A. Overview and Description of the Project

This section of the proposal provides a detailed description of our plan to deliver the Design-Build Improvements. It presents a description of the Project and includes all of the design criteria tables, drawings, specifications, and renderings necessary to illustrate and explain the proposed systems and equipment. We have included several voluntary alternatives that would reduce cost and improve operation.

Overview and Description of the Project

The details of our approach to deliver facilities that will meet performance and reliability requirements are explained in Sections G (Approach to Sustainable Building), H (Preliminary Project Schedule, Scheduled Construction Date, and Scheduled Acceptance Date), I (Plan for the Performance of the Design-Build Work), and J (Plan for Transition and Acceptance Testing). This overview provides a higher level explanation of how CDM Smith will approach the project, followed by a description of our Base Project and summary of our voluntary alternatives.

Our Approach

Our approach to your project is best summarized by our five core values:

- ***Excellence –*** Providing superior performance for our clients.
- ***Initiative –*** Working proactively and responsively with our clients.
- ***Teamwork –*** Working together with our clients to achieve results and build positive relationships.
- ***Shared Commitment –*** Mutual relationship between CDM Smith and our clients based on shared goals, trust, and respect.
- ***Integrity –*** Dealing honestly and respectfully with clients; abiding by all laws, regulations, and professional standards.

For your project this means we are focused on:

1. ***Your objectives –*** we will achieve cost, water quality, reliability, customer, and community objectives. Early in the project we will meet with you and develop key performance indicators that we will measure continuously to make sure that all of your objectives are met.
2. ***All applicable building codes, permitting and regulatory requirements –*** we will contact approving agencies early and often and secure approvals on-time to meet your schedule objectives.
3. ***Quality –*** we will design and build a world-class facility that functions flawlessly.
4. ***Safety –*** we will plan and build the project in a way that promotes maximum personnel and environmental protection.

We will use a 3D design platform to provide an integrated approach to design, construction, and training. This platform includes not only the physical arrangement of the components, but also includes parametric data about the pipe, valves, instruments, and equipment for use in developing detailed lists and quantities of the components. Our 3D design will allow you to more easily see the details of our design, better understand equipment placement and spacing, and facilitate our mutual collaboration to develop plant facilities that meet your operational and maintenance reliability objectives. The 3D design will permit a seamless transition to planning construction and safety, and aid in the training of your operations and maintenance team.

Project Description

Our base project fully complies with the RFP requirements and design criteria. Proposal section C (basis of design report) provides the information that documents our compliance. On the following pages, the site plan for our base project is shown and the process block diagram; is included. For the major treatment facilities and design criteria, please see the descriptions provided in Section 3.0 Technical Proposal, C. Basis of Design Report Submitted with this Proposal.

Operability Considerations in Design Approaches

The operability of this plant was given careful consideration not only in the development of the RFP but our team furthered these requirements in many design details. Below is a table outlining our operability considerations used in our design approach.

Operability Issue	Description of Design Approach to address operability	Operational benefit
Maintenance of high pressure piping	Hybrid design approach of membranes using a combination of high pressure and low pressure membranes	Lower pressures use less energy and put less stress on the piping system.
Maintenance of ancillary pumping systems	Located all of the ancillary pump facilities in one location	Pump maintenance occurs in one primary area
Chemical storage tanks	With the exception of sodium hypochlorite day tanks, the chemical storage tanks will be installed on top of 4 ft pedestals, above maximum spill level.	Provides flooded suction under most operating conditions. Minimizes corrosion of tank hardware in case of a chemical spill.
Chemical feed pumps	Chemical metering pump skids will be installed on top of 4 ft pedestals, above maximum spill level.	Allows operators to operate and perform maintenance on pumps and accessories without bending down. Minimizes corrosion in case of a chemical spill.
Chemical tank fill	All bulk chemical storage tanks are located at the north end of the SWRO Chemical Building.	Provides a centralized location for chemical truck unloading areas, and controlled and easy flow of large truck traffic.
UV equipment access	Access maintained for UV reactors, flowmeters, and valves by keeping all equipment above grade	Will aid operators in bulb replacement and other maintenance
UV equipment operation	Use of EPA validated reactors rather than more common DVGW validation	Allows operator flexibility to turn up or down the UV dose, targeting specific log reduction value.
Chemical Area Exhaust -Safety of Staff	Per the RFP, the stations for control of the exhaust fans are located outside the immediate storage area	This will allow the fans to be put into high exhaust mode without entering the room.
Chemical Area Exhaust – VFD instead of two-speed fans	Allow for adjustment of the flow volume without having to resheave the fans.	Reduced balancing cost and greater operability with ability to fine tune the flow rates and keep the areas slightly negative.
Chemical Area Exhaust Fan - Location	Mounting the exhaust fans on the roof of the lower RO area instead of on the roof of the higher storage area roof.	This allows for safer operation in that the maintenance staff will not have to climb as high for servicing the units. Locations will not require fall protection that would otherwise have been needed.
Use of process heat gain/rejection for building heating during the winter months	Examination of the steady state heat rejection of the VFDs and RO units and determined that no additional heat was required for winter conditions if the building was insulated, thus will not include the installation of Unit Heaters for the RO Building.	This will be an energy saver and a sustainably responsible approach to not install unnecessary unit heaters for the building and reduces the overall operational cost of the system.
Chemical Storage: Maintain minimum temperatures for temperature sensitive chemicals by installing heat tracing	The chemical area requires a minimum of 6 air changes per hour (ACH) under normal mode. Instead of heating the entire area which is costly to operate, the design incorporates heat tracing and insulation of required tanks.	This is a substantially less costly approach than heating the entire area to a minimum temperature.

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Operability Issue	Description of Design Approach to address operability	Operational benefit
Saturated Lime System and Tekkem Lime System (Option 1 and Alternative to Option 1)	Provide abundance of access around large/tall pieces of equipment.	Due to the physical size of the components associated with these systems (silo, saturators, equalization tanks, etc.) CDM Smith elected to provide CAW operations staff with an abundance of access around each piece of equipment. This design approach improves plant safety as operators have plenty of space to walk around each piece of equipment without getting close to moving parts. This design approach also improves plant maintainability as plant staff have sufficient space to work to maintain, service, and repair equipment.
Calcite Contactor System (Option 2)	Provide sufficient height on contactor units to allow water to flow by gravity into the treated water storage tanks and eliminate the need for transfer pumps.	The elimination of a treated water transfer pump station reduces the labor costs associated with the maintenance of this pump station. The elimination of a treated water transfer pump station improves the reliability of the facility due to the elimination of another mechanical system which may fail.
Calcite Contactor System (Option 2)	Eliminate ladders/cages and provide large access hatches on top of each contactor unit to facilitate calcite replenishment via the use of equipment.	Due to the infrequent expected calcite replenishment frequency, CDM Smith elected to eliminate ladders/cages on the calcite contactor units. When necessary, Cal-Am operators will utilize equipment to access the top of the contactors and replenish the calcite. This design approach greatly improves operator safety when compared with alternate methods of calcite replenishment.
Carbon Dioxide System	Provide abundance of access around large/tall pieces of equipment.	Due to the physical size of the components associated with these systems CDM Smith elected to provide Cal-Am operations staff with an abundance of access around each piece of equipment. This design approach improves plant safety as operators have plenty of space to walk around each piece of equipment without getting close to moving parts. This design approach also improves plant maintainability as plant staff have sufficient space to work to maintain, service, and repair equipment.
Carbon Dioxide System	Provide efficient and controllable system.	CDM Smith elected to provide Cal-Am with an efficient and controllable pressure solution feed carbon dioxide system. Injection of carbon dioxide into a carrier water stream greatly increases the utilization of the carbon dioxide an provides superior control when compared with systems that directly inject carbon dioxide into the process stream. This will increase the efficiency of the system as well as consistency of the finished water quality.
Sodium Hypochlorite Generation System	Work with sodium hypochlorite generation system supplier to ensure redundant and robust measures are implemented to ensure system performance.	Redundant and robust measures to ensure system performance enhances operator safety and improves the reliability of the facility by ensuring the generation system does not operate when certain permissives are not met (i.e. hydrogen dilution blowers must be operating before the generation system is allowed to operate).
Minimizing Electrical Manholes.	Efficiently layout electrical ductbanks to put manholes only where absolutely needed, and utilize electrical handholes.	Minimize the need for confined space entry.
Arc Flash Safety	Extra time will be spent during the Arc Flash and Selective Coordination Studies to maximize coordination and minimize Arc Flash Energy. The design and eventual installed equipment will be adjusted to make safety a priority.	Maximize safety for operations and maintenance.

