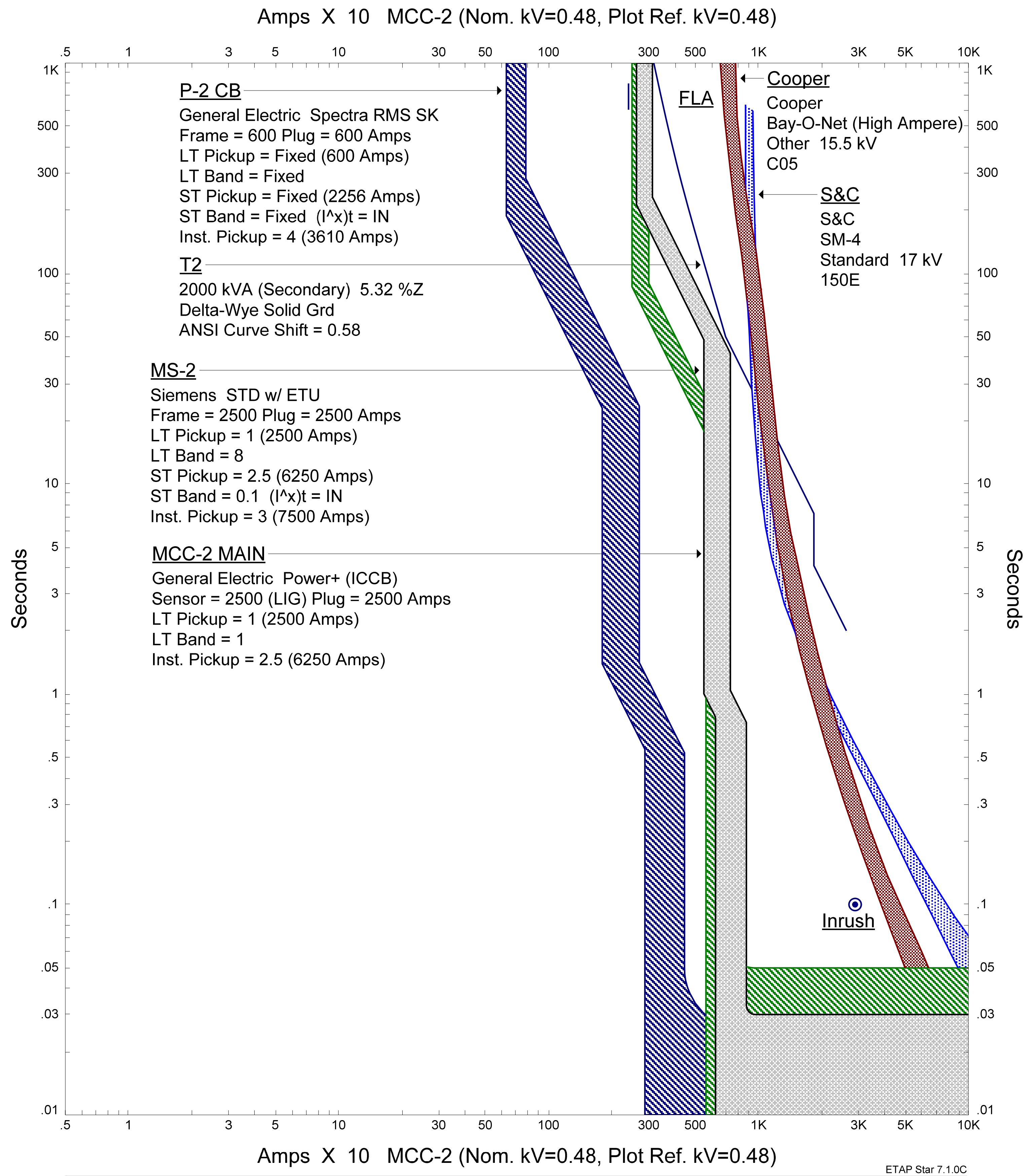
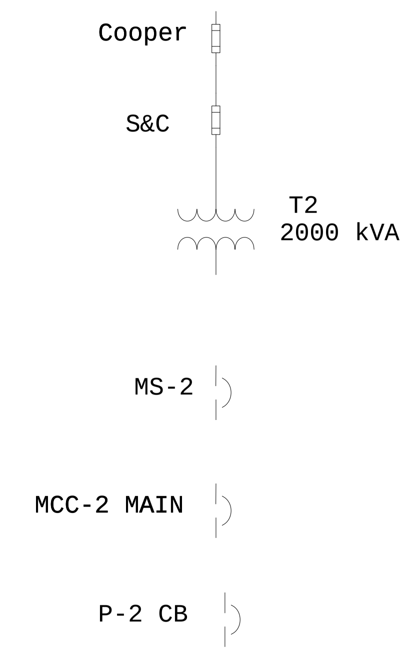
Date: 05-04-2011
SN: JOHNCAROL1
Rev: Revision 1
Fault: Ground







Pump 2

Project:
Location:
Contract:
Engineer:
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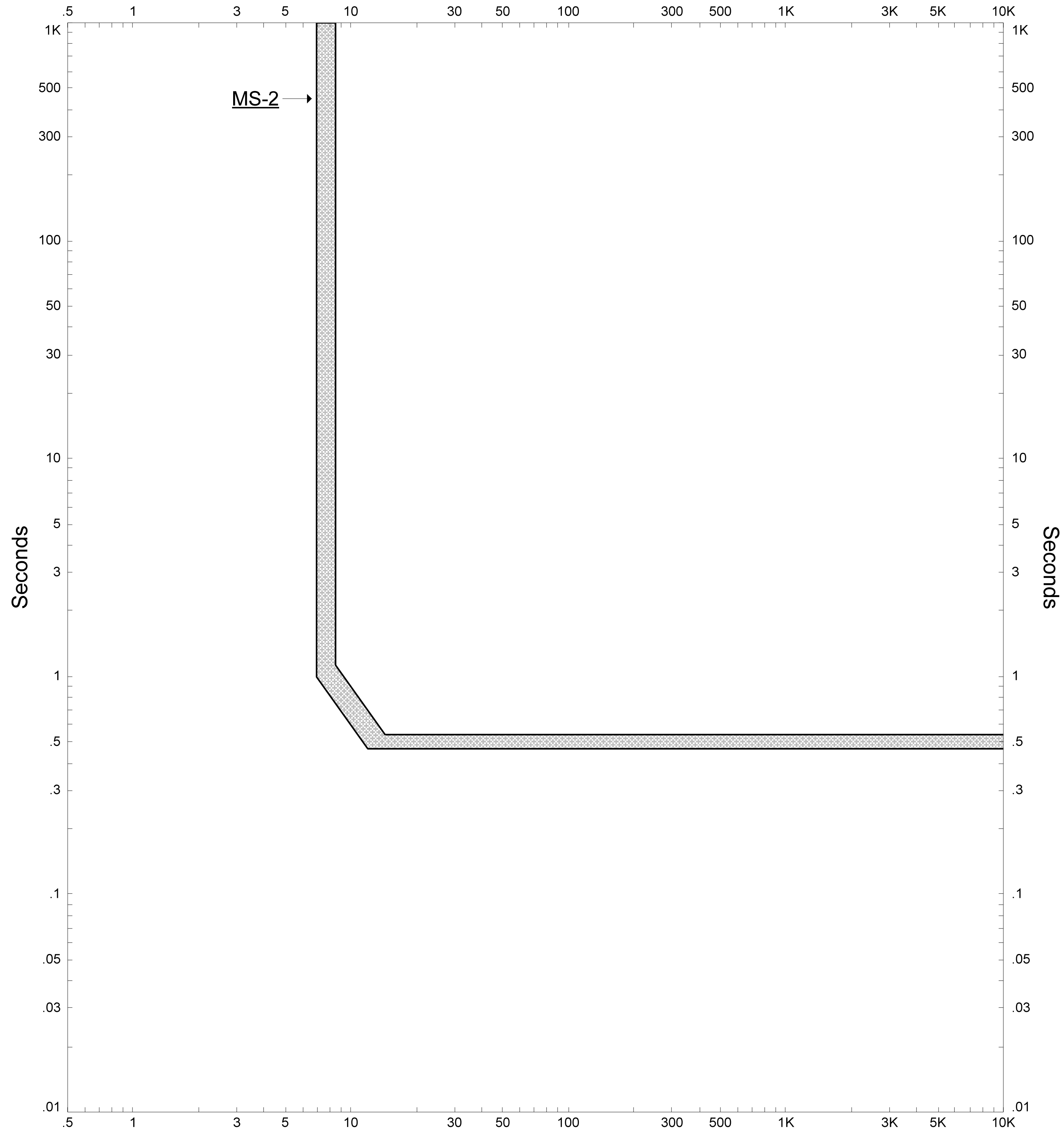
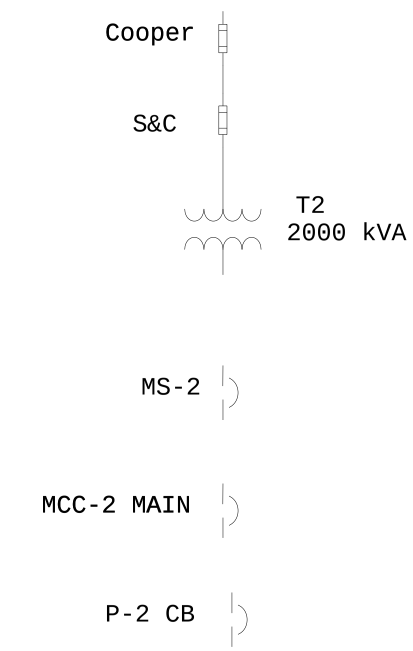
Date: 05-04-2011
SN: JOHNCAROL1
Rev: Revision 1
Fault: Phase

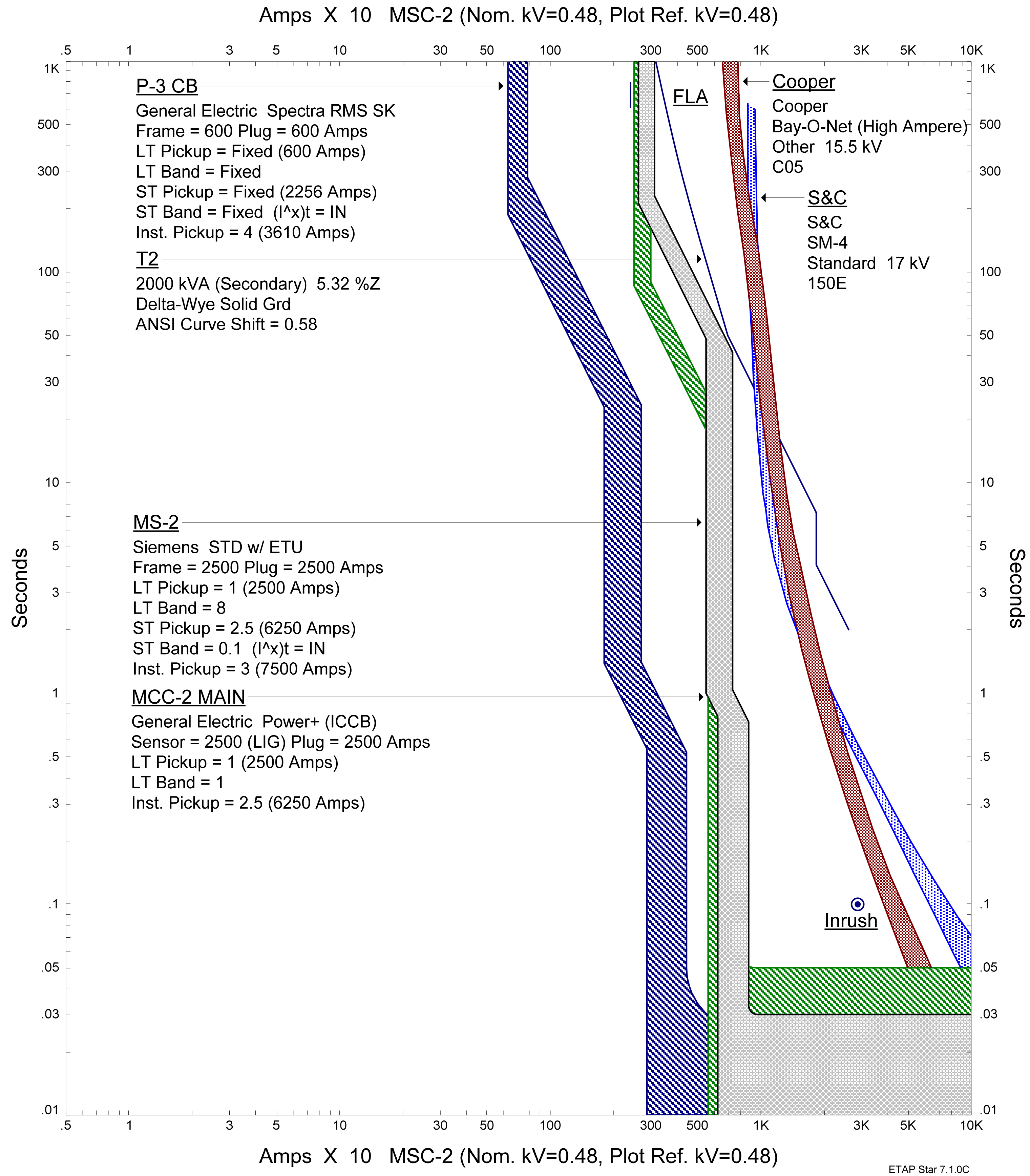


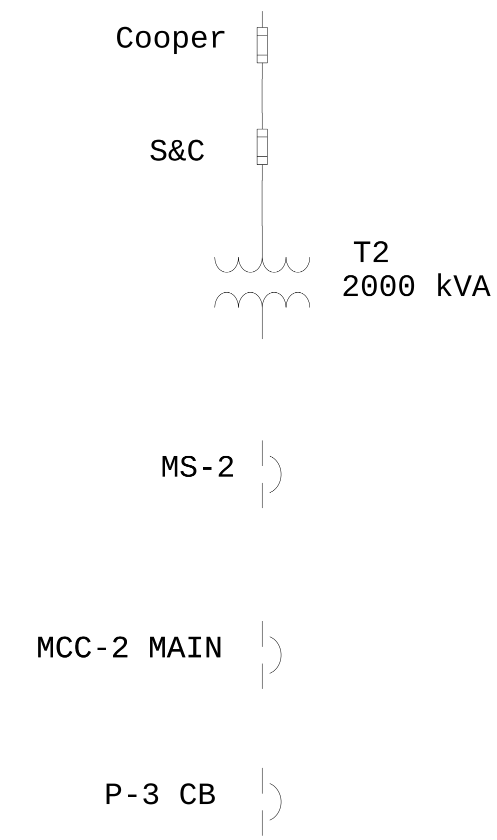
Amps X 100 MSC-2 (Nom. kV=0.48, Plot Ref. kV=0.48)



ETAP Star 7.1.0C

	Pump 2	
Project: Location: Contract: Engineer: Filename: H:\Client\SFID\Arc Flash_ETAP\Cielo PS\Cielo PS\CieloPS.OTI		Date: 05-04-2011 SN: JOHNCAROL1 Rev: Revision 1 Fault: Ground