Operability Issue	Description of Design Approach to address operability	Operational benefit
Control Panel Location	Control panels will be located to provide easy access to them, clear working space in front of them, and also provide clear working space around the mechanical equipment. Remote control stations mounted in easy access areas will be provided for electrical valves where valves are hard to access.	Maximize safety and accessibility. Provide plenty of space for easier maintenance.
Smart MCC	Utilize smart MCC's to simplify control wiring and to provide useful information for maintenance.	Simplify troubleshooting by eliminating hundreds of terminations and allow for improved maintenance.
Admin Bldg.: HVAC System	The HVAC system in the Administration Building will be controlled by a direct digital control (DDC) system that will control and monitor all functions of the HVAC system.	Automatically controls space temperatures. Space temperature set-points are automatically adjusted during unoccupied periods to save energy. Alarms are sent to a central station when equipment malfunctions. Temperature and alarm trends can be documented to warn of future problems and trouble shoot current problems.
Admin Bldg: HVAC and Plumbing Equipment	The HVAC equipment including, air handlers, VAV boxes, boilers, exhaust fans, unit heater and condensing units have been located to allow clearances to allow for proper maintenance.	Equipment serviceability, Staff safety.
Admin Bldg: HVAC and Plumbing Equipment	To the extent possible, roof-mounted equipment was not utilized.	Equipment serviceability, Staff safety.

Voluntary Alternatives

We have developed 12 voluntary alternatives. All of these alternatives will reliably meet your water quality and water production requirements. Each of them add value to the project, and most reduce both capital and annual costs over the base project. Our voluntary alternatives are as follows:

#	Voluntary Alternative	Benefit to Meeting Performance and Reliability Requirements	Capital Cost Savings		Annual O&M Cost Savings	
			9.6 mgd	6.4 mgd	9.6 mgd	6.4 mgd
1	Optimized RO System	▪ Provides a 10-year RO membrane performance guarantee. ▪ Reduces the power consumption below the minimum power use of the base project. ▪ Reduces costs while still providing equipment robustness equivalent to the base project.	$ 3,500,000	$ 1,400,000	$ 506,921	$ 343,142
2	Aeration for Iron Oxidation	▪ Proven technology used for over 100 years ▪ Does not oxidize manganese, thus reducing the risk of Mn fouling of RO membranes. ▪ Reduces use of sodium hypochlorite and sodium bisulfite ▪ Reduces capital and annual costs	$ 650,000	$ 650,000	$ 163,392	$ 111,147
3	Maintain iron and manganese is dissolved form	▪ Keeps iron and manganese in dissolved form, eliminating the need for filters ▪ Reduces chemical consumption ▪ Simplifies O&M ▪ Reduces capital and annual costs	$ 9,700,000	$ 8,100,000	$ 284,909	$ 201,440

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#	Voluntary Alternative	Benefit to Meeting Performance and Reliability Requirements	Capital Cost Savings		Annual O&M Cost Savings	
			9.6 mgd	6.4 mgd	9.6 mgd	6.4 mgd
4	Cal-Flo Lime Slurry System	▪ Simplifies O&M – more reliable and cleaner ▪ Smaller plant footprint ▪ Lower capital cost	$ 1,500,000	$ 1,000,000	($ 23,048)	($ 5,730)
5	Bulk storage and delivery of NaOCL	▪ Lower capital cost	$ 800,000	$ 800,000	($ 54,994)	($ 31,353)
6	Delete Sulfuric Acid and Storage System	▪ Not required based on expected source water quality and design RO recovery. ▪ Removes safety risk of handling acid ▪ Lower capital cost ▪ Lower annual cost	$ 600,000	$ 600,000	$ 146,528	$ 98,348
7	Eliminate walls from pressure filter gallery	▪ Provide canopy instead; typical approach for pressure filters ▪ Eliminates need for fire suppression system ▪ Reduces capital and annual cost	$ 88,000	$ 70,000	$ 0	$ 0
8	Eliminate walls from chemical storage	Provide canopy instead; commonly used approach for chemical storage tanks. Separation still provided between non-compatible chemicals. Reduces capital and annual cost	50,000	40,000	$ 0	$ 0
9	Smaller finished water tanks and install UV	By using EPA validated UV units, this can be achieved with same UV dose specified in RFP Reduces tanks from 750,000 gallons each to 220,000 gallons each, while increasing usable storage for flow equalization. Reduces annual cost Reduces capital cost	400,000	400,000	$ 0	$ 0
10	Substitution of Industry Standard Materials	Substitutes industry standard materials in place of RFP specified materials Reduces capital cost	790,000	790,000	$ 0	$ 0
11	Vibration monitoring elimination	Eliminates vibration monitors on lower horsepower motors Consistent with industry standards Reduces annual maintenance Reduces capital cost	50,000	50,000	$ 0	$ 0
12	FRP Cartridge Filters	Lighter units, making changing filters easier. More aesthetical pleasing – i.e., AL6X prone to some surface rusting, FRP is not. Comparable service life to AL6X Lower capital cost	$ 90,000	$ 64,000	$ 0	$ 0

*Each of the voluntary proposals also works for 6.4 mgd plant; cost savings for 6.4 mgd plant is shown in Section 3.0 Technical Proposal, M. Voluntary Alternative Proposals.

B. Scope of Geotechnical Investigation

The geotechnical investigation is comprised of literature review, site reconnaissance and mapping, subsurface exploration, and laboratory testing to develop geotechnical recommendations to support preparation of final project plans and specifications. This work will culminate in a Design-Level Geotechnical Investigation Report which will summarize the findings and present conclusions and recommendations. The report will include illustrations, (scaled) boring location maps, geologic maps, boring logs and laboratory test results.

Primary geologic and geotechnical considerations for the project include evaluation of seismic hazards, uniform and appropriate bearing for proposed footing loads, static and seismically induced settlement, excavation conditions, general grading, earthwork and compaction considerations, lateral earth pressures, utility trench excavation and backfill requirements, trench stability, shallow groundwater conditions, erosion, corrosion potential of native soils, and surface drainage. These issues will be addressed with the following tasks:

- Site reconnaissance of the project site by the project geotechnical engineer and project geologist, and reconnaissance-level geological mapping of the desalination plant site.
- Compile a set of base maps to create a suitable suite of maps for subsequent data collection, including existing boring data locations, proposed boring locations and a geomorphic analysis. We will review existing available geological and geotechnical engineering reports pertinent to the project site.
- Review of historical stereopair aerial photographs available for an account at the UC Santa Cruz Map Library. Perform a geomorphic analysis of the plant site using the photos and historical topographic maps.
- Proposed boring locations will be marked in white paint before contacting Underground Service Alert (USA) and an independent utility locator to clear boring locations. We propose a field exploration program consisting of the drilling of 10 exploratory borings. The borings will be drilled to depths of 15 to 30 feet, with one boring drilled to a depth of 50 feet at the plant site to evaluate liquefaction potential and/or the presence of groundwater.
- Laboratory testing of selected samples obtained during drilling operations. We anticipate these tests to include (but are not limited to) density, moisture content, Atterberg Limits, grain size distribution, R-Value for preliminary pavement design purposes, soil corrosivity, and applicable strength tests.
- Construction of geological maps and, where deemed warranted, geologic cross sections.
- Engineering analysis and geologic review of data collected from literature review, site mapping and field exploration program. This information will be used to develop preliminary qualitative and quantitative geotechnical recommendations pertinent to the design and construction of the desalination plant. The analysis will include a quantitative evaluation of seismically-induced settlement at the plant site, development of lateral earth pressures and foundation design criteria, development of general earthwork, materials and utility trench recommendations, deterministic evaluation of seismic design parameters in accordance with the California Building Code and discussion of pertinent seismic and geologic hazards.
- Preparation of a Geotechnical Investigation Report. The report will include summaries of the compiled data with related references, factual data, descriptions of the geologic and seismic settings, site history, and descriptions of prospective geologic hazards and attendant risks with respect to liquefaction, landsliding, surface fault ground rupture and seismic shaking. The report will also provide geotechnical conclusions and recommendations pertinent to the design phase of the project and will include boring logs, test results,

a site plan showing boring log locations, and recommendations for design phase studies. The report will be issued in draft form and, following a review and comment period the Final Geotechnical Investigation Report will be submitted. The report will be prepared and signed by a California Registered Geotechnical Engineer with over 23 years of experience within the local area.

C

C. Basis of Design Report Submitted with Proposal

1.0 INTRODUCTION

Led by California-American Water Company (CAW), the Monterey Peninsula Water Supply Project is a complex, multi-component program that is necessary to replace a large percentage of the local drinking water supply that currently originates from the Carmel River. State Water Resources Control Board (SWRCB) Order 95-10 requires CAW to reduce diversions from the Carmel River by approximately 70 percent no later than December 31, 2016. CAW plans to implement three projects to address this regional water crisis:

- Desalination of seawater from beach wells drawing water from Monterey Bay
- Groundwater Replenishment (GWR) with advanced treatment of wastewater from the Monterey Regional Water Pollution Control Authority Plant
- Aquifer Storage and Recovery (ASR)

Dependent upon on the capacities of the planned GWR and ASR projects, the desalination system will be designed and constructed to initially produce between 6.4 and 9.6 million gallons per day (mgd) of drinking water, and will consist of four major sub-systems:

- Raw Water Supply Wells, Pumping and Conveyance
- Treatment Plant
- Concentrate (or Brine) Conveyance and Disposal
- Treated Water Distribution and Storage

The Desalination Infrastructure Basis of Design Report (BODR) presents the preliminary design and related information requested by CAW for the treatment plant, treated water pumping, and concentrate storage facilities confined to the proposed 46-acre plant site on Charles Benson Road. The BODR is organized as outlined by CAW in Appendix 2 of the RFP and includes approximately 110 preliminary design drawings assembled in Section 3.D. Drawings Submitted with Proposal.

2.0 GENERAL PROJECT DESIGN CRITERIA

This section presents general design criteria for the baseline desalination facility to reliably and continuously produce 9.6 mgd of drinking water. Information is presented for items a through l as prescribed by CAW and listed in the contents bar (right).

The proposed Desalination Infrastructure Project includes the following unit processes:

- Pressure Filtration
- Seawater Reverse Osmosis (SWRO)

- Partial Second Pass Brackish Water Reverse Osmosis (BWRO)
- Disinfection (chlorine or UV-chlorine)
- Treated Water Stabilization (carbon dioxide-lime or calcite)
- Washwater Clarification and Recycle
- Concentrate Storage and Disposal
- Residuals Handling and Disposal

Sheet G-5 Process Flow Diagram and Sheet G-6 Residual Process Flow Diagram illustrate the flow of water, application of treatment chemicals, and flow of residuals/waste streams through the proposed facilities. Water surface elevations through the treatment plant at production rates of 6.4, 9.6 and 12.8 mgd are shown on Sheet G-7 Hydraulic Profile – 9.6 mgd Base Case.

The plant layout is presented on Sheet C-1 Proposed Site Plan and an aerial rendering (below) provides a conceptual understanding of the appearance and dimensions of the proposed facilities.

CDM Smith applied a consistent design-build approach for the Base Case (9.6 mgd) Design and the Reduced Capacity Alternative (6.4 mgd). In most cases, the 9.6 MGD design was modified by reducing the number or sizes and/or numbers of the facilities as documented in subsequent sections in the proposal.

Similarly, CDM Smith developed a Voluntary Alternative by implementing several modifications to the Base Case design to further enhance the project through: improved reliability; more efficient operations; lower construction costs; additional safety, aesthetic, public education and environmentally sustainable features; and other benefits.

The remaining sections of the BODR present detailed design criteria and information required by CAW for raw water quality (3.C.3), finished water quality (3.C.4), and each of the plant components or topics listed in Appendix 2 of the RFP.

Section 2:

2.a	Rated Capacity - 9.6 mgd with N+1 Redundancy
2.b.	Life Expectancy - 30 years for equipment and 50 years for infrastructure
2.c.	Staffing for Operation – 3 during normal day shift and 1 during evening and night shift
2.d.	Allowance for Future or Potential Facilities – Space for future DAF pre-treatment and mechanical solids dewatering
2.e.	Sustainable Design, Construction and Operation in Building Technology – Greater than 55% on Envision ™ checklist
2.f.	Spill Protection/Secondary Containment for Liquids – Secondary containment for chemicals and impervious surfaces to capture saline discharges
2.g.	Site Arrangement – Compact integrated utilized with process facilities centralized around RO Equipment Building
2.h.	Safety- Haz-ops identified and safety feature incorporated
2.i.	Redundancy – Full N+1design
2.j.	Process Overflows – Captured to prevent contamination
2.k.	Coastal Marine Environment and Corrosion Control – Corrosion resistant materials and sacrificial coating s used
2.l.	Saline Water and Corrosion Control – Non-metallic or high pitting resistant alloys used

2.a. Rated Capacity

Rated capacity with the single largest redundant process unit out of service is 9.6 mgd. Maximum capacity is 11.2 mgd and is the capacity that can be finished and delivered with the spare RO train in operation. Pretreatment systems, chemical feeders and disinfection systems are designed to allow maximum capacity to be achieved with no allowance for redundancy. The 11.2 mgd maximum capacity allows the spare RO rack to be used to “catch up” to annual production, but not exceed annual allowed production. Both rated capacity and maximum capacity will be permitted capacities recognized by CDPH, including the Cryptosporidium action plan

Table 2-1. Permitted Capacities

Capacity Type	Capacity to be Permitted	Per RFP	Assumptions/Notes
Rated Capacity	9.6 mgd[1]	✓	
Maximum Capacity	11.2 mgd	✓	All SWRO and BWRO units operating including stand-by units

[1] The rated capacity shall be 9.6 mgd or 6.4 mgd. The decision on rated capacity depends on whether the 3,500 afy GWR project is implemented by MRWPCA. For purposes of this BODR, the rated capacity is assumed to be 9.6 mgd.

Table 2-2 identifies the effect of rated capacity on various facility components. An ultimate capacity of 12.8 mgd is shown in Table 2-2 to provide a basis for design of fixed capacity components, and to identify space planning requirements for variable capacity components. The ultimate capacity is based on adding two RO trains (1.6 mgd each) to the 9.6 mgd rated capacity design, or adding four RO trains (1.6 mgd each) to the 6.4 mgd rated capacity design. Chemical storage volumes are identified as fixed because storage tanks are sized to safely receive bulk deliveries.