Pump 3

Project:
Location:
Contract:
Engineer:
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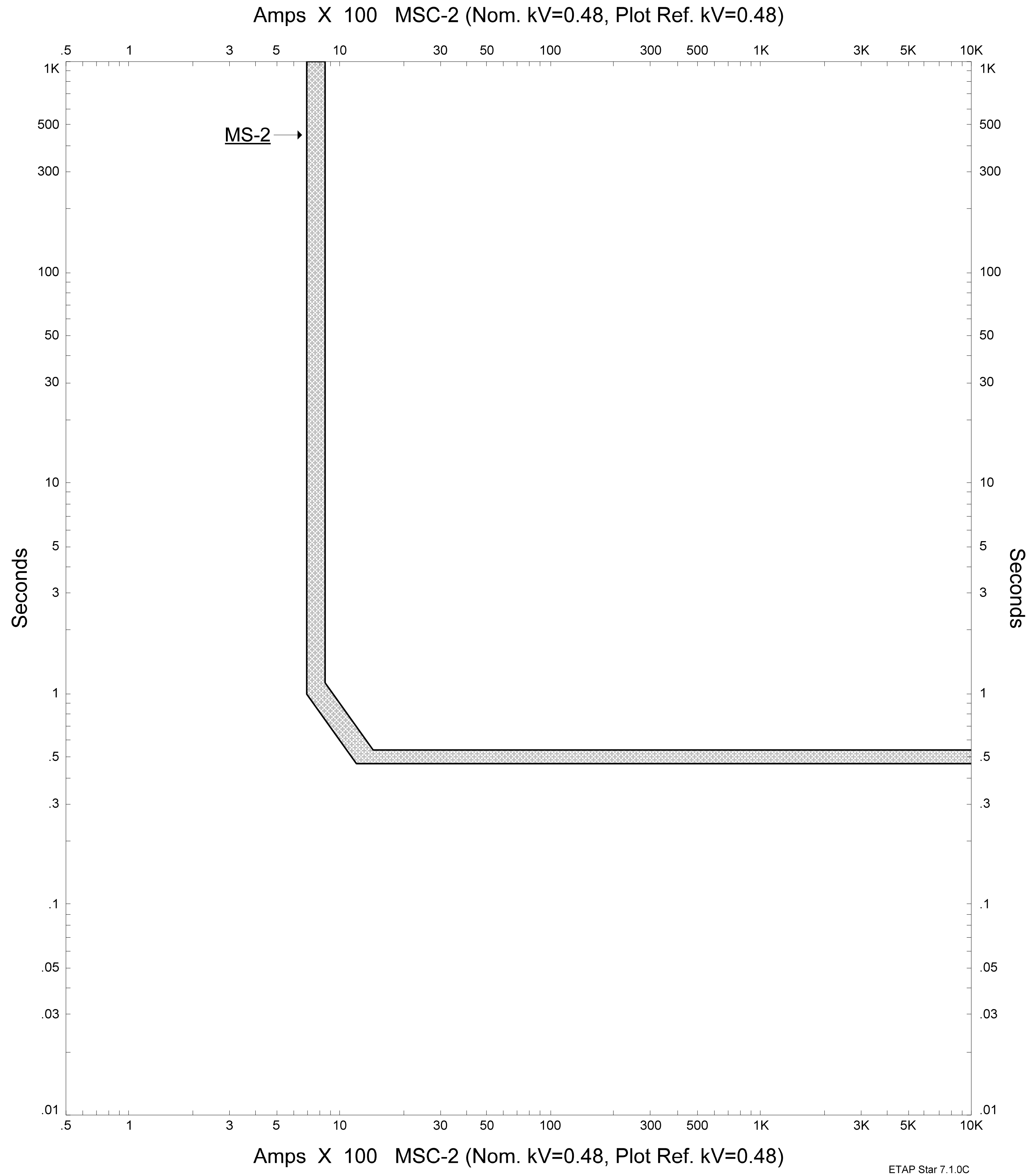
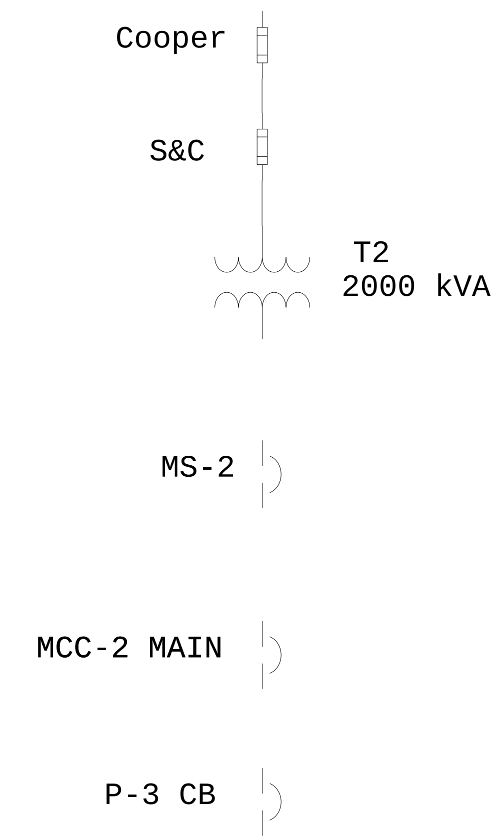
Date: 05-04-2011
SN: JOHNCAROL1
Rev: Revision 1
Fault: Phase

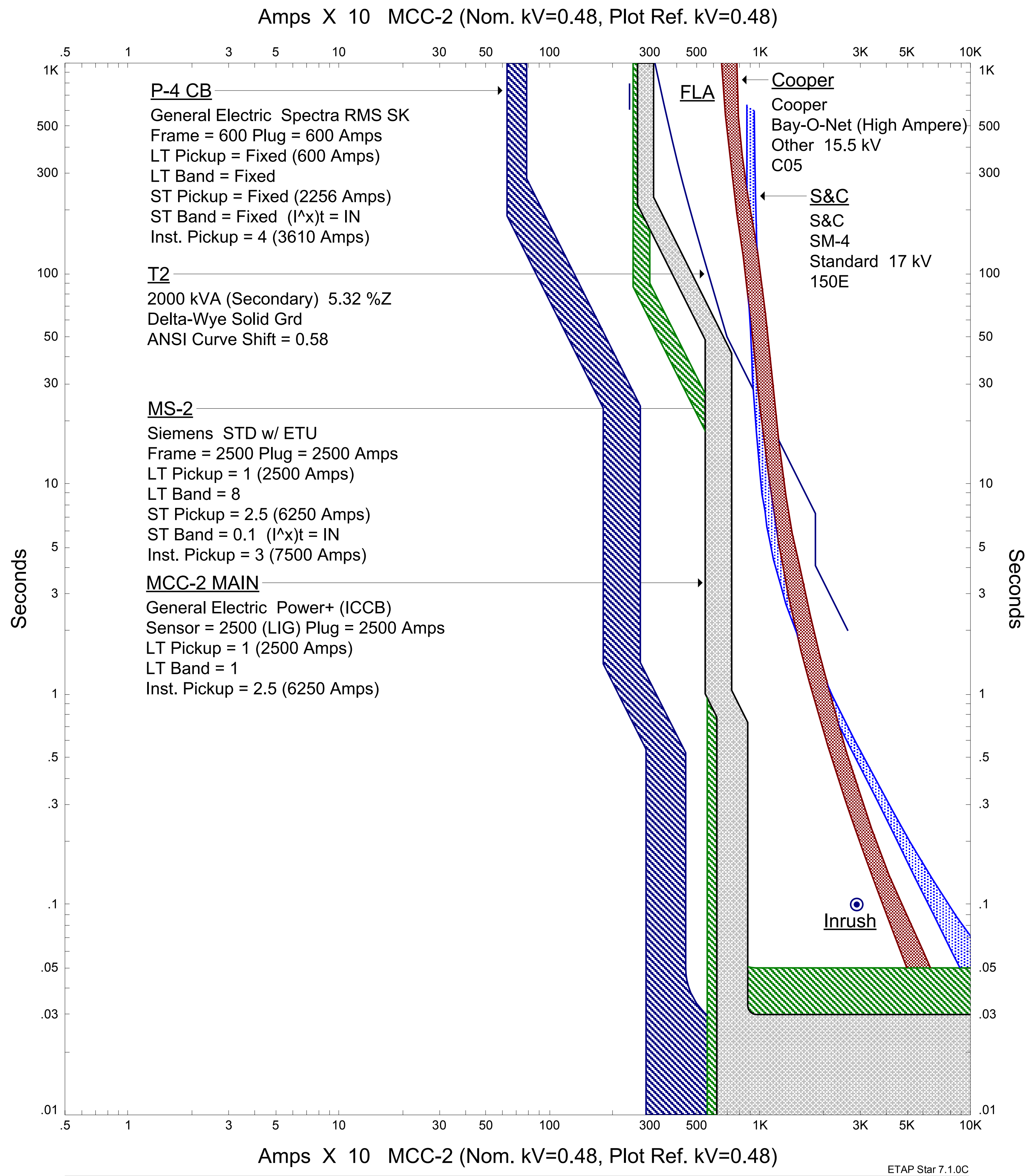


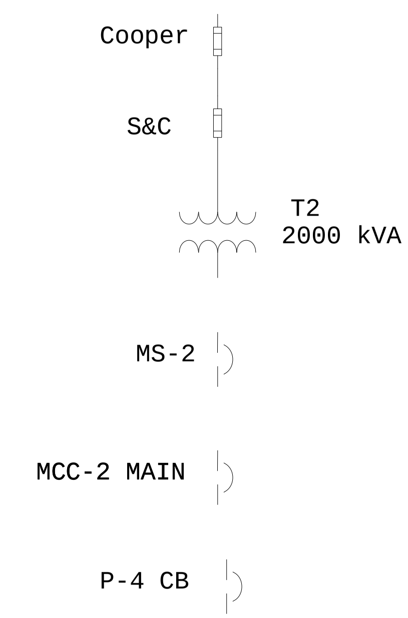


Pump 3

Project:
Location:
Contract:
Engineer:
Filename: H:\Client\SFID\Arc Flash_ETAP\Cielo PS\Cielo PS\CieloPS.OTI

Date: 05-04-2011
SN: JOHNCAROL1
Rev: Revision 1
Fault: Ground





Pump 4

Project:
Location:
Contract:
Engineer:
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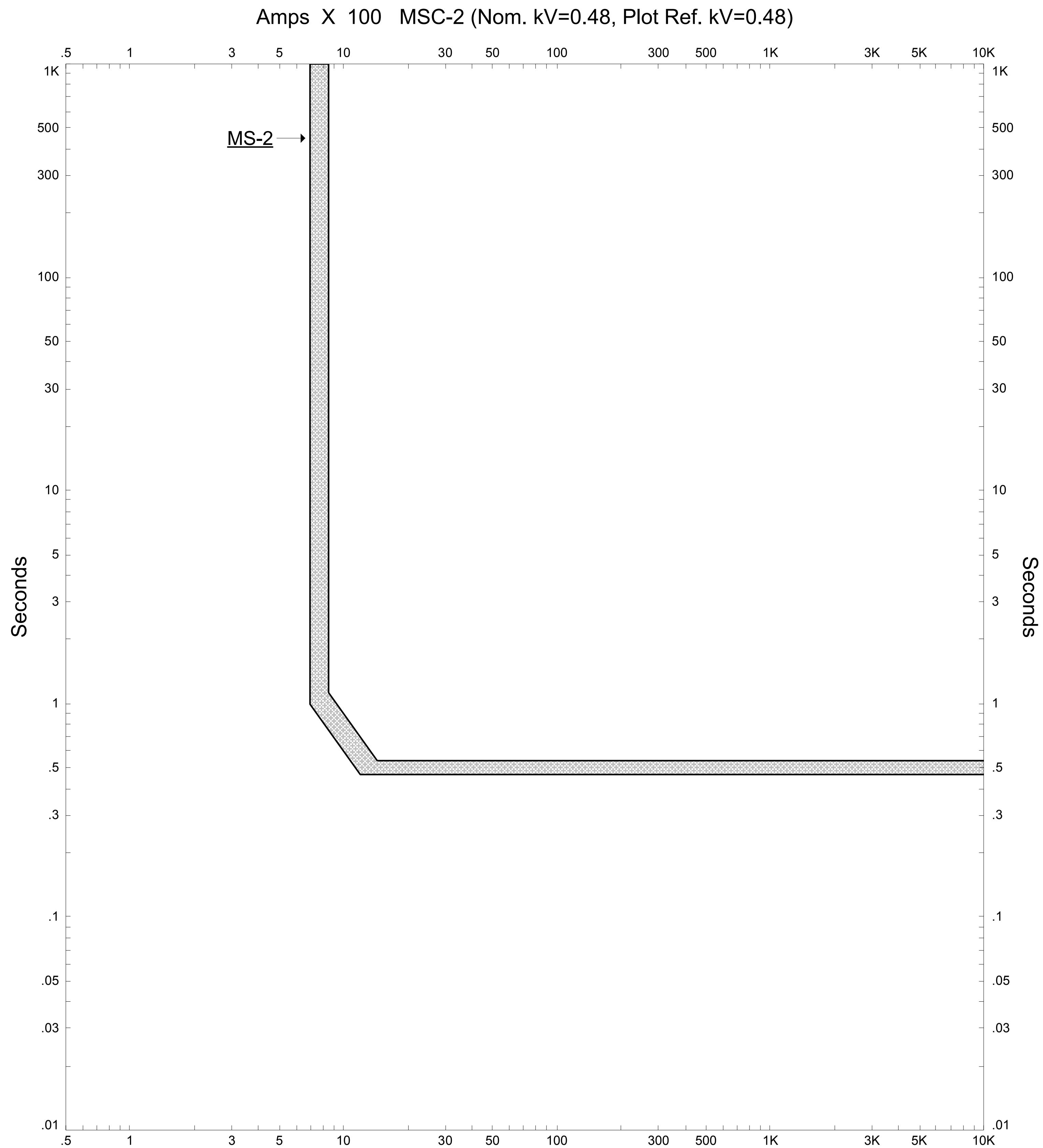
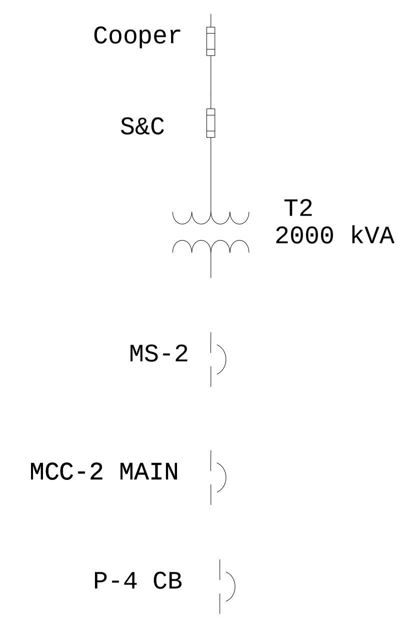
Date: 05-04-2011
SN: JOHNCAROL1
Rev: Revision 1
Fault: Phase





ETAP Star 7.1.0C

Pump 4

Project:
Location:
Contract:
Engineer:
Filename: H:\Client\SFID\Arc Flash_ETAP\Cielo PS\Cielo PS\CieloPS.OTI

Date: 05-04-2011
SN: JOHNCAROL1
Rev: Revision 1
Fault: Ground

CIELO ORIGINAL ARCH FLASH RESULTS

ID	kV	Total Energy (Cal/cm^2)	Flash Protection Boundary (ft)	PPE Description	Hazard Category
AC-2	0.48	0.3	0.7	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
AC-2 DISCONNECT	0.48	0.3	0.8	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
ACP-2	0.48	0.2	0.6	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
ACP-2 DISCONNECT	0.48	0.3	0.7	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
ATS Utility Bus	0.48	31.2	7.6	A total clothing system consisting of FR shirt and pants and/or FR coveralls and/or arc flash coat and pants (clothing system minimum arc rating of 40)	Cat 4
MCC-2	0.48	31.2	7.6	A total clothing system consisting of FR shirt and pants and/or FR coveralls and/or arc flash coat and pants (clothing system minimum arc rating of 40)	Cat 4
MCC-2 LINE	0.48	31.2	7.6	A total clothing system consisting of FR shirt and pants and/or FR coveralls and/or arc flash coat and pants (clothing system minimum arc rating of 40)	Cat 4
MSC-2	0.48	137.7	16.1	Must be de-energized before work is performed.	> Cat 4
P-1-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-1 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-2-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-2 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-3-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1

P-3 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-4-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-4 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
T2 Load Side	0.48	158.8	17.2	Must be de-energized before work is performed.	> Cat 4

CIELO REVISED ARCH FLASH RESULTS

ID	kV	Total Energy (Cal/cm^2)	Flash Protection Boundary (ft)	PPE Description	Hazard Category
AC-2	0.48	0.3	0.7	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
AC-2 DISCONNECT	0.48	0.3	0.8	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
ACP-2	0.48	0.2	0.6	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
ACP-2 DISCONNECT	0.48	0.3	0.7	Non-melting or untreated natural fiber long-sleeve shirt, long pants, safety glasses, hearing protection, and leather gloves	Cat 0
ATS Utility Bus	0.48	2.1	2	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
MCC-2	0.48	2.1	2	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
MCC-2 LINE	0.48	2.1	2	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
MSC-2	0.48	137.7	16.1	Must be de-energized before work is performed.	> Cat 4
P-1-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-1 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-2-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-2 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1

P-3-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-3 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-4-RVSS	0.48	1.6	1.8	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
P-4 Term	0.48	1.5	1.7	FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8) or FR coveralls (minimum arc rating of 8)	Cat 1
T2 Load Side	0.48	158.8	17.2	Must be de-energized before work is performed.	> Cat 4

APPENDIX D:
Net Present Value Calculations for Solar Photovoltaic Options

Area 1 Net Present Value Analysis

Net Present Value Analysis Parameters & Assumptions	
PV System Size (kW)	287
PV System Construction Cost (2012 Dollars)	$ 2,296,000
Year 1 Energy Production (kWh)	473,550
Annual O&M Cost (2012 Dollars)	$ 5,000
Year 20 Equipment Replacement (2012 Dollars)	$ 229,600
Annual Output Degradation (% of Year 1)	0.2309%
SDG&E Year 1 Average Energy Rate ($/kWh)	$ 0.1000
SDG&E Average Annual Rate Escalation	3.00%
Average Annual Inflation Rate	3.00%
Project Discount Rate	3.00%
California Solar Initiative	$ 0.1500
California Solar Initiative 5-Year Total	$ 353,522
Net Present Value (30-Year System Life)	$ (1,007,600)

Net Present Value Analysis Annual Cash Flows

Year	Capital Cost	O&M Cost	Energy Production (kWh)	SDG&E Energy Rate ($/kWh)	Energy Production Value	California Solar Initiative Rebate	Annual Cash Flow	Discounted Annual Cash Flow	Cumulative Discounted Annual Cash Flow
0	$ (2,296,000)	$ -	0	$ -	$ -	$ -	$ (2,296,000)	$ (2,296,000)	$ (2,296,000)
1	$ -	$ (5,000)	473,550	$ 0.1000	$ 47,355	$ 71,033	$ 113,388	$ 110,085	$ (2,185,915)
2	$ -	$ (5,150)	472,457	$ 0.1030	$ 48,663	$ 70,868	$ 114,382	$ 107,816	$ (2,078,100)
3	$ -	$ (5,305)	471,363	$ 0.1061	$ 50,007	$ 70,704	$ 115,407	$ 105,614	$ (1,972,486)
4	$ -	$ (5,464)	470,270	$ 0.1093	$ 51,388	$ 70,540	$ 116,464	$ 103,477	$ (1,869,009)
5	$ -	$ (5,628)	469,176	$ 0.1126	$ 52,806	$ 70,376	$ 117,555	$ 101,404	$ (1,767,605)
6	$ -	$ (5,796)	468,083	$ 0.1159	$ 54,264	$ -	$ 48,467	$ 40,591	$ (1,727,014)
7	$ -	$ (5,970)	466,989	$ 0.1194	$ 55,761	$ -	$ 49,791	$ 40,484	$ (1,686,530)
8	$ -	$ (6,149)	465,896	$ 0.1230	$ 57,299	$ -	$ 51,150	$ 40,378	$ (1,646,151)
9	$ -	$ (6,334)	464,803	$ 0.1267	$ 58,880	$ -	$ 52,546	$ 40,272	$ (1,605,879)
10	$ -	$ (6,524)	463,709	$ 0.1305	$ 60,504	$ -	$ 53,980	$ 40,166	$ (1,565,713)
11	$ -	$ (6,720)	462,616	$ 0.1344	$ 62,172	$ -	$ 55,452	$ 40,060	$ (1,525,654)
12	$ -	$ (6,921)	461,522	$ 0.1384	$ 63,885	$ -	$ 56,964	$ 39,954	$ (1,485,700)
13	$ -	$ (7,129)	460,429	$ 0.1426	$ 65,646	$ -	$ 58,517	$ 39,847	$ (1,445,852)
14	$ -	$ (7,343)	459,335	$ 0.1469	$ 67,455	$ -	$ 60,112	$ 39,741	$ (1,406,111)
15	$ -	$ (7,563)	458,242	$ 0.1513	$ 69,313	$ -	$ 61,750	$ 39,635	$ (1,366,476)
16	$ -	$ (7,790)	457,149	$ 0.1558	$ 71,222	$ -	$ 63,432	$ 39,529	$ (1,326,947)
17	$ -	$ (8,024)	456,055	$ 0.1605	$ 73,183	$ -	$ 65,160	$ 39,423	$ (1,287,524)
18	$ -	$ (8,264)	454,962	$ 0.1653	$ 75,198	$ -	$ 66,934	$ 39,317	$ (1,248,208)
19	$ -	$ (8,512)	453,868	$ 0.1702	$ 77,268	$ -	$ 68,756	$ 39,211	$ (1,208,997)
20	$ -	$ (411,373)	452,775	$ 0.1754	$ 79,394	$ -	$ (331,978)	$ (183,808)	$ (1,392,805)
21	$ -	$ (9,031)	451,681	$ 0.1806	$ 81,579	$ -	$ 72,548	$ 38,998	$ (1,353,807)
22	$ -	$ (9,301)	450,588	$ 0.1860	$ 83,823	$ -	$ 74,521	$ 38,892	$ (1,314,915)
23	$ -	$ (9,581)	449,495	$ 0.1916	$ 86,128	$ -	$ 76,547	$ 38,786	$ (1,276,129)
24	$ -	$ (9,868)	448,401	$ 0.1974	$ 88,496	$ -	$ 78,628	$ 38,680	$ (1,237,449)
25	$ -	$ (10,164)	447,308	$ 0.2033	$ 90,928	$ -	$ 80,764	$ 38,574	$ (1,198,876)
26	$ -	$ (10,469)	446,214	$ 0.2094	$ 93,427	$ -	$ 82,958	$ 38,467	$ (1,160,408)
27	$ -	$ (10,783)	445,121	$ 0.2157	$ 95,994	$ -	$ 85,211	$ 38,361	$ (1,122,047)
28	$ -	$ (11,106)	444,027	$ 0.2221	$ 98,631	$ -	$ 87,525	$ 38,255	$ (1,083,792)
29	$ -	$ (11,440)	442,934	$ 0.2288	$ 101,340	$ -	$ 89,900	$ 38,149	$ (1,045,643)
30	$ -	$ (11,783)	441,841	$ 0.2357	$ 104,123	$ -	$ 92,340	$ 38,043	$ (1,007,600)

Area 2 Net Present Value Analysis

Net Present Value Analysis Parameters & Assumptions	
PV System Size (kW)	710
PV System Construction Cost (2012 Dollars)	$ 5,680,000
Year 1 Energy Production (kWh)	1,171,500
Annual O&M Cost (2012 Dollars)	$ 12,369
Year 20 Equipment Replacement (2012 Dollars)	$ 568,000
Annual Output Degradation (% of Year 1)	0.2309%
SDG&E Year 1 Average Energy Rate ($/kWh)	$ 0.1000
SDG&E Average Annual Rate Escalation	3.00%
Average Annual Inflation Rate	3.00%
Project Discount Rate	3.00%
California Solar Initiative	$ 0.1500
California Solar Initiative 5-Year Total	$ 874,568
Net Present Value (30-Year System Life)	$ (2,492,670)

Net Present Value Analysis Annual Cash Flows

Year	Capital Cost	O&M Cost	Energy Production (kWh)	SDG&E Energy Rate ($/kWh)	Energy Production Value	California Solar Initiative Rebate	Annual Cash Flow	Discounted Annual Cash Flow	Cumulative Discounted Annual Cash Flow
0	$ (5,680,000)	$ -	0	$ -	$ -	$ -	$ (5,680,000)	$ (5,680,000)	$ (5,680,000)
1	$ -	$ (12,369)	1,171,500	$ 0.1000	$ 117,150	$ 175,725	$ 280,506	$ 272,336	$ (5,407,664)
2	$ -	$ (12,740)	1,168,795	$ 0.1030	$ 120,386	$ 175,319	$ 282,965	$ 266,721	$ (5,140,943)
3	$ -	$ (13,123)	1,166,090	$ 0.1061	$ 123,710	$ 174,914	$ 285,501	$ 261,274	$ (4,879,669)
4	$ -	$ (13,516)	1,163,385	$ 0.1093	$ 127,126	$ 174,508	$ 288,118	$ 255,989	$ (4,623,680)
5	$ -	$ (13,922)	1,160,680	$ 0.1126	$ 130,636	$ 174,102	$ 290,816	$ 250,860	$ (4,372,820)
6	$ -	$ (14,339)	1,157,975	$ 0.1159	$ 134,241	$ -	$ 119,902	$ 100,416	$ (4,272,404)
7	$ -	$ (14,770)	1,155,270	$ 0.1194	$ 137,945	$ -	$ 123,176	$ 100,153	$ (4,172,251)
8	$ -	$ (15,213)	1,152,565	$ 0.1230	$ 141,751	$ -	$ 126,538	$ 99,890	$ (4,072,361)
9	$ -	$ (15,669)	1,149,860	$ 0.1267	$ 145,661	$ -	$ 129,992	$ 99,628	$ (3,972,733)
10	$ -	$ (16,139)	1,147,155	$ 0.1305	$ 149,678	$ -	$ 133,539	$ 99,365	$ (3,873,368)
11	$ -	$ (16,623)	1,144,450	$ 0.1344	$ 153,805	$ -	$ 137,181	$ 99,103	$ (3,774,265)
12	$ -	$ (17,122)	1,141,745	$ 0.1384	$ 158,044	$ -	$ 140,922	$ 98,840	$ (3,675,425)
13	$ -	$ (17,636)	1,139,040	$ 0.1426	$ 162,400	$ -	$ 144,764	$ 98,577	$ (3,576,848)
14	$ -	$ (18,165)	1,136,335	$ 0.1469	$ 166,875	$ -	$ 148,710	$ 98,315	$ (3,478,533)
15	$ -	$ (18,710)	1,133,630	$ 0.1513	$ 171,472	$ -	$ 152,762	$ 98,052	$ (3,380,481)
16	$ -	$ (19,271)	1,130,925	$ 0.1558	$ 176,194	$ -	$ 156,923	$ 97,789	$ (3,282,691)
17	$ -	$ (19,849)	1,128,220	$ 0.1605	$ 181,046	$ -	$ 161,197	$ 97,527	$ (3,185,164)
18	$ -	$ (20,445)	1,125,515	$ 0.1653	$ 186,030	$ -	$ 165,586	$ 97,264	$ (3,087,900)
19	$ -	$ (21,058)	1,122,810	$ 0.1702	$ 191,151	$ -	$ 170,093	$ 97,002	$ (2,990,899)
20	$ -	$ (1,017,681)	1,120,105	$ 0.1754	$ 196,411	$ -	$ (821,270)	$ (454,717)	$ (3,445,616)
21	$ -	$ (22,340)	1,117,400	$ 0.1806	$ 201,815	$ -	$ 179,474	$ 96,476	$ (3,349,139)
22	$ -	$ (23,011)	1,114,695	$ 0.1860	$ 207,366	$ -	$ 184,356	$ 96,214	$ (3,252,926)
23	$ -	$ (23,701)	1,111,990	$ 0.1916	$ 213,069	$ -	$ 189,368	$ 95,951	$ (3,156,975)
24	$ -	$ (24,412)	1,109,285	$ 0.1974	$ 218,927	$ -	$ 194,515	$ 95,689	$ (3,061,286)
25	$ -	$ (25,144)	1,106,580	$ 0.2033	$ 224,945	$ -	$ 199,801	$ 95,426	$ (2,965,860)
26	$ -	$ (25,899)	1,103,875	$ 0.2094	$ 231,127	$ -	$ 205,228	$ 95,163	$ (2,870,697)
27	$ -	$ (26,676)	1,101,170	$ 0.2157	$ 237,477	$ -	$ 210,802	$ 94,901	$ (2,775,796)
28	$ -	$ (27,476)	1,098,465	$ 0.2221	$ 244,001	$ -	$ 216,525	$ 94,638	$ (2,681,158)
29	$ -	$ (28,300)	1,095,760	$ 0.2288	$ 250,702	$ -	$ 222,402	$ 94,375	$ (2,586,783)
30	$ -	$ (29,149)	1,093,055	$ 0.2357	$ 257,586	$ -	$ 228,436	$ 94,113	$ (2,492,670)

Area 3 Net Present Value Analysis

Net Present Value Analysis Parameters & Assumptions	
PV System Size (kW)	437
PV System Construction Cost (2012 Dollars)	$ 3,496,000
Year 1 Energy Production (kWh)	721,050
Annual O&M Cost (2012 Dollars)	$ 7,613
Year 20 Equipment Replacement (2012 Dollars)	$ 349,600
Annual Output Degradation (% of Year 1)	0.2309%
SDG&E Year 1 Average Energy Rate ($/kWh)	$ 0.1000
SDG&E Average Annual Rate Escalation	3.00%
Average Annual Inflation Rate	3.00%
Project Discount Rate	3.00%
California Solar Initiative	$ 0.1500
California Solar Initiative 5-Year Total	$ 538,290
Net Present Value (30-Year System Life)	$ (1,534,221)