Table 2-2. Component Capacity

Component	Variable or Fixed Capacity	Capacity to be Provided	Design Criteria for Ultimate Capacity
Administration Facilities/Building	Fixed	As identified in Appendix 2	NA
Arterial Piping (such as Raw Water supply piping, piping to finished water tanks)	Fixed	12.8 mgd	Ultimate hydraulic capacity of 12.8 mgd
Chemical Storage Volumes	Fixed	As identified in Appendix 2	As identified in Appendix 2
Chemical Feeders	Variable	9.6 mgd	12.8 mgd
Electrical Service and Service Transformers	Variable	See electrical criteria in Appendix 2	Ultimate 12.8 mgd Capacity
Electrical Bus Capacity (4160 volt)	Fixed	12.8 mgd	Ultimate 12.8 mgd Capacity
Standby Electrical Generator	Fixed	As identified in Appendix 2	12.8 mgd
Granular Media Filtration Capacity	Variable	9.6 mgd	12.8 mgd
Granular Media Filtration Wastewater Clarification	Fixed	9.6 mgd	12.8 mgd
Post Stabilization Chemical Storage	Fixed	9.6 mgd	12.8 mgd
Post Stabilization Calcite Contactors	Variable	9.6 mgd	12.8 mgd
Post Stabilization Lime Saturation System	Fixed	9.6 mgd	12.8 mgd
UV Disinfection	Variable	9.6 mgd	12.8 mgd
Clearwell Size	Fixed	As identified in Appendix 2	1.5 MG
Hypochlorite Generation Capacity	Variable	As identified in Appendix 2	12.8 mgd
Hypochlorite Storage Capacity	Fixed	As identified in Appendix 2	As defined in Appendix 2
Reverse Osmosis Capacity	Variable	9.6 mgd	12.8 mgd
Reverse Osmosis Building	Variable	9.6 mgd	12.8 mgd

Component	Variable or Fixed Capacity	Capacity to be Provided	Design Criteria for Ultimate Capacity
Concentrate Equalization Pond Volume	Fixed	As identified in Appendix 2	3 MG
Finished Water Pumping Capacity	Variable	9.6 mgd	12.8 mgd

2.b. Life Expectancy

Table 2-3 identifies the expected life assumed by CAW for depreciation of selected assets.

Table 2-3. Life Expectancy of Selected Assets

Equipment Type	Life Expectancy (Years)	Per RFP	Notes/Assumption
Process Equipment			
RO Equipment	25	✓	Excludes membranes and pumps
Pressure Filters	15	✓	Replace rubber lining
Electrical Power Equipment	30	✓	
Instrumentation and control equipment	20	✓	Software and processor may be obsolete in 5-10 years
Tankage			
Chemical Bulk Storage Tanks	25	✓	Hypochlorite and sulfuric tanks require more frequent replacement
Chemical Day Tanks	15	✓	Not applicable
Finished Water Storage Tanks	50	✓	Requires periodic coating replacement
Earthen reservoirs	25 (life of liner)	✓	20 year extended warranty provided
Buildings/Structures			
Reinforced Concrete Structures	75	✓	
Administration Facilities	50	✓	
Stand Alone Electrical Buildings	30	✓	
Piping and Valves			
Finished Water Piping	50	✓	
Finished Water Valves	25	✓	
Saline Water Piping	25	✓	
Saline Water Valves	15	✓	
Chemical Piping	15	✓	
Chemical Valves	15	✓	

2.c. Staffing for Operation

As indicated by CAW, it is expected that the facility will be staffed 24 hours per day, seven days per week. In order to enable operation to be sufficiently reliable to allow partially attended operation, automation where prudent is provided to enable safe and efficient operation, monitoring, and control of pumping and treatment facilities. Automated components are summarized in Table 1-4.

Table 1-4. Automated Facility Components

Process	Automation	Operational Benefit
Backwash	Automated backwash sequence	Provides for the routine unmanned operation of backwash sequence based upon start-up sequence, pressure differential, and or time based upon operating conditions without operator intervention. Failure of backwash initiation is alarmed for operator attention.
RO Flushing System	Automated system including flush supply and waste valves	Required flushing of the system is initiated as part of the system shutdown sequence, readying system for subsequent restarts, parking the membranes in a permeate solution rather than salt or brackish water extending the life of the membranes.
RO Concentrate	Automatic sampler at sampling station	Collects composited samples for ease of collection, for analysis, to comply with discharge permit requirements.
Lime Slurry System	Automated batching system	Provides a continuous supply of lime while limiting the exposure of operations and maintenance staff to lime.
UV System	Automated start-up and shutdown sequence	Conserves power and extends life of bulbs and ballasts.
Medium Voltage Switchgear	Automated transfer control of the main-tie-main arrangement with capability of being fully automated in the future	Allows for automatic start and switch over in the event of power failure, allowing O&M staff to concentrate on equipment and system issues resulting from a power failure and the temporary power loss during the switchover
Supply to Filtered Water Feedwater Pumps and Finished Water Pumps	Automatic transfer control associated with the 480 VAC standby power generator	Allows for automatic start and switch over in the event of power failure, allowing O&M staff to concentrate on equipment and system issues resulting from a power failure and the temporary power loss during the switchover
Standby Power	Genset shall start automatically upon loss of power	Allows for automatic start and switch over in the event of power failure, allowing O&M staff to concentrate on equipment and system issues resulting from a power failure and the temporary power loss during the switchover.
Alarms	Automatic dialing capabilities	Provides duty operator with means to monitor alarms, via a duty mobile phone, to receive alarms when not stationed at control panel while making rounds, adjusting equipment, and performing other operation and maintenance duties. Feature also provides for future alarm response in the event scheduling and permits allow for unmanned operation periods.
Day Tanks Larger than 100 gallons	Automatic shutoff of the transfer pumps.	Mitigates the potential for accidental overfilling of Day Tanks. Automatic shutdown is controlled by Day Tank levels

2.d. Allowance for future or potential facilities

2.d.i. Seawater Treatment

Sheet C-6 in the drawing set identifies the area of the Project Site west of the pressure filters where pretreatment processes for seawater from a surface water intake can be treated using dissolved air flotation and granular media filtration. This process generates up to 2 tons of dry solids per day and requires the construction of residuals holding tanks, thickeners and dewater equipment. The site plan shows a dewatering equipment building with an enclosed truck loading station and pull through.

2.d.i.i. Planning for Plant Expansion

As shown on the base case site plan for a 9.6 mgd facility M-5 the design reserves space on the east side of the building for future expansion of the Building by 20 feet and installation of an eighth 1.6 mgd SWRO unit and one 1.3 mgd BWRO unit. These areas have been maintained free of large piping, duct banks, and similar obstructions that would be difficult or costly to move/relocate in the future.

2.e. Sustainable Design, Construction and Operation in Building Technology

Recognizing CAW's interest in undertaking this project in a sustainable manner that ultimately improves the resilience of the facility, improves environmental stewardship and contributes to community quality of life, CDM Smith considered the following sustainability features during development of the preliminary design of the project:

- Use of recycled materials for in the backfill of structures, as well as the backfill of pipe.
- Use of recycled materials in concrete such as flyash and reinforcing bar using recycled materials
- Reduction of painted surfaces to reduce future maintenance of VOC materials
- Energy efficient equipment
- Energy reduction, including occupancy lighting, light level correction and energy efficient lighting
- Materials selection criteria based upon recycled, rapidly renewable and locally manufactured materials
- Indoor air quality principles

In addition the CDM Smith team will consider the following:

- Compliance with the requirements of the International Energy Conservation Code, which is an additional requirement of the GBA. Compliance will be demonstrated through the COMCHECK compliance program related to insulation, lighting and building HVAC and plumbing Systems.
- Use of selected LEED® criteria to inform design decisions on the project.
- Implement design/build decisions based upon the Institute for Sustainable Infrastructure (ISI) (www.sustainableinfrastructure.org) Envision™ infrastructure sustainability rating system. Envision has been developed for use on civil engineering infrastructure projects, assessing the sustainability of projects in five major categories: quality of life, leadership, resource allocation,

natural world, and climate and risk. The system allows for rating and recognition of infrastructure projects much like LEED provides through certification of buildings.

LEED® and Envision™ Application in D/B

The Leadership in Energy and Environmental Design (LEED®) green building rating system has been instrumental in "transforming the way buildings and communities are designed, built and operated." Since its introduction in 2000 by the U.S. Green Building Council (USGBC), projects undertaken using the LEED rating system have resulted in building sustainability improvement. Yet LEED doesn't address civil infrastructure like that for in the CAW project.

In undertaking any infrastructure project it is becoming increasingly important to consider not only the environmental impacts and benefits over the full life-cycle of the project, not just that resulting during the construction phase. Consideration of the social and economic, as well as environmental, dimensions of sustainability is also important in crucial for any infrastructure project. LEED has been used by some to guide the design of infrastructure projects but the framework doesn't address the unique issues that horizontal infrastructure pose.