Net Present Value Analysis Annual Cash Flows

Year	Capital Cost	O&M Cost	Energy Production (kWh)	SDG&E Energy Rate ($/kWh)	Energy Production Value	California Solar Initiative Rebate	Annual Cash Flow	Discounted Annual Cash Flow	Cumulative Discounted Annual Cash Flow
0	$ (3,496,000)	$ -	0	$ -	$ -	$ -	$ (3,496,000)	$ (3,496,000)	$ (3,496,000)
1	$ -	$ (7,613)	721,050	$ 0.1000	$ 72,105	$ 108,158	$ 172,649	$ 167,621	$ (3,328,379)
2	$ -	$ (7,842)	719,385	$ 0.1030	$ 74,097	$ 107,908	$ 174,163	$ 164,165	$ (3,164,214)
3	$ -	$ (8,077)	717,720	$ 0.1061	$ 76,143	$ 107,658	$ 175,724	$ 160,812	$ (3,003,402)
4	$ -	$ (8,319)	716,055	$ 0.1093	$ 78,245	$ 107,408	$ 177,334	$ 157,559	$ (2,845,842)
5	$ -	$ (8,569)	714,390	$ 0.1126	$ 80,405	$ 107,159	$ 178,995	$ 154,403	$ (2,691,440)
6	$ -	$ (8,826)	712,725	$ 0.1159	$ 82,624	$ -	$ 73,799	$ 61,805	$ (2,629,635)
7	$ -	$ (9,091)	711,061	$ 0.1194	$ 84,904	$ -	$ 75,814	$ 61,644	$ (2,567,991)
8	$ -	$ (9,363)	709,396	$ 0.1230	$ 87,247	$ -	$ 77,883	$ 61,482	$ (2,506,509)
9	$ -	$ (9,644)	707,731	$ 0.1267	$ 89,653	$ -	$ 80,009	$ 61,320	$ (2,445,189)
10	$ -	$ (9,934)	706,066	$ 0.1305	$ 92,126	$ -	$ 82,192	$ 61,159	$ (2,384,030)
11	$ -	$ (10,232)	704,401	$ 0.1344	$ 94,666	$ -	$ 84,434	$ 60,997	$ (2,323,033)
12	$ -	$ (10,539)	702,736	$ 0.1384	$ 97,275	$ -	$ 86,737	$ 60,835	$ (2,262,198)
13	$ -	$ (10,855)	701,071	$ 0.1426	$ 99,956	$ -	$ 89,101	$ 60,674	$ (2,201,525)
14	$ -	$ (11,180)	699,406	$ 0.1469	$ 102,710	$ -	$ 91,530	$ 60,512	$ (2,141,012)
15	$ -	$ (11,516)	697,741	$ 0.1513	$ 105,540	$ -	$ 94,024	$ 60,350	$ (2,080,662)
16	$ -	$ (11,861)	696,076	$ 0.1558	$ 108,446	$ -	$ 96,585	$ 60,189	$ (2,020,473)
17	$ -	$ (12,217)	694,412	$ 0.1605	$ 111,433	$ -	$ 99,216	$ 60,027	$ (1,960,446)
18	$ -	$ (12,584)	692,747	$ 0.1653	$ 114,500	$ -	$ 101,917	$ 59,865	$ (1,900,581)
19	$ -	$ (12,961)	691,082	$ 0.1702	$ 117,652	$ -	$ 104,691	$ 59,704	$ (1,840,877)
20	$ -	$ (626,376)	689,417	$ 0.1754	$ 120,890	$ -	$ (505,486)	$ (279,875)	$ (2,120,752)
21	$ -	$ (13,750)	687,752	$ 0.1806	$ 124,216	$ -	$ 110,465	$ 59,381	$ (2,061,372)
22	$ -	$ (14,163)	686,087	$ 0.1860	$ 127,632	$ -	$ 113,470	$ 59,219	$ (2,002,153)
23	$ -	$ (14,588)	684,422	$ 0.1916	$ 131,142	$ -	$ 116,555	$ 59,057	$ (1,943,096)
24	$ -	$ (15,025)	682,757	$ 0.1974	$ 134,748	$ -	$ 119,723	$ 58,896	$ (1,884,200)
25	$ -	$ (15,476)	681,092	$ 0.2033	$ 138,452	$ -	$ 122,976	$ 58,734	$ (1,825,466)
26	$ -	$ (15,940)	679,427	$ 0.2094	$ 142,257	$ -	$ 126,317	$ 58,572	$ (1,766,894)
27	$ -	$ (16,419)	677,762	$ 0.2157	$ 146,166	$ -	$ 129,747	$ 58,411	$ (1,708,483)
28	$ -	$ (16,911)	676,098	$ 0.2221	$ 150,181	$ -	$ 133,270	$ 58,249	$ (1,650,234)
29	$ -	$ (17,419)	674,433	$ 0.2288	$ 154,305	$ -	$ 136,887	$ 58,087	$ (1,592,147)
30	$ -	$ (17,941)	672,768	$ 0.2357	$ 158,542	$ -	$ 140,601	$ 57,926	$ (1,534,221)

Area 4 Net Present Value Analysis

Net Present Value Analysis Parameters & Assumptions	
PV System Size (kW)	584
PV System Construction Cost (2012 Dollars)	$ 4,672,000
Year 1 Energy Production (kWh)	963,600
Annual O&M Cost (2012 Dollars)	$ 10,174
Year 20 Equipment Replacement (2012 Dollars)	$ 467,200
Annual Output Degradation (% of Year 1)	0.2309%
SDG&E Year 1 Average Energy Rate ($/kWh)	$ 0.1000
SDG&E Average Annual Rate Escalation	3.00%
Average Annual Inflation Rate	3.00%
Project Discount Rate	3.00%
California Solar Initiative	$ 0.1500
California Solar Initiative 5-Year Total	$ 719,363
Net Present Value (30-Year System Life)	$ (2,050,309)

Net Present Value Analysis Annual Cash Flows

Year	Capital Cost	O&M Cost	Energy Production (kWh)	SDG&E Energy Rate ($/kWh)	Energy Production Value	California Solar Initiative Rebate	Annual Cash Flow	Discounted Annual Cash Flow	Cumulative Discounted Annual Cash Flow
0	$ (4,672,000)	$ -	0	$ -	$ -	$ -	$ (4,672,000)	$ (4,672,000)	$ (4,672,000)
1	$ -	$ (10,174)	963,600	$ 0.1000	$ 96,360	$ 144,540	$ 230,726	$ 224,006	$ (4,447,994)
2	$ -	$ (10,479)	961,375	$ 0.1030	$ 99,022	$ 144,206	$ 232,748	$ 219,388	$ (4,228,607)
3	$ -	$ (10,794)	959,150	$ 0.1061	$ 101,756	$ 143,873	$ 234,835	$ 214,907	$ (4,013,699)
4	$ -	$ (11,118)	956,925	$ 0.1093	$ 104,566	$ 143,539	$ 236,987	$ 210,560	$ (3,803,140)
5	$ -	$ (11,451)	954,700	$ 0.1126	$ 107,452	$ 143,205	$ 239,206	$ 206,341	$ (3,596,798)
6	$ -	$ (11,795)	952,475	$ 0.1159	$ 110,418	$ -	$ 98,623	$ 82,595	$ (3,514,203)
7	$ -	$ (12,149)	950,250	$ 0.1194	$ 113,465	$ -	$ 101,316	$ 82,379	$ (3,431,823)
8	$ -	$ (12,513)	948,025	$ 0.1230	$ 116,595	$ -	$ 104,082	$ 82,163	$ (3,349,660)
9	$ -	$ (12,888)	945,800	$ 0.1267	$ 119,811	$ -	$ 106,923	$ 81,947	$ (3,267,713)
10	$ -	$ (13,275)	943,575	$ 0.1305	$ 123,115	$ -	$ 109,840	$ 81,731	$ (3,185,981)
11	$ -	$ (13,673)	941,350	$ 0.1344	$ 126,510	$ -	$ 112,836	$ 81,515	$ (3,104,466)
12	$ -	$ (14,083)	939,126	$ 0.1384	$ 129,997	$ -	$ 115,913	$ 81,299	$ (3,023,166)
13	$ -	$ (14,506)	936,901	$ 0.1426	$ 133,580	$ -	$ 119,074	$ 81,083	$ (2,942,083)
14	$ -	$ (14,941)	934,676	$ 0.1469	$ 137,260	$ -	$ 122,319	$ 80,867	$ (2,861,216)
15	$ -	$ (15,389)	932,451	$ 0.1513	$ 141,042	$ -	$ 125,652	$ 80,651	$ (2,780,564)
16	$ -	$ (15,851)	930,226	$ 0.1558	$ 144,926	$ -	$ 129,075	$ 80,435	$ (2,700,129)
17	$ -	$ (16,327)	928,001	$ 0.1605	$ 148,917	$ -	$ 132,590	$ 80,219	$ (2,619,910)
18	$ -	$ (16,816)	925,776	$ 0.1653	$ 153,017	$ -	$ 136,200	$ 80,003	$ (2,539,907)
19	$ -	$ (17,321)	923,551	$ 0.1702	$ 157,228	$ -	$ 139,907	$ 79,787	$ (2,460,119)
20	$ -	$ (837,079)	921,326	$ 0.1754	$ 161,555	$ -	$ (675,524)	$ (374,021)	$ (2,834,140)
21	$ -	$ (18,376)	919,101	$ 0.1806	$ 166,000	$ -	$ 147,624	$ 79,355	$ (2,754,785)
22	$ -	$ (18,927)	916,876	$ 0.1860	$ 170,566	$ -	$ 151,639	$ 79,139	$ (2,675,646)
23	$ -	$ (19,495)	914,651	$ 0.1916	$ 175,257	$ -	$ 155,762	$ 78,923	$ (2,596,723)
24	$ -	$ (20,080)	912,426	$ 0.1974	$ 180,075	$ -	$ 159,995	$ 78,707	$ (2,518,016)
25	$ -	$ (20,682)	910,201	$ 0.2033	$ 185,025	$ -	$ 164,343	$ 78,491	$ (2,439,524)
26	$ -	$ (21,303)	907,976	$ 0.2094	$ 190,110	$ -	$ 168,808	$ 78,275	$ (2,361,249)
27	$ -	$ (21,942)	905,751	$ 0.2157	$ 195,334	$ -	$ 173,392	$ 78,059	$ (2,283,190)
28	$ -	$ (22,600)	903,526	$ 0.2221	$ 200,699	$ -	$ 178,099	$ 77,843	$ (2,205,347)
29	$ -	$ (23,278)	901,301	$ 0.2288	$ 206,211	$ -	$ 182,933	$ 77,627	$ (2,127,720)
30	$ -	$ (23,976)	899,076	$ 0.2357	$ 211,873	$ -	$ 187,897	$ 77,411	$ (2,050,309)

Area 5 Net Present Value Analysis

Net Present Value Analysis Parameters & Assumptions	
PV System Size (kW)	289
PV System Construction Cost (2012 Dollars)	$ 2,312,000
Year 1 Energy Production (kWh)	476,850
Annual O&M Cost (2012 Dollars)	$ 5,035
Year 20 Equipment Replacement (2012 Dollars)	$ 231,200
Annual Output Degradation (% of Year 1)	0.2309%
SDG&E Year 1 Average Energy Rate ($/kWh)	$ 0.1000
SDG&E Average Annual Rate Escalation	3.00%
Average Annual Inflation Rate	3.00%
Project Discount Rate	3.00%
California Solar Initiative	$ 0.1500
California Solar Initiative 5-Year Total	$ 355,986
Net Present Value (30-Year System Life)	$ (1,014,622)

Net Present Value Analysis Annual Cash Flows

Year	Capital Cost	O&M Cost	Energy Production (kWh)	SDG&E Energy Rate ($/kWh)	Energy Production Value	California Solar Initiative Rebate	Annual Cash Flow	Discounted Annual Cash Flow	Cumulative Discounted Annual Cash Flow
0	$ (2,312,000)	$ -	0	$ -	$ -	$ -	$ (2,312,000)	$ (2,312,000)	$ (2,312,000)
1	$ -	$ (5,035)	476,850	$ 0.1000	$ 47,685	$ 71,528	$ 114,178	$ 110,852	$ (2,201,148)
2	$ -	$ (5,186)	475,749	$ 0.1030	$ 49,002	$ 71,362	$ 115,179	$ 108,567	$ (2,092,581)
3	$ -	$ (5,341)	474,648	$ 0.1061	$ 50,355	$ 71,197	$ 116,211	$ 106,350	$ (1,986,231)
4	$ -	$ (5,502)	473,547	$ 0.1093	$ 51,746	$ 71,032	$ 117,276	$ 104,198	$ (1,882,033)
5	$ -	$ (5,667)	472,446	$ 0.1126	$ 53,174	$ 70,867	$ 118,374	$ 102,111	$ (1,779,922)
6	$ -	$ (5,837)	471,345	$ 0.1159	$ 54,642	$ -	$ 48,805	$ 40,873	$ (1,739,049)
7	$ -	$ (6,012)	470,244	$ 0.1194	$ 56,150	$ -	$ 50,138	$ 40,767	$ (1,698,282)
8	$ -	$ (6,192)	469,143	$ 0.1230	$ 57,699	$ -	$ 51,506	$ 40,660	$ (1,657,623)
9	$ -	$ (6,378)	468,042	$ 0.1267	$ 59,290	$ -	$ 52,912	$ 40,553	$ (1,617,070)
10	$ -	$ (6,569)	466,941	$ 0.1305	$ 60,925	$ -	$ 54,356	$ 40,446	$ (1,576,624)
11	$ -	$ (6,766)	465,840	$ 0.1344	$ 62,605	$ -	$ 55,839	$ 40,339	$ (1,536,285)
12	$ -	$ (6,969)	464,738	$ 0.1384	$ 64,331	$ -	$ 57,361	$ 40,232	$ (1,496,053)
13	$ -	$ (7,178)	463,637	$ 0.1426	$ 66,104	$ -	$ 58,925	$ 40,125	$ (1,455,928)
14	$ -	$ (7,394)	462,536	$ 0.1469	$ 67,925	$ -	$ 60,531	$ 40,018	$ (1,415,910)
15	$ -	$ (7,616)	461,435	$ 0.1513	$ 69,796	$ -	$ 62,181	$ 39,911	$ (1,375,999)
16	$ -	$ (7,844)	460,334	$ 0.1558	$ 71,719	$ -	$ 63,874	$ 39,804	$ (1,336,194)
17	$ -	$ (8,079)	459,233	$ 0.1605	$ 73,693	$ -	$ 65,614	$ 39,698	$ (1,296,497)
18	$ -	$ (8,322)	458,132	$ 0.1653	$ 75,722	$ -	$ 67,400	$ 39,591	$ (1,256,906)
19	$ -	$ (8,571)	457,031	$ 0.1702	$ 77,806	$ -	$ 69,235	$ 39,484	$ (1,217,422)
20	$ -	$ (414,239)	455,930	$ 0.1754	$ 79,948	$ -	$ (334,292)	$ (185,089)	$ (1,402,511)
21	$ -	$ (9,093)	454,829	$ 0.1806	$ 82,147	$ -	$ 73,054	$ 39,270	$ (1,363,241)
22	$ -	$ (9,366)	453,728	$ 0.1860	$ 84,407	$ -	$ 75,040	$ 39,163	$ (1,324,078)
23	$ -	$ (9,647)	452,627	$ 0.1916	$ 86,728	$ -	$ 77,081	$ 39,056	$ (1,285,022)
24	$ -	$ (9,937)	451,526	$ 0.1974	$ 89,113	$ -	$ 79,176	$ 38,949	$ (1,246,073)
25	$ -	$ (10,235)	450,425	$ 0.2033	$ 91,562	$ -	$ 81,327	$ 38,842	$ (1,207,230)
26	$ -	$ (10,542)	449,324	$ 0.2094	$ 94,078	$ -	$ 83,537	$ 38,735	$ (1,168,495)
27	$ -	$ (10,858)	448,223	$ 0.2157	$ 96,663	$ -	$ 85,805	$ 38,629	$ (1,129,866)
28	$ -	$ (11,184)	447,122	$ 0.2221	$ 99,319	$ -	$ 88,135	$ 38,522	$ (1,091,345)
29	$ -	$ (11,519)	446,021	$ 0.2288	$ 102,046	$ -	$ 90,527	$ 38,415	$ (1,052,930)
30	$ -	$ (11,865)	444,920	$ 0.2357	$ 104,848	$ -	$ 92,983	$ 38,308	$ (1,014,622)

Areas 1-5 Net Present Value Analysis

Net Present Value Analysis Parameters & Assumptions	
PV System Size (kW)	2307
PV System Construction Cost (2012 Dollars)	$ 18,456,000
Year 1 Energy Production (kWh)	3,806,550
Annual O&M Cost (2012 Dollars)	$ 40,192
Year 20 Equipment Replacement (2012 Dollars)	$ 1,845,600
Annual Output Degradation (% of Year 1)	0.2309%
SDG&E Year 1 Average Energy Rate ($/kWh)	$ 0.1000
SDG&E Average Annual Rate Escalation	3.00%
Average Annual Inflation Rate	3.00%
Project Discount Rate	3.00%
California Solar Initiative	$ 0.1500
California Solar Initiative 5-Year Total	$ 1,231,785
Net Present Value (30-Year System Life)	$ (9,574,238)