The American Public Works Association (APWA), the American Council of Engineering Companies (ACEC) and ASCE seeing the need for a unified approach to addressing the issue of infrastructure sustainability founded the Institute of Sustainable Infrastructure (ISI) in 2011. ISI's mission is to transform tomorrow's infrastructure through the application of a sustainability rating system for civil infrastructure that fosters the efficient delivery of infrastructure in an environmentally and socially responsible. Early in 2012, ISI in collaboration with the Zofnass Program for Sustainable Infrastructure at Harvard University released the Envision™ infrastructure sustainability rating system. The Envision™ rating system guides users in assessing the sustainability of projects in five major categories: quality of life, leadership, resource allocation, natural world, and climate and risk. The system allows for rating and recognition of projects much like LEED provides through certification of building projects.

The demand for an sustainability rating system that can be uniformly applied across all horizontal infrastructure continues to gain momentum as evidenced by increases in the numbers of ISI accredited Envision™ Sustainability Professionals (ENV SP), the number of ISI members from professional organizations becoming members of ISI including the American Society for Landscape Architects (ASLA) and the American Water Works Association (AWWA), and the adoption of the framework by the engineering community, and municipal sector. ISI public agency members represent a combined service population of over 45 million.

The CAW project will contribute to the improved sustainability of service area by providing clean drinking water essential for ensuring quality of life; application of Envision will allow the project team to apply sustainability principles and approaches in every element of the D/B rather than merely identifying potential sustainability features.

Envision™ infrastructure sustainability rating system provides a framework that will allow the CAW D/B team to systematically and consistently apply sustainability principles and embed sustainability practices into the project.

Applying sustainability principles and practices during project design should provide overall benefits and not result in significant costs. Sustainable infrastructure solutions may have higher first costs but ultimate long term benefits.

Approach

Although the Envision™ infrastructure rating system has only recently been available for use, increasing numbers of public sector project proponents are using the system to assess their projects. The project team will apply the Envision infrastructure sustainability rating system checklist to identify appropriate sustainability approaches that could be used to improve the sustainability performance of the project during D/B and operation. CDM Smith will conduct a 4-hr workshop with key D/B team members to identify opportunities for sustainability improvement. The workshop will be designed and delivered by Tom Pedersen, CDM Smith Director of Sustainability, who is a trained facilitator and accredited Envision™ Sustainability Professional (ENV SP).

Tasks

1. Design Workshop – CDM Smith will meet with CAW staff and D/B project team to discuss overall project objectives and define learning objectives for the workshop. In collaboration with CDM Smith design engineers, a workshop will be developed defining learning objectives and delivery methods, and proposed workshop participants. The draft workshop plan will be submitted to CAW for review and upon approval CDM Smith will work with CAW to schedule the 4-hour workshop and distribute background information to participants including pre-reading and the Envision™ spreadsheet.

2. Conduct Workshop – CDM Smith will conduct the workshop and gather feedback through the series of interactive workshop brainstorming, table-top and small group exercises. The results of the workshop will be compiled and summarized immediately following the workshop.

3. Develop Recommendations – Based on the results of the workshop feedback and in consultation with the CAW and D/B team, recommendations regarding sustainability approaches that could be implemented will be identified. A roadmap that would define key milestones for embedding the sustainability design principles and practices into the project. The Workshop summary report will also outline plans for Envision™ have application to the project D/B and operation.

2.f. Spill Protection/Secondary Containment for Liquids

Table 2-6 identifies controls that have been implemented to protect against groundwater contamination from all process fluids, including seawater, RO concentrate, RO chemical waste, and treatment chemicals. Secondary containment of seawater and RO concentrate below grade piping is not required.

Table 2-6. Controls Implemented to Protect Against Groundwater Contamination

Item for Containment	Method of Prevention
Process Fluids	
Seawater	The area under the pressure filters, filtered water tanks and pumps and cartridge filters are paved with impervious concrete to prevent infiltration. Any leaks or discharges associated with maintenance will be directed to the area drains that are pumped to the Brine EQ Basin. The filtered seawater for the feed water to the seawater RO units is contained in trenches which drain to a saline wet well which is pumped to the Brine EQ Basin.
RO concentrate	Seawater RO Brine discharge pipe is contained in the SWRO Building pipe trench and any leaks drain to the saline wet well and pumped to the Brine EQ

Item for Containment	Method of Prevention
	Basin.
RO chemical waste	Chemical spills in the individual rooms is removed by vacuum truck or the neutralized waste is pumped to a holding tank. The RO cleaning chemical waste is neutralized in the neutralization tanks and pumped directly to a haul truck for disposal at the MRWPF.
Treatment chemicals	Spills contained in the storage rooms or the double contained pipes and pull boxes from the storage and metering rooms to the application point.
Tankage	
For saline fluids	The Filtered Water Tank overflow is piped directly to the Brine Equalization Basin to prevent the discharge of saline water to the site. In addition the tanks are surrounded by asphalt paving to capture incidental spills and leak, and convey them to the area sumps which are then pump to the Brine EQ Basin.
Overflow discharge	Filtered seawater tanks, pressure filter leaks on the slab and the cartridge filters drainage are directed to area sump and pumped to the Brine EQ Basin. The pressure filter and filtered water tank drains can be discharged to the Backwash Reclamation basin and returned to the inlet to the pretreatment granular media filters rather than direct discharge to the ground
Overflow caused by uncalibrated level monitors.	High level switches and alarms, independent of continuous level monitors, are provided
Chemical storage	Chemical storage tanks will be located within concrete curbing/walls to provide secondary containment of chemical tanks. Any leaks from the tank fill connection, tanks, tank to pump piping, and pump discharge piping will be contained in the secondary containment area. The secondary containment area will be sloped toward a 2 ft x 2 ft x 2 ft sump that is equipped with level sensor and sump pump. The level sensor inside of the sump will alarm when there is a spill.
Other	
Buried chemical piping	All chemical piping outside of secondary containment areas will be provided with secondary containment, either as double wall pipe or replaceable tubing within a carrier pipe. For most chemicals, as discussed in Section 21, the piping outside of secondary containment areas will be flexible PVC tubing double contained inside HDPE piping for support and secondary containment. The HDPE piping will be intentionally sloped to leak detection manholes, and leak detection sensors will be provided at the low points of each chemical line to alarm when there is a leak in the chemical piping.
Liquid chemical spill containment for delivery trucks	Most chemical spills from tank fill operation occur at the truck to tank fill connection. Therefore, the truck to tank fill connections will be located inside of the respective chemical storage room secondary containment areas to capture the spills from the tank fill operation. The chemical storage room secondary containment areas have sufficient capacity to hold the spills from chemical delivery trucks. The chemical storage room secondary containment areas are sized to contain 110 percent of the largest chemical storage tank, which are sized to store 150 percent of the full truck delivery. To fill the chemical tanks, the operator will open the door to the chemical storage room and make the connection inside of the containment area.

2.g. Site Arrangement – Integrated vs. Campus Layout

Table 2-7 summarizes the decisions made regarding the arrangement of the administration facilities, RO housing, and (liquid) chemical facilities to facilitate rapid access by walking between each of the functions. Drawing C-1 illustrates the relative location of all the facilities referenced in the following table.

Table 2-7. Site Arrangement Decisions

Function	Description of Location	Considerations
Administration	Site Location – south central Distance from RO Equipment Building –50 ft Distance from Chemicals – 150 ft	• Noise control –50 ft separation from RO process room and two insulated walls • Corrosion control –galvanized and aluminum construction • Structural –structural steel braced frame • Building code compliance – yes including Title 24 energy code
RO Housing	Site Location –south central Distance from Administration –50 ft Distance from Chemicals – adjacent	• Noise control – insulated walls • Corrosion control –galvanized and aluminum construction • Safety –separation from chemical and electrical rooms • Structural –structural steel braced frame • Building code compliance –yes including Title 24 energy code
Liquid Chemical	Site Location –south central Distance from Administration –150 ft Distance from RO Equipment Building – adjacent	• Noise control – Full height CMU walls separate the chemical rooms from the RO process room to provide fire separation and noise isolation • Corrosion control –coated concrete , CMU and galvanized aluminum • Safety –Separation of chemicals, sprinkler system, separate high and low rate ventilation systems; low concentration sodium hypochlorite • Structural – structural steel braced frame • Building code compliance – yes

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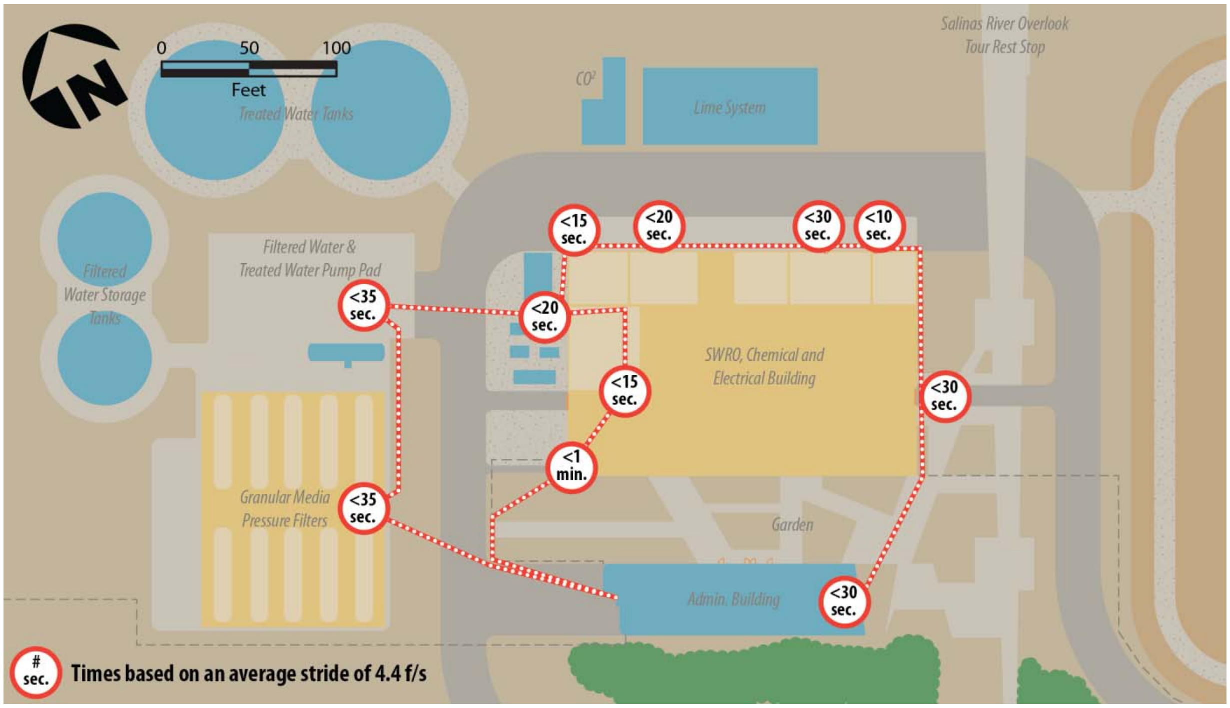

Figure 2.7-1

Figure 2.7-1 illustrates the anticipated route the operators would use to check equipment and monitor chemical unloading.

2.h. Safety

Table 2-8 summarizes the safety measures taken to meet or surpass OSHA standards and requirements.

Table 2-8. Facility Safety Measures

Facility	Safety Measure	Meets or Exceeds OSHA
Raw water hypochlorite chemical feed	Above grade access, double contained piping and safety showers	Yes
Pressure filter pipe gallery	No overhead piping and valves, no exposed water surface on filters that could be slippery and require access	Yes
Filtered water sodium bisulfite, antiscalant and acid addition	Above grade access, double contained piping and safety showers	Yes
RO Process Room	Pipe installed in trench to improve access around medium voltage motors and high pressure pump equipment	Yes
Chemical Storage Rooms	Walkways above the containment areas, high and low rate ventilation rate for every chemical room	Yes
Post Treatment Stabilization	Above grade access, double contained piping and safety showers	Yes
Electrical Room	Separation of medium voltage equipment	Yes

2.i. Redundancy

Table 2-9 summarizes the redundancy for all major process mechanical equipment.

Table 2-9. Redundancy Provisions

Process	Redundancy Provided	Per RFP	Notes/Assumptions
RO Train	Spare RO Rack	✓	
RO Concentrate Disposal	Reserve pump	✓	
UV System	Spare UV unit	✓	
Liquid Chemical Systems			
Sodium Hypochlorite	Spare unit for Raw Water dosing Spare unit for post-treatment dosing	✓	
Sodium Bisulfite	One reserve metering pump	✓	
Sulfuric Acid	One reserve metering pump	✓	
Threshold Inhibitor	One reserve metering pump	✓	
Sodium Hydroxide	One reserve metering pump	✓	
Zinc Orthophosphate/Phosphoric Acid Corrosion Inhibitor	One reserve metering pump	✓	

2.j. Process Overflows

Table 2-10 details the processes for which overflows, continuous level monitors, and an independent high level switch are provided.

Table 2-10. Process for Overflows

Process	Continuous Level Monitor	Independent High Level Switch	Overflow	Overflow Piping Direction	Per RFP	Notes/Assumptions
Filtered Feedwater Receiving Tanks	Yes	Yes	Yes	Concentrate Equalization Basin	✓	Over flow piped directly to the Brine EQ Basin. For minor tank and pipe leaks the area around the tanks is paved with impervious concrete so seawater drains to collection sump
Finished Water Storage	Yes	Yes	Yes	Energy dissipation and infiltration	✓	
Sodium Bisulfite	Yes	Yes	Yes	To Containment Basin	✓	
Sulfuric Acid	Yes	Yes	Yes	To Containment Basin	✓	
Threshold Inhibitor	Yes	Yes	Yes	To Containment Basin	✓	

Sodium Hydroxide	Yes	Yes	Yes	To Containment Basin	✓	
Zinc Orthophosphate/ Phosphoric Acid Corrosion Inhibitor	Yes	Yes	Yes	TO Containment Basin	✓	

2.k. Coastal Marine Environment and Corrosion Control

To provide protection from the natural corrosivity of the coastal marine environment, seawater and RO permeate, construction materials have been carefully selected to provide long service life and aesthetic appearance. Table 2-11 summarizes facilities and materials of construction where corrosion has been taken into consideration.

Table 2-11. Corrosion Resistant Construction Materials Used

Process/Facility	Equipment or Item	Material Used	Per RFP	Notes/Assumptions
Filtered Water Receiving Tanks	Tank sidewall panels	Glass lining	✓	
Site	Fencing	PVC coated galvanized steel	✓	
Pre-treatment	Steel Pressure Vessels	Epoxy coated exterior Rubber lined interior	✓	
RO Feed	Cartridge Filters	AL6XN corrosion resistant alloy	✓	
Chemical Storage Area	Tanks	HDPE Tanks, FRP grating	✓	
Finished Water Storage Tanks	Steel Tank	Epoxy coated steel	✓	
Site	Vents	Zincalume		
Administration, RO/Chemical and Pressure Filter Building	Facade	Zincalume		
Administration, RO/Chemical and Pressure Filter Building	Roof	Zincalume		
Above ground low pressure piping	Piping	FRP	✓	

2.l. Saline Water and Corrosion Control

As saline water can be highly corrosive to metals, all metallic components in contact with saline water will be constructed with corrosion resistant materials that are compatible with seawater. For each item a Pitting Resistance Equivalency Number ("PREN") has been identified.

Table 2-12. Corrosion Resistant Materials Used for Metallic Components in Contact with Saline Water

Metallic Component	Material Used	PREN
RO System Trains – bolts, nuts, washers, anchors, and support systems	316 stainless steel	24.2
Seawater Pre-treatment pressure filters	¼ rubber lining as required by RFP	NA
Cartridge filters for filtered seawater	AL6XN	42
SWRO High pressure feed water piping and brine piping	Super duplex 2507	42
SWRO Permeate piping	FRP piping	NA
BWRO high pressure feed water pipe	316L	23
BWRO brine piping	Duplex stainless 2205	34

3.0 RAW WATER QUALITY

Facility design is based on the design maximum values of the raw water quality conditions identified in the below table, as provided in Attachment 2 of the Design-Build Agreement Appendix 2.