Net Present Value Analysis Annual Cash Flows

Year	Capital Cost	O&M Cost	Energy Production (kWh)	SDG&E Energy Rate ($/kWh)	Energy Production Value	California Solar Initiative Rebate	Annual Cash Flow	Discounted Annual Cash Flow	Cumulative Discounted Annual Cash Flow
0	$ (18,456,000)	$ -	0	$ -	$ -	$ -	$ (18,456,000)	$ (18,456,000)	$ (18,456,000)
1	$ -	$ (40,192)	3,806,550	$ 0.1000	$ 380,655	$ 247,500	$ 587,963	$ 570,838	$ (17,885,162)
2	$ -	$ (41,397)	3,797,761	$ 0.1030	$ 391,169	$ 246,929	$ 596,700	$ 562,447	$ (17,322,714)
3	$ -	$ (42,639)	3,788,971	$ 0.1061	$ 401,972	$ 246,357	$ 605,690	$ 554,292	$ (16,768,422)
4	$ -	$ (43,918)	3,780,182	$ 0.1093	$ 413,071	$ 245,786	$ 614,938	$ 546,364	$ (16,222,058)
5	$ -	$ (45,236)	3,771,393	$ 0.1126	$ 424,474	$ 245,214	$ 624,452	$ 538,657	$ (15,683,401)
6	$ -	$ (46,593)	3,762,603	$ 0.1159	$ 436,189	$ -	$ 389,596	$ 326,280	$ (15,357,120)
7	$ -	$ (47,991)	3,753,814	$ 0.1194	$ 448,225	$ -	$ 400,234	$ 325,427	$ (15,031,694)
8	$ -	$ (49,431)	3,745,025	$ 0.1230	$ 460,591	$ -	$ 411,160	$ 324,574	$ (14,707,120)
9	$ -	$ (50,914)	3,736,235	$ 0.1267	$ 473,295	$ -	$ 422,382	$ 323,720	$ (14,383,400)
10	$ -	$ (52,441)	3,727,446	$ 0.1305	$ 486,347	$ -	$ 433,906	$ 322,867	$ (14,060,533)
11	$ -	$ (54,014)	3,718,657	$ 0.1344	$ 499,756	$ -	$ 445,742	$ 322,014	$ (13,738,519)
12	$ -	$ (55,635)	3,709,867	$ 0.1384	$ 513,532	$ -	$ 457,898	$ 321,160	$ (13,417,359)
13	$ -	$ (57,304)	3,701,078	$ 0.1426	$ 527,685	$ -	$ 470,382	$ 320,307	$ (13,097,052)
14	$ -	$ (59,023)	3,692,289	$ 0.1469	$ 542,225	$ -	$ 483,202	$ 319,454	$ (12,777,598)
15	$ -	$ (60,793)	3,683,499	$ 0.1513	$ 557,162	$ -	$ 496,369	$ 318,600	$ (12,458,998)
16	$ -	$ (62,617)	3,674,710	$ 0.1558	$ 572,508	$ -	$ 509,891	$ 317,747	$ (12,141,251)
17	$ -	$ (64,496)	3,665,921	$ 0.1605	$ 588,273	$ -	$ 523,777	$ 316,894	$ (11,824,357)
18	$ -	$ (66,431)	3,657,131	$ 0.1653	$ 604,468	$ -	$ 538,037	$ 316,040	$ (11,508,317)
19	$ -	$ (68,424)	3,648,342	$ 0.1702	$ 621,106	$ -	$ 552,682	$ 315,187	$ (11,193,130)
20	$ -	$ (3,306,747)	3,639,553	$ 0.1754	$ 638,198	$ -	$ (2,668,549)	$ (1,477,511)	$ (12,670,641)
21	$ -	$ (72,591)	3,630,764	$ 0.1806	$ 655,756	$ -	$ 583,166	$ 313,480	$ (12,357,161)
22	$ -	$ (74,768)	3,621,974	$ 0.1860	$ 673,794	$ -	$ 599,026	$ 312,627	$ (12,044,534)
23	$ -	$ (77,011)	3,613,185	$ 0.1916	$ 692,324	$ -	$ 615,312	$ 311,774	$ (11,732,760)
24	$ -	$ (79,322)	3,604,396	$ 0.1974	$ 711,359	$ -	$ 632,037	$ 310,920	$ (11,421,840)
25	$ -	$ (81,701)	3,595,606	$ 0.2033	$ 730,913	$ -	$ 649,211	$ 310,067	$ (11,111,773)
26	$ -	$ (84,152)	3,586,817	$ 0.2094	$ 751,000	$ -	$ 666,847	$ 309,214	$ (10,802,559)
27	$ -	$ (86,677)	3,578,028	$ 0.2157	$ 771,634	$ -	$ 684,957	$ 308,360	$ (10,494,199)
28	$ -	$ (89,277)	3,569,238	$ 0.2221	$ 792,831	$ -	$ 703,554	$ 307,507	$ (10,186,692)
29	$ -	$ (91,956)	3,560,449	$ 0.2288	$ 814,605	$ -	$ 722,649	$ 306,654	$ (9,880,038)
30	$ -	$ (94,714)	3,551,660	$ 0.2357	$ 836,972	$ -	$ 742,258	$ 305,800	$ (9,574,238)

APPENDIX E:
Net Present Value Calculations for Substation Options

Concept 1 Substation Net Present Value Analysis

Net Present Value Analysis Parameters & Assumptions	
Substation Size (kVA)	3000
Year 1 Total SDPS Energy Consumption (kWh)	2,836,000
Substation Construction Cost (2012 Dollars)	$ 540,000
Substation Lifespan (Years)	30
Year 1 Operation & Maintenance Cost (% of Capital)	3%
Year 1 O&M Cost (2012 Dollars)	$ 16,200
SDG&E Energy Rate Savings($/kWh)	$ 0.0200
Average Annual Inflation Rate	3.00%
Project Discount Rate	3.00%
Net Present Value (30-Year System Life)	$ 99,892
Payback (Years)	21.73

Net Present Value Analysis Annual Cash Flows

Year	Capital Cost	O&M Cost	Energy Cost Savings	Annual Cash Flow	Discounted Annual Cash Flow	Cumulative Discounted Annual Cash Flow
0	$ (540,000)	$ -	$ -	$ (540,000)	$ (540,000)	$ (540,000)
1	$ -	$ (16,200)	$ 56,720	$ 40,520	$ 39,340	$ (500,660)
2	$ -	$ (16,686)	$ 56,720	$ 40,034	$ 37,736	$ (462,924)
3	$ -	$ (17,187)	$ 56,720	$ 39,533	$ 36,179	$ (426,746)
4	$ -	$ (17,702)	$ 56,720	$ 39,018	$ 34,667	$ (392,079)
5	$ -	$ (18,233)	$ 56,720	$ 38,487	$ 33,199	$ (358,880)
6	$ -	$ (18,780)	$ 56,720	$ 37,940	$ 31,774	$ (327,106)
7	$ -	$ (19,344)	$ 56,720	$ 37,376	$ 30,390	$ (296,715)
8	$ -	$ (19,924)	$ 56,720	$ 36,796	$ 29,047	$ (267,668)
9	$ -	$ (20,522)	$ 56,720	$ 36,198	$ 27,743	$ (239,925)
10	$ -	$ (21,137)	$ 56,720	$ 35,583	$ 26,477	$ (213,448)
11	$ -	$ (21,771)	$ 56,720	$ 34,949	$ 25,248	$ (188,201)
12	$ -	$ (22,425)	$ 56,720	$ 34,295	$ 24,054	$ (164,147)
13	$ -	$ (23,097)	$ 56,720	$ 33,623	$ 22,895	$ (141,251)
14	$ -	$ (23,790)	$ 56,720	$ 32,930	$ 21,770	$ (119,481)
15	$ -	$ (24,504)	$ 56,720	$ 32,216	$ 20,678	$ (98,803)
16	$ -	$ (25,239)	$ 56,720	$ 31,481	$ 19,618	$ (79,185)
17	$ -	$ (25,996)	$ 56,720	$ 30,724	$ 18,588	$ (60,596)
18	$ -	$ (26,776)	$ 56,720	$ 29,944	$ 17,589	$ (43,008)
19	$ -	$ (27,579)	$ 56,720	$ 29,141	$ 16,618	$ (26,389)
20	$ -	$ (28,407)	$ 56,720	$ 28,313	$ 15,676	$ (10,713)
21	$ -	$ (29,259)	$ 56,720	$ 27,461	$ 14,762	$ 4,049
22	$ -	$ (30,137)	$ 56,720	$ 26,583	$ 13,874	$ 17,922
23	$ -	$ (31,041)	$ 56,720	$ 25,679	$ 13,011	$ 30,934
24	$ -	$ (31,972)	$ 56,720	$ 24,748	$ 12,174	$ 43,108
25	$ -	$ (32,931)	$ 56,720	$ 23,789	$ 11,362	$ 54,470
26	$ -	$ (33,919)	$ 56,720	$ 22,801	$ 10,573	$ 65,042
27	$ -	$ (34,937)	$ 56,720	$ 21,783	$ 9,807	$ 74,849
28	$ -	$ (35,985)	$ 56,720	$ 20,735	$ 9,063	$ 83,912
29	$ -	$ (37,064)	$ 56,720	$ 19,656	$ 8,341	$ 92,253
30	$ -	$ (38,176)	$ 56,720	$ 18,544	$ 7,640	$ 99,892

Concept 2 Substation Net Present Value Analysis

Net Present Value Analysis Parameters & Assumptions	
Substation Size (kVA)	5000
Year 1 Total WFP & SDPS Energy Consumption (kWh)	5,026,000
Substation Construction Cost (2012 Dollars)	$ 900,000
Substation Lifespan (Years)	30
Year 1 Operation & Maintenance Cost (% of Capital)	3%
Year 1 O&M Cost (2012 Dollars)	$ 27,000
SDG&E Energy Rate Savings($/kWh)	$ 0.0200
Average Annual Inflation Rate	3.00%
Project Discount Rate	3.00%
Net Present Value (30-Year System Life)	$ 283,829
Payback (Years)	18.68

Net Present Value Analysis Annual Cash Flows

Year	Capital Cost	O&M Cost	Energy Cost Savings	Annual Cash Flow	Discounted Annual Cash Flow	Cumulative Discounted Annual Cash Flow
0	$ (900,000)	$ -	$ -	$ (900,000)	$ (900,000)	$ (900,000)
1	$ -	$ (27,000)	$ 100,520	$ 73,520	$ 71,379	$ (828,621)
2	$ -	$ (27,810)	$ 100,520	$ 72,710	$ 68,536	$ (760,085)
3	$ -	$ (28,644)	$ 100,520	$ 71,876	$ 65,776	$ (694,309)
4	$ -	$ (29,504)	$ 100,520	$ 71,016	$ 63,097	$ (631,212)
5	$ -	$ (30,389)	$ 100,520	$ 70,131	$ 60,496	$ (570,716)
6	$ -	$ (31,300)	$ 100,520	$ 69,220	$ 57,970	$ (512,745)
7	$ -	$ (32,239)	$ 100,520	$ 68,281	$ 55,518	$ (457,227)
8	$ -	$ (33,207)	$ 100,520	$ 67,313	$ 53,138	$ (404,089)
9	$ -	$ (34,203)	$ 100,520	$ 66,317	$ 50,827	$ (353,263)
10	$ -	$ (35,229)	$ 100,520	$ 65,291	$ 48,583	$ (304,680)
11	$ -	$ (36,286)	$ 100,520	$ 64,234	$ 46,404	$ (258,276)
12	$ -	$ (37,374)	$ 100,520	$ 63,146	$ 44,289	$ (213,987)
13	$ -	$ (38,496)	$ 100,520	$ 62,024	$ 42,236	$ (171,751)
14	$ -	$ (39,650)	$ 100,520	$ 60,870	$ 40,242	$ (131,509)
15	$ -	$ (40,840)	$ 100,520	$ 59,680	$ 38,306	$ (93,203)
16	$ -	$ (42,065)	$ 100,520	$ 58,455	$ 36,427	$ (56,776)
17	$ -	$ (43,327)	$ 100,520	$ 57,193	$ 34,603	$ (22,173)
18	$ -	$ (44,627)	$ 100,520	$ 55,893	$ 32,831	$ 10,658
19	$ -	$ (45,966)	$ 100,520	$ 54,554	$ 31,112	$ 41,770
20	$ -	$ (47,345)	$ 100,520	$ 53,175	$ 29,442	$ 71,212
21	$ -	$ (48,765)	$ 100,520	$ 51,755	$ 27,821	$ 99,033
22	$ -	$ (50,228)	$ 100,520	$ 50,292	$ 26,247	$ 125,280
23	$ -	$ (51,735)	$ 100,520	$ 48,785	$ 24,719	$ 149,999
24	$ -	$ (53,287)	$ 100,520	$ 47,233	$ 23,236	$ 173,234
25	$ -	$ (54,885)	$ 100,520	$ 45,635	$ 21,795	$ 195,030
26	$ -	$ (56,532)	$ 100,520	$ 43,988	$ 20,397	$ 215,427
27	$ -	$ (58,228)	$ 100,520	$ 42,292	$ 19,039	$ 234,466
28	$ -	$ (59,975)	$ 100,520	$ 40,545	$ 17,721	$ 252,188
29	$ -	$ (61,774)	$ 100,520	$ 38,746	$ 16,442	$ 268,629
30	$ -	$ (63,627)	$ 100,520	$ 36,893	$ 15,199	$ 283,829

Concepts 3/4 Substation Net Present Value Analysis

Net Present Value Analysis Parameters & Assumptions	
Substation Size (kVA per Transformer)	5000
Year 1 Total WFP & SDPS Energy Consumption (kWh)	5,026,000
Substation Construction Cost (2012 Dollars)	$ 1,800,000
Substation Lifespan (Years)	30
Year 1 Operation & Maintenance Cost (% of Capital)	3%
Year 1 O&M Cost (2012 Dollars)	$ 54,000
SDG&E Energy Rate Savings($/kWh)	$ 0.0200
Average Annual Inflation Rate	3.00%
Project Discount Rate	3.00%
Net Present Value (30-Year System Life)	$ (1,402,579)
Payback (Years)	>30

Net Present Value Analysis Annual Cash Flows

Year	Capital Cost	O&M Cost	Energy Cost Savings	Annual Cash Flow	Discounted Annual Cash Flow	Cumulative Discounted Annual Cash Flow
0	$ (1,800,000)	$ -	$ -	$ (1,800,000)	$ (1,800,000)	$ (1,800,000)
1	$ -	$ (54,000)	$ 100,520	$ 46,520	$ 45,165	$ (1,754,835)
2	$ -	$ (55,620)	$ 100,520	$ 44,900	$ 42,323	$ (1,712,512)
3	$ -	$ (57,289)	$ 100,520	$ 43,231	$ 39,563	$ (1,672,950)
4	$ -	$ (59,007)	$ 100,520	$ 41,513	$ 36,884	$ (1,636,066)
5	$ -	$ (60,777)	$ 100,520	$ 39,743	$ 34,282	$ (1,601,784)
6	$ -	$ (62,601)	$ 100,520	$ 37,919	$ 31,757	$ (1,570,027)
7	$ -	$ (64,479)	$ 100,520	$ 36,041	$ 29,305	$ (1,540,722)
8	$ -	$ (66,413)	$ 100,520	$ 34,107	$ 26,924	$ (1,513,798)
9	$ -	$ (68,406)	$ 100,520	$ 32,114	$ 24,613	$ (1,489,185)
10	$ -	$ (70,458)	$ 100,520	$ 30,062	$ 22,369	$ (1,466,816)
11	$ -	$ (72,571)	$ 100,520	$ 27,949	$ 20,191	$ (1,446,625)
12	$ -	$ (74,749)	$ 100,520	$ 25,771	$ 18,076	$ (1,428,550)
13	$ -	$ (76,991)	$ 100,520	$ 23,529	$ 16,022	$ (1,412,528)
14	$ -	$ (79,301)	$ 100,520	$ 21,219	$ 14,028	$ (1,398,499)
15	$ -	$ (81,680)	$ 100,520	$ 18,840	$ 12,093	$ (1,386,407)
16	$ -	$ (84,130)	$ 100,520	$ 16,390	$ 10,214	$ (1,376,193)
17	$ -	$ (86,654)	$ 100,520	$ 13,866	$ 8,389	$ (1,367,804)
18	$ -	$ (89,254)	$ 100,520	$ 11,266	$ 6,618	$ (1,361,186)
19	$ -	$ (91,931)	$ 100,520	$ 8,589	$ 4,898	$ (1,356,288)
20	$ -	$ (94,689)	$ 100,520	$ 5,831	$ 3,228	$ (1,353,060)
21	$ -	$ (97,530)	$ 100,520	$ 2,990	$ 1,607	$ (1,351,453)
22	$ -	$ (100,456)	$ 100,520	$ 64	$ 33	$ (1,351,419)
23	$ -	$ (103,470)	$ 100,520	$ (2,950)	$ (1,495)	$ (1,352,914)
24	$ -	$ (106,574)	$ 100,520	$ (6,054)	$ (2,978)	$ (1,355,892)
25	$ -	$ (109,771)	$ 100,520	$ (9,251)	$ (4,418)	$ (1,360,310)
26	$ -	$ (113,064)	$ 100,520	$ (12,544)	$ (5,817)	$ (1,366,127)
27	$ -	$ (116,456)	$ 100,520	$ (15,936)	$ (7,174)	$ (1,373,301)
28	$ -	$ (119,950)	$ 100,520	$ (19,430)	$ (8,492)	$ (1,381,793)
29	$ -	$ (123,548)	$ 100,520	$ (23,028)	$ (9,772)	$ (1,391,565)
30	$ -	$ (127,255)	$ 100,520	$ (26,735)	$ (11,014)	$ (1,402,579)

APPENDIX F:
Hydroelectric Facility for Net Present Value and Payback Calculations

Hydroelectric Facility Base Condition Net Present Value Analysis

Net Present Value Analysis Parameters & Assumptions	
Maximum Annual Energy Production (kWh) [1]	3139042
System Availability	75%
Actual Annual Energy Production (kWh)	2354282
Annual WFP Energy Consumption (kWh) [2]	2190000
Annual Energy Export to SDG&E (kWh)	164282
Alternative Capital Cost (2012 Dollars)	$ -
Equipment Lifespan (Years)	5
Year 1 Operation & Maintenance Cost ($/kWh)	$ 0.03
Year 1 O&M Cost (2012 Dollars)	$ 70,628
Average SDG&E Energy Export Rate ($/kWh)	$ 0.0800
Average SDG&E Energy Import Rate ($/kWh)	$ 0.0800
Annual SDG&E Energy Rate Escalation	3.00%
Average Annual Inflation Rate	3.00%
Project Discount Rate	3.00%
Net Present Value (5-Year System Life)	$ 571,428
Payback (Years)	0.00

Notes:
1. Refer to Appendix G for Annual Energy Production calculation.
2. Annual WFP Energy Consumption based on an average instantaneous power demand of 250 kW.