Table 3-1. Raw Water Quality Conditions for Basis of Design

Parameter	Units	Design Value [1, 2] (mg/L seawater)		Per RFP	Notes/Assumptions
		Average	Design Maximum		
Applicable for the Pretreatment System					
Color	color units	-	9	✓	
Turbidity	NTU	-	10	✓	
Total Organic Carbon	mg/L	-	4	✓	
Iron, total	mg/L	-	2	✓	
Manganese, total	mg/L	-	0.2	✓	
Applicable for the Reverse Osmosis System					
Salinity	PSS	33.57	37.00	✓	
Temperature	ºC	12	8 to 20	✓	
Chloride	mg/L	19,030	21,000	✓	
Sodium	mg/L	10,604	11,700	✓	
Sulfate	mg/L	2,667	2,900	✓	
Magnesium	mg/L	1,262	1,400	✓	
Calcium	mg/L	405	500	✓	
Potassium	mg/L	392	570	✓	
Bicarbonate	mg/L	105	150	✓	
Carbonate	mg/L	16	-	✓	
Bromide	mg/L	71	110	✓	
Silica	mg/L	1.3	30	✓	
Barium	mg/L	0.013	0.16	✓	

Parameter	Units	Design Value [1, 2] (mg/L seawater) Average	Design Maximum	Per RFP	Notes/Assumptions
Strontium	mg/L	7.81	15	✓	
Fluoride	mg/L	1.28	2	✓	
Boron	mg/L	4.8	5.4	✓	
pH	mg/L	8	8.3	✓	

[1] Design of the RO system, including high-pressure feed pumps, 2nd pass feed pumps, and SWRO and BWRO membranes, shall be based on the maximum design values.

[2] Acceptance Testing of the RO system shall be based on computer model projected future performance after 5 years, for both average concentrations and maximum concentrations, taking into account increased salt passage over time as the membranes age.

4.0 FINISHED WATER QUALITY

Finished water quality performance standards were established for this Project and are presented in the table below in conformance with the performance standards provided in Attachment 3 of the Design-Build Agreement Appendix 2.

Table 4-1. Finished Water Basis of Design Standards and Requirements

Parameter	Units	Pretreatment Effluent		Combined RO Permeate		Finished Water After Stabilization		Per RFP
		Maximum Average Concentration [1, 2]	Not to Exceed Concentration [3]	Maximum Average Concentration [1, 2]	Not to Exceed Concentration [3]	Maximum Average Concentration [1, 2]	Not to Exceed Concentration [3]	
General and Inorganic								
Total Dissolved Solids (TDS)	mg/L						300	✓
Turbidity	NTU	0.15 [4]	1.0	0.1 [4]	0.5	0.5 [4]	1.0	✓
Silt Density Index (SDI)	min^{-1}	2 [4]	4 [5]					✓
Boron	mg/L			0.5	0.7	0.5	0.7	✓
Chloride	mg/L			60	100	60	100	✓
Bromide	mg/L			0.3	0.5	0.3	0.5	✓
Sodium	mg/L			35	60	35	60	✓
Iron, total	mg/L	0.02	0.04					✓
Manganese, total	mg/L	0.01	0.02					✓
Product Water Stabilization [6]								
Hardness, total [7]	mg/L as $CaCO_3$					40 to 100	–	✓
pH [7]	pH units					7.7 to 8.7	–	✓
Alkalinity, total [7]	mg/L as $CaCO_3$					40 to 100	–	✓
Langelier Saturation	–					0 to 0.2	–	✓

Parameter	Units	Pretreatment Effluent		Combined RO Permeate		Finished Water After Stabilization		Per RFP
		Maximum Average Concentra-tion [1, 2]	Not to Exceed Concentra-tion[3]	Maximum Average Concentra-tion [1, 2]	Not to Exceed Concentra-tion[3]	Maximum Average Concentra-tion [1, 2]	Not to Exceed Concentra-tion[3]	
Index (LSI) [7]								
Calcium Carbonate Precipitation Potential (CCPP) [7]	mg/L					0 to 5	–	✓
Orthophosphate [7]	mg/L as PO_4					Set by Owner within the range of 1.0 to 3.5 mg/L	3.5	✓
Disinfection and Disinfection Byproducts (DBPs)								
Total Chlorine Residual	mg/L as Cl_2					Set by Owner for a target of 2 mg/L, within the range of 1.5 to 2.5 mg/L	3.5 mg/L	✓
Trihalomethanes, total (TTHM) [8]	µg/L					40	64	✓
Haloacetic Acids, total of 5 (HAA5) [8]	µg/L					30	48	✓
Total Nitrosamines [8, 9]	ng/L					5	8	✓
Bromate	µg/L					5	8	✓

[1] The average of the measured concentrations shall be below the Maximum Average Concentration at all times. This footnote does not apply to (a) turbidity or SDI, or (b) finished water total hardness, pH, alkalinity, LSI or CCPP; separate footnotes apply to these parameters.

[2] Maximum Average Concentration cannot be exceeded during the applicable period, which shall be (i) daily for continuous samples and samples collected every 15 minutes; and (ii) for the duration of the Acceptance Test, for samples collected daily or weekly.

[3] No measurement shall exceed this value, at any time.

[4] Measured values must be less than the "maximum average" concentration 95% of the time.

[5] The maximum SDI limit applies unless more stringent requirements apply based on the SWRO membrane supplier warranty.

[6] The Owner will set the conditions for product water stabilization to minimize corrosion in the existing distribution system. Conditions will likely not be set for all of these parameters concurrently.

[7] Finished Water shall be within the "target range" at all times, where the target range is the target concentration set by the Owner, plus or minus the allowed variance shown in Appendix 7..

[8] TTHM, HAA5, and total nitrosamine concentrations shall be determined using the Simulated Distribution (SDS) test method in Standard Methods (Method 5710C). Samples of the finished water where it enters the distribution system shall be collected, with no adjustment of chlorine residual or pH, and held at the temperature of the finished water at the time of collection (±2ºC) for a 48-hour holding time.

[9] Total Nitrosamines includes the 6 nitrosamine compounds on the EPA's UCMR2-List 2; NDEA, NDMA, NDBA, NDPA, NMEA and NPYR.

5.0 RAW WATER PUMPING

Raw water pumping design will be provided through a separate project. For purposes of this project, the following has been assumed:

- Beach wells will be provided through a separate procurement process.
- CAW has been in contact with the property owner and is working to secure permanent easements on an approximately 376-acre parcel of land located due west of its proposed Project Site.
- The final arrangement of well type, number, and location will be determined at a later date.
- Electric power for the beach wells will not be provided from the Project Site. A separate electric service for the beach wells shall be assumed.
- Source water hydraulic grade line of 175 feet MSL shall be assumed available at the fence.
- Communication with the beach well pump station shall be via fiber optic cable or high speed Ethernet radio (spread spectrum). Fiber optic cable shall be buried adjacent to the feed water pipeline. Off-site fiber optic cable, and piping, shall be provided by others. Antenna towers are unlikely to be acceptable at either the wells or the Project Site.
- The Design-Builder is responsible for Raw Water piping within the Project Site boundary.
- PLCs for control of the well pumps will be part of the raw water pumping scope (by others). Control programming for the wells will reside in the well PLCs. However, control of the wells is an important facet of plant operation and the detailed control strategy for the wells is to be developed by the Design-Builder and coordinated with the designer and constructor(s) of the raw water pumping facilities, and CAW. Communication with the wells is to include start/stop commands, pump status, motor starter status, pumping levels, flow rates, and energy consumption. Security/intrusion data is to also be communicated from the wells to the treatment plant.
- It is expected that the pumps delivering raw water to the Project Site will be variable speed.