Net Present Value Analysis Annual Cash Flows

Year	Capital Cost	O&M Cost	Energy Export Revenue	WFP Energy Cost Savings	Annual Cash Flow	Discounted Annual Cash Flow	Cumulative Discounted Annual Cash Flow
0	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1	$ -	$ (70,628)	$ 13,143	$ 175,200	$ 117,714	$ 114,286	$ 114,286
2	$ -	$ (72,747)	$ 13,537	$ 180,456	$ 121,245	$ 114,286	$ 228,571
3	$ -	$ (74,930)	$ 13,943	$ 185,870	$ 124,883	$ 114,286	$ 342,857
4	$ -	$ (77,178)	$ 14,361	$ 191,446	$ 128,629	$ 114,286	$ 457,142
5	$ -	$ (79,493)	$ 14,792	$ 197,189	$ 132,488	$ 114,286	$ 571,428

Hydroelectric Facility Alternative 2 Net Present Value Analysis

Net Present Value Analysis Parameters & Assumptions	
Maximum Annual Energy Production (kWh) [1]	3139042
System Availability	90%
Actual Annual Energy Production (kWh)	2825138
Annual WFP Energy Consumption (kWh) [2]	2190000
Annual Energy Export to SDG&E (kWh)	635138
Alternative Capital Cost (2012 Dollars)	$ 1,600,000
Equipment Lifespan (Years)	10
Year 1 Operation & Maintenance Cost ($/kWh)	$ 0.02
Year 1 O&M Cost (2012 Dollars)	$ 56,503
Average SDG&E Energy Export Rate ($/kWh)	$ 0.0800
Average SDG&E Energy Import Rate ($/kWh)	$ 0.0800
Annual SDG&E Energy Rate Escalation	3.00%
Average Annual Inflation Rate	3.00%
Project Discount Rate	3.00%
Net Present Value (5-Year System Life)	$ 45,711
Payback (Years)	9.7

Notes:
1. Refer to Appendix G for Annual Energy Production calculation.
2. Annual WFP Energy Consumption based on an average instantaneous power demand of 250 kW.

Net Present Value Analysis Annual Cash Flows

Year	Capital Cost	O&M Cost	Energy Export Revenue	WFP Energy Cost Savings	Annual Cash Flow	Discounted Annual Cash Flow	Cumulative Discounted Annual Cash Flow
0	$ (1,600,000)	$ -	$ -	$ -	$ (1,600,000)	$ (1,600,000)	$ (1,600,000)
1	$ -	$ (56,503)	$ 50,811	$ 175,200	$ 169,508	$ 164,571	$ (1,435,429)
2	$ -	$ (58,198)	$ 52,335	$ 180,456	$ 174,594	$ 164,571	$ (1,270,858)
3	$ -	$ (59,944)	$ 53,905	$ 185,870	$ 179,831	$ 164,571	$ (1,106,287)
4	$ -	$ (61,742)	$ 55,523	$ 191,446	$ 185,226	$ 164,571	$ (941,715)
5	$ -	$ (63,594)	$ 57,188	$ 197,189	$ 190,783	$ 164,571	$ (777,144)
6	$ -	$ (65,502)	$ 58,904	$ 203,105	$ 196,507	$ 164,571	$ (612,573)
7	$ -	$ (67,467)	$ 60,671	$ 209,198	$ 202,402	$ 164,571	$ (448,002)
8	$ -	$ (69,491)	$ 62,491	$ 215,474	$ 208,474	$ 164,571	$ (283,431)
9	$ -	$ (71,576)	$ 64,366	$ 221,938	$ 214,728	$ 164,571	$ (118,860)
10	$ -	$ (73,723)	$ 66,297	$ 228,596	$ 221,170	$ 164,571	$ 45,711

Hydroelectric Facility Alternative 3 Net Present Value Analysis

Net Present Value Analysis Parameters & Assumptions	
Maximum Annual Energy Production (kWh) [1]	3139042
System Availability	95%
Actual Annual Energy Production (kWh)	2982090
Annual WFP Energy Consumption (kWh) [2]	2190000
Annual Energy Export to SDG&E (kWh)	792090
Alternative Capital Cost (2012 Dollars)	$ 5,000,000
Equipment Lifespan (Years)	15
Year 1 Operation & Maintenance Cost ($/kWh)	$ 0.02
Year 1 O&M Cost (2012 Dollars)	$ 59,642
Average SDG&E Energy Export Rate ($/kWh)	$ 0.0800
Average SDG&E Energy Import Rate ($/kWh)	$ 0.0800
Annual SDG&E Energy Rate Escalation	3.00%
Average Annual Inflation Rate	3.00%
Project Discount Rate	3.00%
Net Present Value (5-Year System Life)	$ (2,394,290)
Payback (Years)	>15

Notes:
1. Refer to Appendix G for Annual Energy Production calculation.
2. Annual WFP Energy Consumption based on an average instantaneous power demand of 250 kW.

Net Present Value Analysis Annual Cash Flows

Year	Capital Cost	O&M Cost	Energy Export Revenue	WFP Energy Cost Savings	Annual Cash Flow	Discounted Annual Cash Flow	Cumulative Discounted Annual Cash Flow
0	$ (5,000,000)	$ -	$ -	$ -	$ (5,000,000)	$ (5,000,000)	$ (5,000,000)
1	$ -	$ (59,642)	$ 63,367	$ 175,200	$ 178,925	$ 173,714	$ (4,826,286)
2	$ -	$ (61,431)	$ 65,268	$ 180,456	$ 184,293	$ 173,714	$ (4,652,572)
3	$ -	$ (63,274)	$ 67,226	$ 185,870	$ 189,822	$ 173,714	$ (4,478,858)
4	$ -	$ (65,172)	$ 69,243	$ 191,446	$ 195,517	$ 173,714	$ (4,305,144)
5	$ -	$ (67,127)	$ 71,320	$ 197,189	$ 201,382	$ 173,714	$ (4,131,430)
6	$ -	$ (69,141)	$ 73,460	$ 203,105	$ 207,424	$ 173,714	$ (3,957,716)
7	$ -	$ (71,215)	$ 75,664	$ 209,198	$ 213,646	$ 173,714	$ (3,784,002)
8	$ -	$ (73,352)	$ 77,934	$ 215,474	$ 220,056	$ 173,714	$ (3,610,288)
9	$ -	$ (75,552)	$ 80,272	$ 221,938	$ 226,657	$ 173,714	$ (3,436,574)
10	$ -	$ (77,819)	$ 82,680	$ 228,596	$ 233,457	$ 173,714	$ (3,262,860)
11	$ -	$ (80,154)	$ 85,160	$ 235,454	$ 240,461	$ 173,714	$ (3,089,146)
12	$ -	$ (82,558)	$ 87,715	$ 242,518	$ 247,675	$ 173,714	$ (2,915,432)
13	$ -	$ (85,035)	$ 90,346	$ 249,793	$ 255,105	$ 173,714	$ (2,741,718)
14	$ -	$ (87,586)	$ 93,057	$ 257,287	$ 262,758	$ 173,714	$ (2,568,004)
15	$ -	$ (90,214)	$ 95,849	$ 265,006	$ 270,641	$ 173,714	$ (2,394,290)

Hydroelectric Facility Alternative 4 Net Present Value Analysis

Net Present Value Analysis Parameters & Assumptions	
Maximum Annual Energy Production (kWh) [1]	5868643
System Availability	98%
Actual Annual Energy Production (kWh)	5751271
Annual WFP Energy Consumption (kWh) [2]	2190000
Annual Energy Export to SDG&E (kWh)	3561271
Alternative Capital Cost (2012 Dollars)	$ 7,600,000
Equipment Lifespan (Years)	25
Year 1 Operation & Maintenance Cost ($/kWh)	$ 0.01
Year 1 O&M Cost (2012 Dollars)	$ 57,513
25 Year O&M Expenditures (2012 Dollars)	$ 2,096,871
Average SDG&E Energy Export Rate ($/kWh)	$ 0.0800
Average SDG&E Energy Import Rate ($/kWh)	$ 0.0800
Annual SDG&E Energy Rate Escalation	3.00%
Average Annual Inflation Rate	3.00%
Project Discount Rate	3.00%
Net Present Value at Year 25	$ 2,171,576
Payback (Years)	19.5

Notes:
1. Refer to Appendix G for Annual Energy Production calculation.
2. Annual WFP Energy Consumption based on an average instantaneous power demand of 250 kW.

Net Present Value Analysis Annual Cash Flows

Year	Capital Cost	O&M Cost	Energy Export Revenue	WFP Energy Cost Savings	Annual Cash Flow	Discounted Annual Cash Flow	Cumulative Discounted Annual Cash Flow
0	$ (7,600,000)	$ -	$ -	$ -	$ (7,600,000)	$ (7,600,000)	$ (7,600,000)
1	$ -	$ (57,513)	$ 284,902	$ 175,200	$ 402,589	$ 390,863	$ (7,209,137)
2	$ -	$ (59,238)	$ 293,449	$ 180,456	$ 414,667	$ 390,863	$ (6,818,274)
3	$ -	$ (61,015)	$ 302,252	$ 185,870	$ 427,107	$ 390,863	$ (6,427,411)
4	$ -	$ (62,846)	$ 311,320	$ 191,446	$ 439,920	$ 390,863	$ (6,036,548)
5	$ -	$ (64,731)	$ 320,659	$ 197,189	$ 453,117	$ 390,863	$ (5,645,685)
6	$ -	$ (66,673)	$ 330,279	$ 203,105	$ 466,711	$ 390,863	$ (5,254,822)
7	$ -	$ (68,673)	$ 340,187	$ 209,198	$ 480,712	$ 390,863	$ (4,863,959)
8	$ -	$ (70,733)	$ 350,393	$ 215,474	$ 495,134	$ 390,863	$ (4,473,096)
9	$ -	$ (72,855)	$ 360,905	$ 221,938	$ 509,988	$ 390,863	$ (4,082,233)
10	$ -	$ (75,041)	$ 371,732	$ 228,596	$ 525,287	$ 390,863	$ (3,691,370)
11	$ -	$ (77,292)	$ 382,884	$ 235,454	$ 541,046	$ 390,863	$ (3,300,506)
12	$ -	$ (79,611)	$ 394,371	$ 242,518	$ 557,277	$ 390,863	$ (2,909,643)
13	$ -	$ (81,999)	$ 406,202	$ 249,793	$ 573,996	$ 390,863	$ (2,518,780)
14	$ -	$ (84,459)	$ 418,388	$ 257,287	$ 591,215	$ 390,863	$ (2,127,917)
15	$ -	$ (86,993)	$ 430,939	$ 265,006	$ 608,952	$ 390,863	$ (1,737,054)
16	$ -	$ (89,603)	$ 443,867	$ 272,956	$ 627,220	$ 390,863	$ (1,346,191)
17	$ -	$ (92,291)	$ 457,183	$ 281,145	$ 646,037	$ 390,863	$ (955,328)
18	$ -	$ (95,060)	$ 470,899	$ 289,579	$ 665,418	$ 390,863	$ (564,465)
19	$ -	$ (97,912)	$ 485,026	$ 298,266	$ 685,381	$ 390,863	$ (173,602)
20	$ -	$ (100,849)	$ 499,577	$ 307,214	$ 705,942	$ 390,863	$ 217,261
21	$ -	$ (103,874)	$ 514,564	$ 316,431	$ 727,120	$ 390,863	$ 608,124
22	$ -	$ (106,991)	$ 530,001	$ 325,924	$ 748,934	$ 390,863	$ 998,987
23	$ -	$ (110,200)	$ 545,901	$ 335,701	$ 771,402	$ 390,863	$ 1,389,850
24	$ -	$ (113,506)	$ 562,278	$ 345,772	$ 794,544	$ 390,863	$ 1,780,713
25	$ -	$ (116,911)	$ 579,146	$ 356,146	$ 818,380	$ 390,863	$ 2,171,576

APPENDIX G:
Hydroelectric Facility Energy Production Calculations

ESTIMATED ANNUAL HYDROELECTRIC FACILITY ENERGY PRODUCTION

Hydro Inlet Pressure = 150 psi

	Average CWA Flow (MGD) [1]	Averge CWA Flow (CFS)	Hydro Inlet Pressure (psi)	WFP Influent Pressure (psi)	Hydro Diff. Head (psi)	Turbine Efficiency	Generator Efficiency	Power Output (kW)	Days/Month	Energy (kWh)
January	0.000	0.000	150	35	115	0.915	0.940	0	31	0
February	0.000	0.000	150	35	115	0.915	0.940	0	28	0
March	0.000	0.000	150	35	115	0.915	0.940	0	31	0
April	10.630	16.447	150	35	115	0.915	0.940	318	30	228867
May	21.021	32.524	150	35	115	0.915	0.940	629	31	467675
June	23.795	36.816	150	35	115	0.915	0.940	712	30	512314
July	23.531	36.407	150	35	115	0.915	0.940	704	31	523517
August	23.959	37.069	150	35	115	0.915	0.940	716	31	533040
September	22.513	34.832	150	35	115	0.915	0.940	673	30	484712
October	17.481	27.047	150	35	115	0.915	0.940	523	31	388917
November	0.000	0.000	150	35	115	0.915	0.940	0	30	0
December	0.000	0.000	150	35	115	0.915	0.940	0	31	0
									Total Annual Energy Production	**3139042**

Notes
1. Monthy average CWA flow rates are based on future projections for local and imported water supplies.

Hydro Inlet Pressure = 250 psi

	Average CWA Flow (MGD) [1]	Averge CWA Flow (CFS)	Hydro Inlet Pressure (psi)	WFP Influent Pressure (psi)	Hydro Diff. Head (psi)	Turbine Efficiency	Generator Efficiency	Power Output (kW)	Days/Month	Energy (kWh)
January	0.000	0.000	250	35	215	0.915	0.940	0	31	0
February	0.000	0.000	250	35	215	0.915	0.940	0	28	0
March	0.000	0.000	250	35	215	0.915	0.940	0	31	0
April	10.630	16.447	250	35	215	0.915	0.940	594	30	427882
May	21.021	32.524	250	35	215	0.915	0.940	1175	31	874349
June	23.795	36.816	250	35	215	0.915	0.940	1330	30	957804
July	23.531	36.407	250	35	215	0.915	0.940	1316	31	978750
August	23.959	37.069	250	35	215	0.915	0.940	1339	31	996552
September	22.513	34.832	250	35	215	0.915	0.940	1259	30	906200
October	17.481	27.047	250	35	215	0.915	0.940	977	31	727106
November	0.000	0.000	250	35	215	0.915	0.940	0	30	0
December	0.000	0.000	250	35	215	0.915	0.940	0	31	0
									Total Annual Energy Production	**5868643**

Notes
1. Monthy average CWA flow rates are based on future projections for local and imported water supplies.

APPENDIX H:
Notable Structural Deficiencies

Figure H.1 The Backwash Water Tank is an 80-ft tall welded steel tank founded on a shallow concrete ringwall footing.

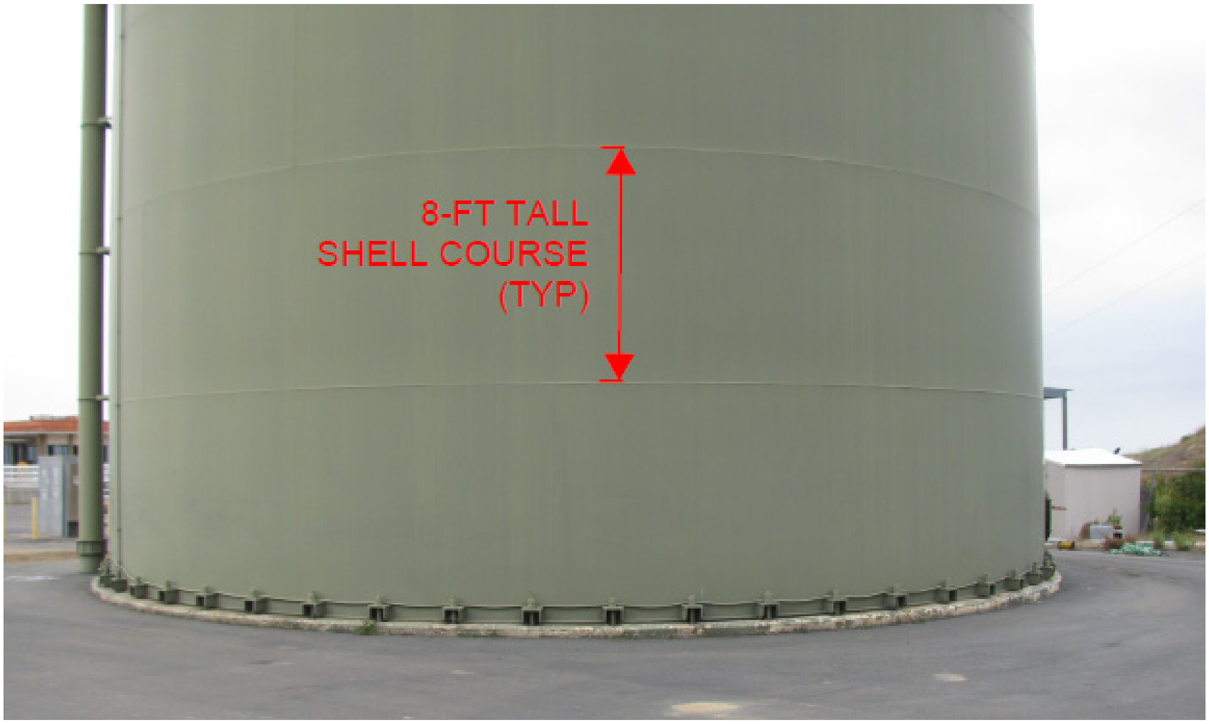


Figure H.2 The Backwash Water Tank is constructed with 8-ft tall steel shell courses.

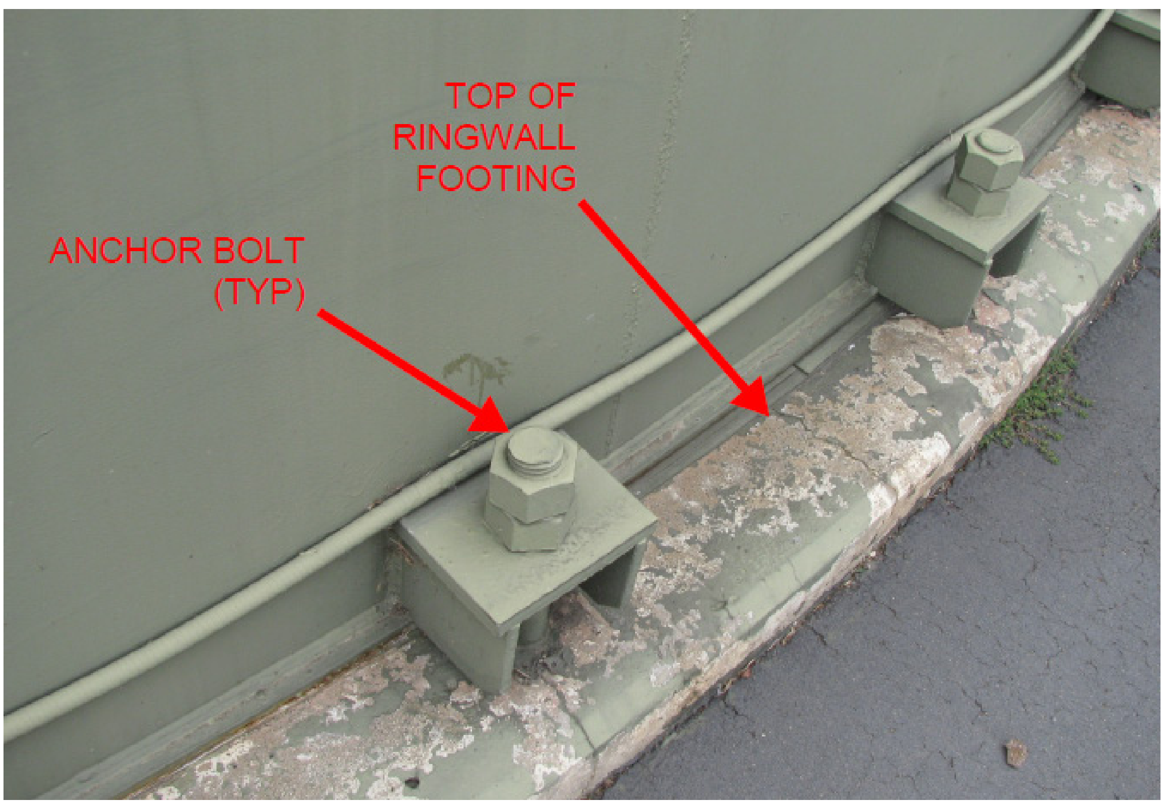


Figure H.3 The Backwash Water Tank is anchored to the concrete ringwall footing with (54) 2-inch diameter galvanized steel anchor bolts.

Figure H.4 **The small propane tank at the chemical storage area has a damaged anchor bolt that requires replacement.**

Figure H.5 **The small propane tank at the chemical storage area is missing an anchor bolt.**

Figure H.6 The sludge collector mechanism rolls on a steel rail system.

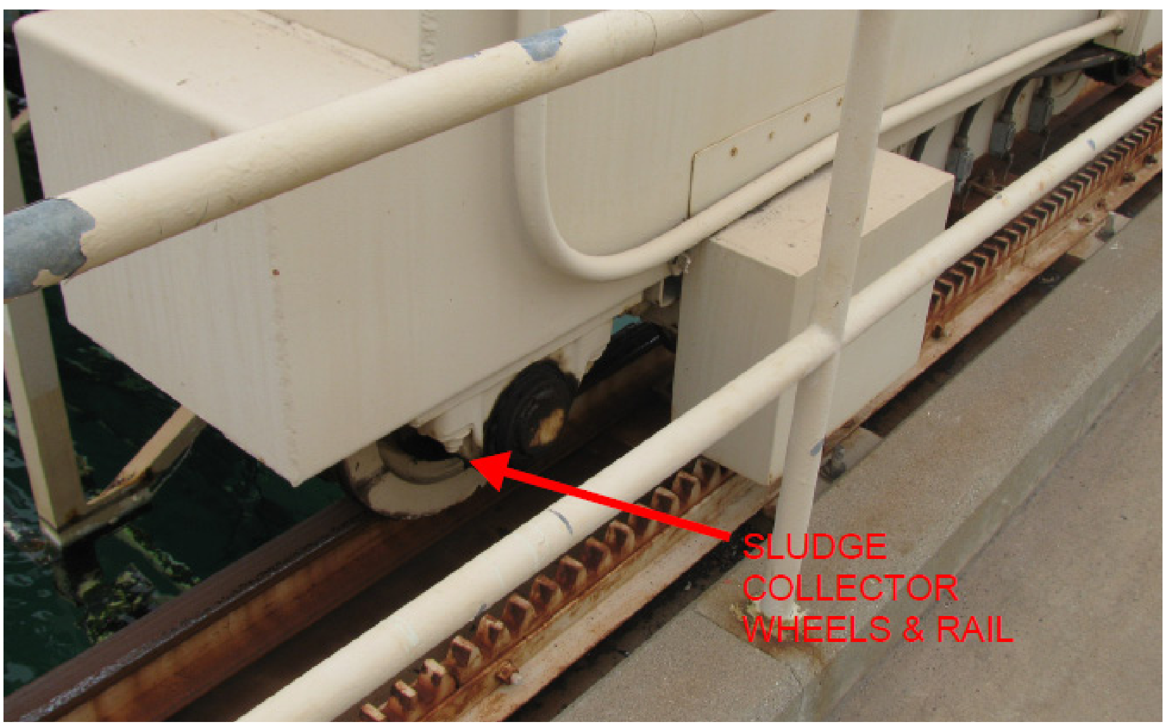


Figure H.7 The sludge collector mechanism does not appear to have a positive means of seismic anchorage. The wheel appears to have limited grip to the rail.

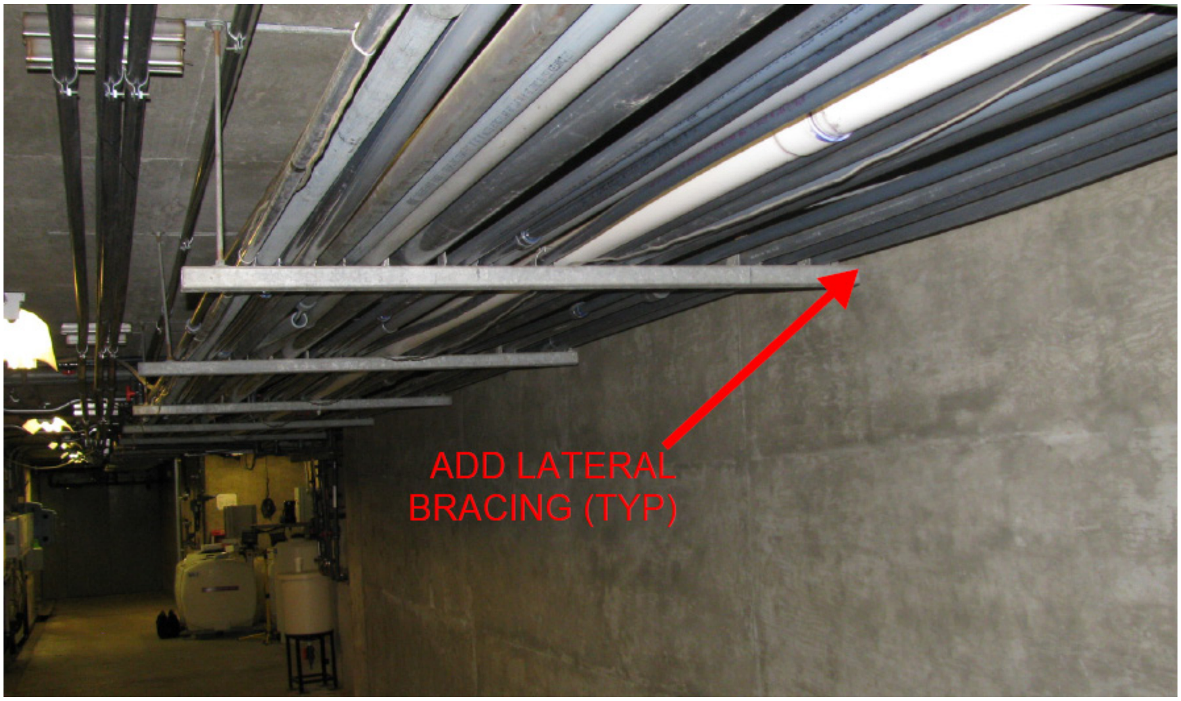


Figure H.8 **Conduit supported from the pipe gallery tunnel south of the Flocculation Basins lacks lateral bracing against seismic loads.**

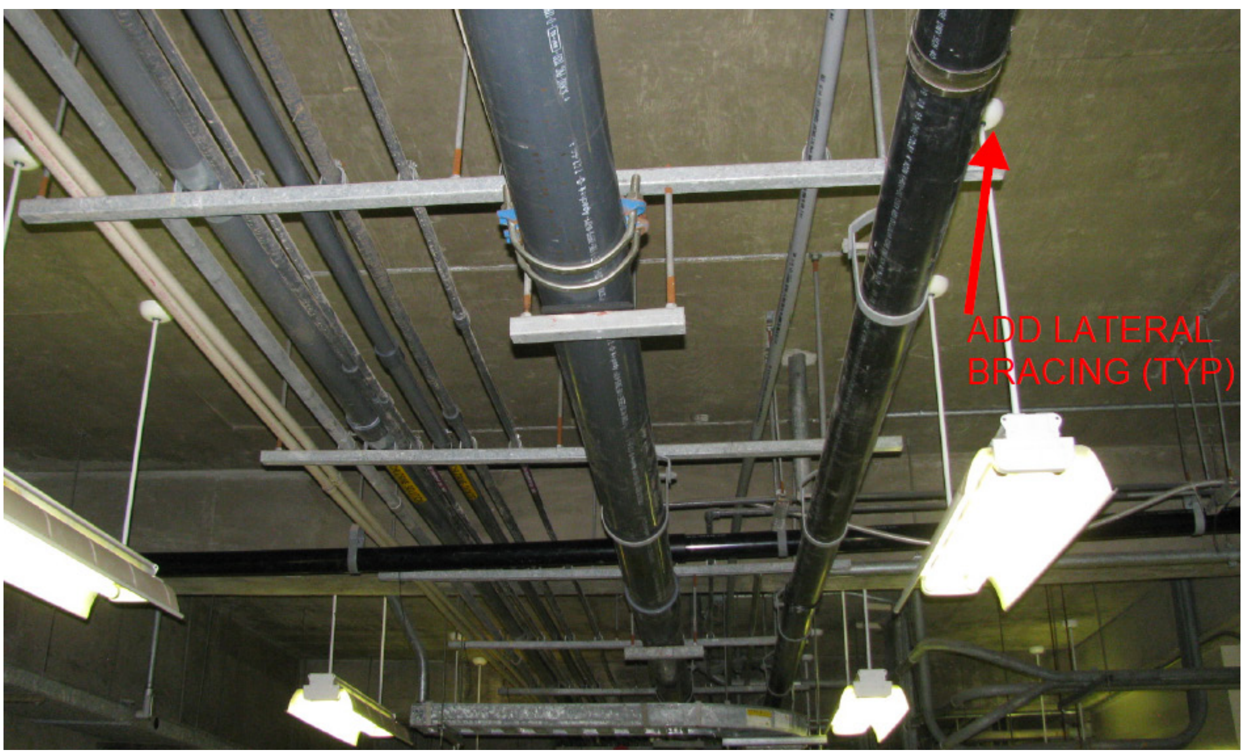


Figure H.9 **Conduit and pipe hung from the ceiling of the Operations Bldg Basement lacks lateral bracing against seismic loads.**

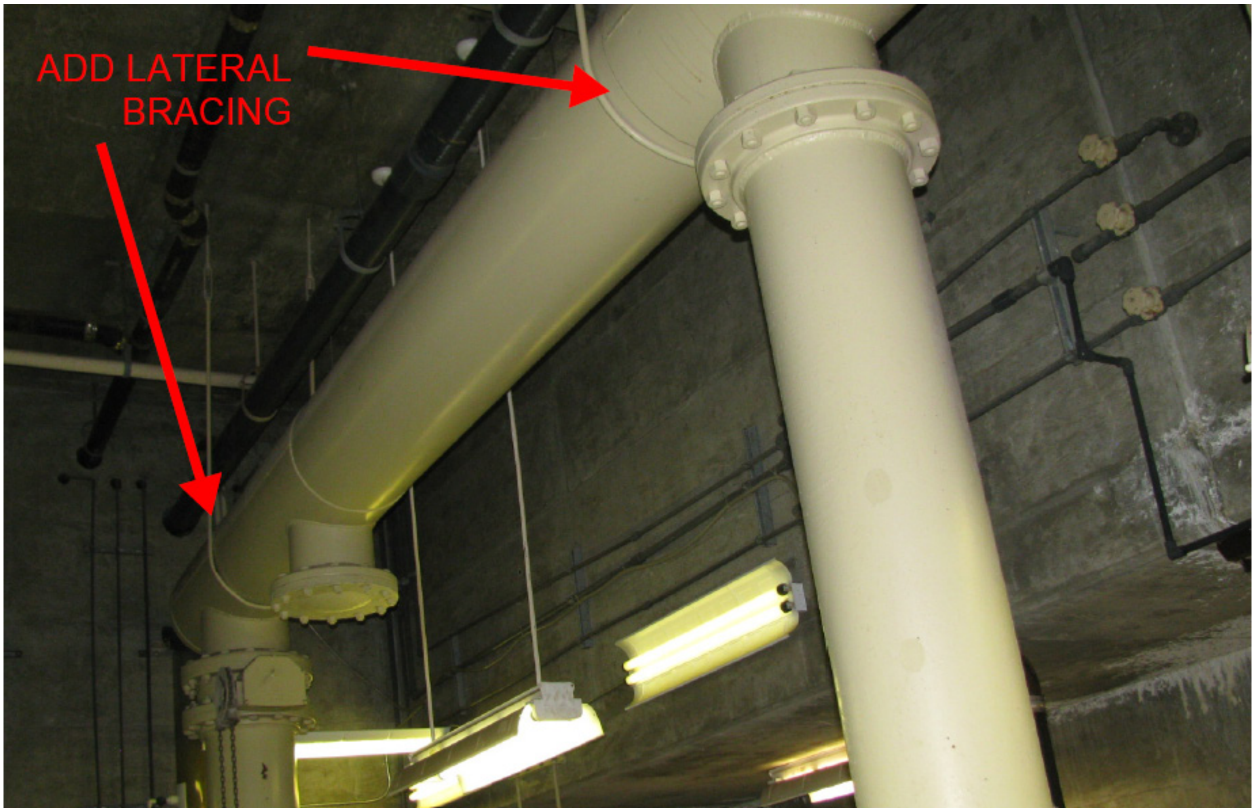


Figure H.10 Large diameter pipe at the lower basement of the Operations Bldg lacks lateral support.

APPENDIX I:
Wash Water Tank Design Drawing

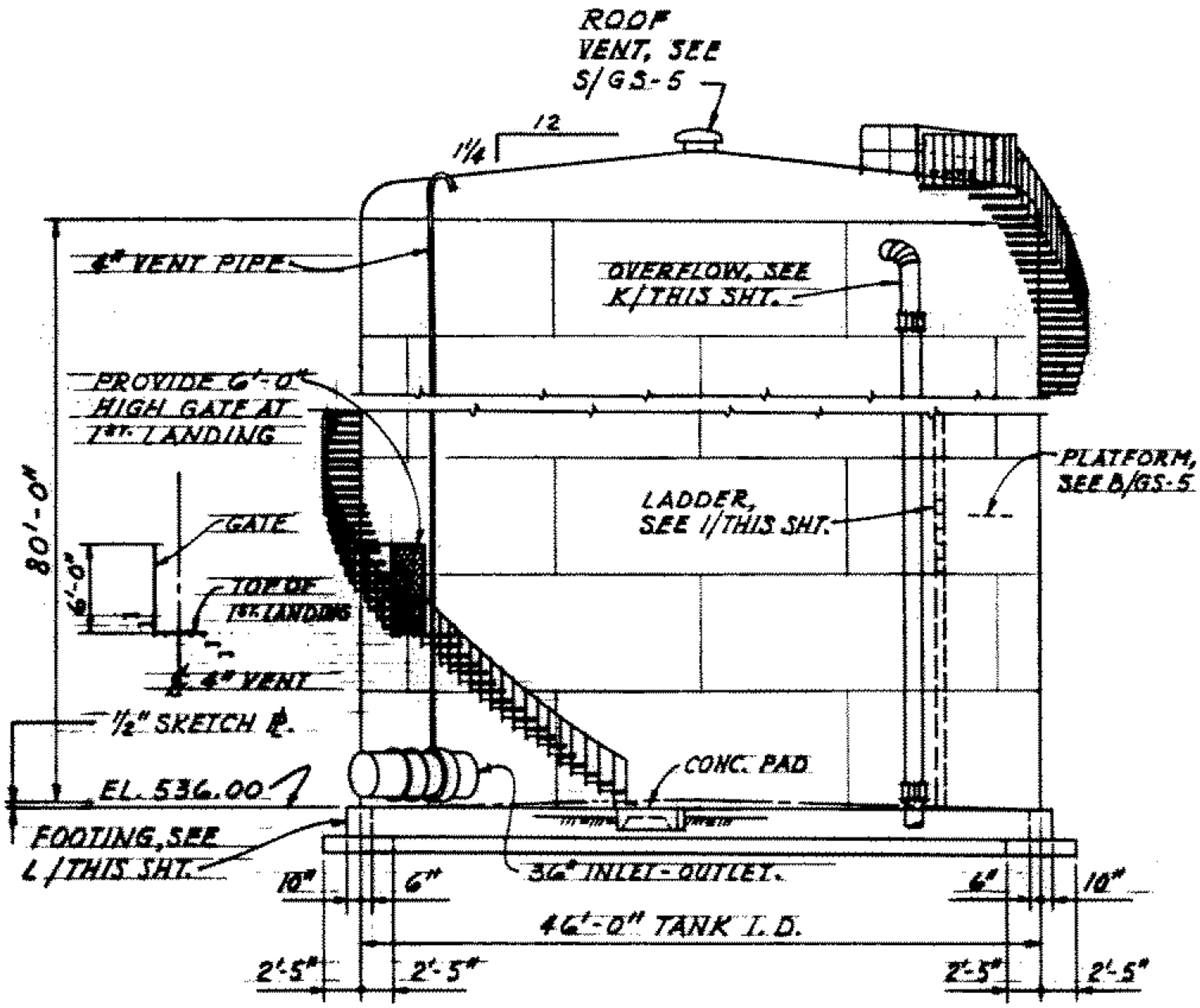


Figure I.1
Tank Elevation as Detailed on the 1968 Joint Filtration Plant Drawings

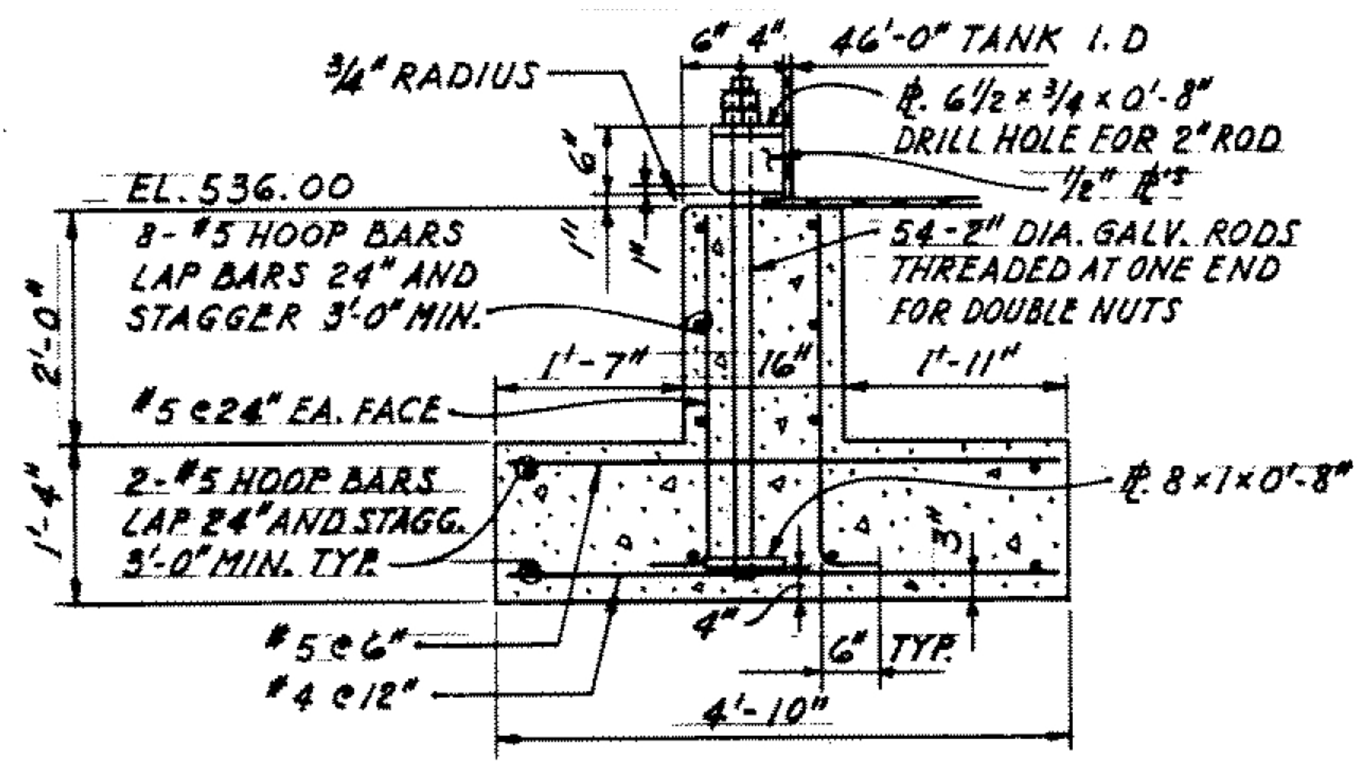


Figure I.2
Section of Ringwall Footing as Detailed on the 1968 Joint Filtration Plant Drawings

APPENDIX J:
Joint Facilities Master Plan
Project Rankings

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Project Rankings

		Joint Facilities															
		New 30-inch Parallel Pipeline from Cielo PS to SDR		New 15 MGD SDPS		Reline Existing 30-inch SDPS Force Main to Plant or Construct New 30-inch Line		Mechanical Dewatering and Filter Waste Washwater Improvements		Install Permanent Chlorine Dioxide Generation		Chemical Storage and Feed Improvements		New Flocculators		New Sludge Collection Equipment	
Evaluation Criteria	**Category Weight**	**PRF**	**Score**	**PRF**	**Score**	**PRF**	**Score**	**PRF**	**Score**	**PRF**	**Score**	**PRF**	**Score**	**PRF**	**Score**	**PRF**	**Score**
Regulatory Compliance and/or Flow-Pressure Objectives	10	3	30	3	30			2	20	2	20	3	30				
Staff Safety and Working Environment	10	1	10	3	30			3	30	2	20	1	10	1	10	1	10
Reliability - Remaining Useful Life, Condition, Accessibility	9	1	9	3	27	3	27	3	27	3	27	2	18	3	27	3	27
Redundancy - Joint Facilities	8	2	16	2	16	3	24	2	16	2	16	2	16				
O&M Cost Efficiency	8	3	24	2	16	1	8			2	16	1	8	1	8	1	8
Increased Local Water Usage	7	3	21	1	7	1	7	2	14	1	7						
Water Quality Enhancement and Taste and Odor Control	7							2	14	1	7	1	7				
Enhanced Operational Control	6	3	18	2	12			2	12	2	12	2	12	2	12	2	12
Total Score			**128**		**138**		**66**		**133**		**125**		**101**		**57**		**57**

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Project Rankings

	Joint Facilities																	
	Electrical Distribution Improvements		Clearwell Seismic Improvements		Reline or Replace 15-inch Drain Line to SDR		SDR Pretreatment Enhancements		SDR Siltation Basins		SDR Sediment Mound Reduction		SDR Inlet Channel Modifications		Natural Treatment Wetlands		SCADA Upgrades	
Evaluation Criteria	**PRF**	**Score**	**PRF**	**Score**	**PRF**	**Score**	**PRF**	**Score**	**PRF**	**Score**	**PRF**	**Score**	**PRF**	**Score**	**PRF**	**Score**	**PRF**	**Score**
Regulatory Compliance and/or Flow-Pressure Objectives	2	20	3	30	1	10	2	20	3	30	2	20	2	20	1	10	1	10
Staff Safety and Working Environment	3	30	3	30	2	20											1	10
Reliability - Remaining Useful Life, Condition, Accessibility	3	27	3	27	3	27	1	9	3	27	2	18	2	18	3	27	2	18
Redundancy - Joint Facilities	3	24					1	8							1	8	2	16
O&M Cost Efficiency	1	8					1	8	1	8					1	8	1	8
Increased Local Water Usage							3	21										
Water Quality Enhancement and Taste and Odor Control							3	21	1	7	2	14	2	14	2	14		
Enhanced Operational Control	2	12	1	6	3	18	3	18			1	6	1	6			2	12
Total Score		**121**		**93**		**75**		**105**		**72**		**58**		**58**		**67**		**74**

SANTA FE IRRIGATION DISTRICT/SAN DIEGUITO WATER DISTRICT
JOINT FACILITIES MASTER PLAN
Project Rankings

	Treat >5,700 AF/Yr Local Water		Business Case Decisions												Beyond Planning Horizon							
	Pre-ozonation and Pilot Testing		Replace or Upgrade Hydroelectric Facility		High Voltage Substation		Washwater Tank		SDR Vegetation Removal		SDR Volume Enhancement through Dredging or Outlet Elevation Modifications		Construct New Third Floc/Sed Basin		Filter Improvements		UV Disinfection		Reline/Rehabilitate Old 54-inch Treated Water Line	
Evaluation Criteria	PRF	Score	PRF	Score	PRF	Score	PRF	Score	PRF	Score	PRF	Score	PRF	Score	PRF	Score	PRF	Score	PRF	Score
Regulatory Compliance and/or Flow-Pressure Objectives	2	20	2	20			3	30					1	10			1	10		
Staff Safety and Working Environment			3	30			3	30												
Reliability - Remaining Useful Life, Condition, Accessibility			3	27							1	9	1	9	1	9			2	18
Redundancy - Joint Facilities	1	8	2	16	1	8							2	16			2	16	2	16
O&M Cost Efficiency			3	24	3	24											1	8		
Increased Local Water Usage	3	21									1	7	1	7	1	7	1	7		
Water Quality Enhancement and Taste and Odor Control	3	21							1	7	2	14	2	14	1	7	1	7		
Enhanced Operational Control	2	12									1	6	1	6	1	6	1	6		
Total Score		**82**		**117**		**32**		**60**		**7**		**36**		**62**		**29**		**54**		**34**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