6.0 PRE-TREATMENT SYSTEM WITH GRANULAR MEDIA FILTRATION

The recommended pre-treatment process at the proposed Plant will consist of ten pressure filters with dual granular media using hypochorite to oxidize dissolved iron. Eight duty and two redundant pressure filters with 540 sq ft of filter surface areas will be provided in each filter. Related drawings are provided in Section 3.D; and design criteria is presented in Table 6-1.

KEY REFERENCE DRAWINGS:

M-1	PLAN AND SECTION - SEA WATER PRESSURE FILTER
M-2	PLAN - FILTERED WATER, BACKWASH WATER, CARTIDGE FILTER AND FINISHED WATER PUMP PAD AND TREATED WATER PUMP – 9.6 MGD
M-3	SECTIONS - FILTERED WATER, BACKWASH WATER, CARTIDGE FILTER AND FINISHED WATER PUMP PAD AND TREATED WATER PUMP – 9.6 MGD
I-5	P&ID IRON & MANGANESE FILTERS 1, 3, 5, 7 & 9
I-6	P&ID IRON & MANGANESE FILTERS 2, 4, 6, 8 & 10
I-40	P&ID BACKWASH SUPPLY PUMPS

Table 6-1. Pre-treatment System Basis of Design Standards and Requirements

Description	Units	Design Criteria	Per RFP	Notes/Assumptions
Filter Media: Dual Media: Sand and Anthracite				
Type: Complies with AWWA B100	-	Yes	✓	
Sand Depth	inches	12	✓	
Sand Effective Size	mm	0.5	✓	
Sand Uniformity Coefficient		1.4	✓	
Anthracite Depth	inches	18	✓	
Anthracite Effective Size	mm	0.65 to 0.85	✓	
Anthracite Uniformity Coefficient		1.4	✓	
Conditioned with permanganate prior to service	-	Yes	✓	
Media Support	-	Graded gravel	✓	
Underdrain	-	PVC header encased in concrete with replaceable non-metallic distribution nozzles	✓	
Pressure Filter Vessels				
Type: Single Cell; Constructed in accordance with ASME unfired pressure vessel and code stamped	-	Yes	✓	
Filter vessel type	-	Steel	✓	
Lining type	-	¼ neoprene rubber lining	✓	
Interior pressure vessel lining: Enduraflex black, soft neoprene	inches	¼	✓	
Personnel Access	-	Two (2) flanged hatches (24" diameter) with self-supporting davit	✓	
Media Inspection Port	-	Two (2) six inch flanged nozzles located top dead center to allow media levels to be measured	✓	
Drain	inches	3	✓	
Air Wash or Surface Wash				
Nozzle size	inches	12		
Blind flange on each filter (1 per filter)	-	150	✓	
Filter to Waste				
Flow	mgd	3	✓	Adjustable up to design rating of the filter
Effluent turbidity is to be monitored during filter to waste			✓	Backwash reclamation sized to allow minimum of 15 minutes of filter to waste

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Description	Units	Design Criteria	Per RFP	Notes/Assumptions
Washwater Collector (influent distributor)				
Material: nonmetallic	-	PVC		
Location above surface of filter media	inches	18	✓	
Underdrain Maldistribution				
Maldistribution of flow during backwash	percent	<10	✓	
Air Release				
Air release valve for each filter		2	✓	Minimum 3 inch air release valve
Wastewater				
Observation and sampling means during backwashing			✓	Sample line on drain
Filter Instrumentation				
Flowmeter	no.	10	✓	
Differential Pressure	no.	10	✓	
Turbidimeter	no.	10	✓	
Valves				
Type		Butterfly	✓	
Open-close actuated valves type		Pneumatic	✓	
Open-close actuated valves actuator type		quarter turn vane	✓	
Rate of flow control modulating valves type		Butterfly	✓	
Rate of flow control modulating valves actuator		electric (208 volt, 3 phase)	✓	
Valve position indicators		clearly indicate valve position	✓	
Local panel for each filter valve type		Pneumatic	✓	
Housing				
Filter End/Head Housing Type		Enclosed	✓	
Backwash and Backwash Supply				
Backwash supply		filtered water storage tanks	✓	
Backwash pumps		2 (one duty, one reserve)	✓	
Capacity	mgd	15.6 mgd (each)		
Type		Horizontal End Suction		
Materials		Super duplex		
Backwash sequence		low, high, low rate	✓	5 gpm/sq ft/ 18 gpm/sq ft/ 5 gpm/sq ft
Only one filter shall wash at a time.			✓	
Maximum backwash rate	percent	30	✓	

Description	Units	Design Criteria	Per RFP	Notes/Assumptions
bed expansion of sand and anthracite media at coldest water temperature				
Means of backwash flow control		electrically actuated modulating butterfly valve;	✓	
Backwash sequence automation as initiated by Operator		1) time, 2) loss of head, and 3) effluent turbidity	✓	
Backwash sequence filter to waste cycle termination		1) time, 2) volume, and 3) filtered turbidity	✓	
Filter Backwash Waste Settling and Recycle				
Minimum Number of Wastewater Basins		2	✓	Backwash water waste is discharged by gravity flow to the wastewater reclamation basins
Minimum Wastewater Basin Volume		Two filter backwashes plus residuals storage (one year)	✓	
Minimum Unit Filter Waste Volume (backwash and filter to waste)	gal/sf/ wash	200	✓	
Basin operation mode		Batch Fill – Settle – Draw/Recycle	✓	
Construction Material		HDPE Lined Earthen Basin	✓	
Top of embankment / service road size	feet	12	✓	
Top of embankment / service road capacity		Supports the weight of service vehicles	✓	
Minimum freeboard	feet	3	✓	
Protect lagoon from surface runoff			✓	
Provide continuous level measurement with ultrasonic level monitor; provide high level switch to alarm			✓	
Liner type		HDPE Double lined with leak collection material and textured on the exposed side, protected from wind uplift, oxidation and sharp objects	✓	
Collection sump pump and flow metering		Level switch with sump connected to alarm in SCADA	✓	
Provide a means of emergency egress		Sloped ramps provided in the middle of the basin	✓	
Provide seepage collars;			✓	

Description	Units	Design Criteria	Per RFP	Notes/Assumptions
provide erosion protection at inlet				
Security/Fencing		Lagoon will be fenced in with gates for vehicles and personnel	✓	
		Recycle Pumping		
Type		Central supernatant sump with submersible recycle pumps	✓	
Material		Super duplex		
Duty pumps		2	✓	
Reserve pumps		1	✓	
Flow control		VFD	✓	
Recycle flow metering			✓	
Recycle quality monitoring		Continuous turbidimeter	✓	
Regulatory Requirements			✓	Complies with CDPH Cryptosporidium Action Plan
Recycle flow vs. influent flow at all times	percent	<10	✓	
Recycle flow turbidity	NTU	<2	✓	
Minimum number of settling basins	-	2	✓	
Ability to continuously dose polymer as settling aid			✓	

7.0 FILTERED FEEDWATER RECEIVING TANKS

Filters will discharge to filtered feed water receiving tanks. Filtered feed water receiving tanks will then feed the cartridge filters associated with the RO trains, and provide backwash water for granular media filters.

See section 3.D for drawings and Table 7-1 for design criteria.

KEY REFERENCE DRAWINGS:
M-14 FILTERED WATER STORAGE TANKS PLAN
M-15 FILTERED WATER STORAGE TANKS SECTION
I-7 P&ID FILTERED WATER STORAGE TANKS

Table 7-1. Filtered Feedwater Receiving Tanks Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Flow Split	-	Piping to each feed water receiving tank shall be identical to obtain a reasonably equal flow to each tank.	✓	
Number of tanks	-	2	✓	
Tank capacity	gallons	300,000 (each)	✓	
Capable of operating at rated capacity with a single feed tank.	-	Yes	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Cover type	-	aluminum self-supporting dome	✓	
Internal roof supports	-	None	✓	
Piped Overflow	-	Internal weir box with overflow to Concentrate Equalization Basin	✓	
Materials of Construction Standards				
AWWA D103 Factory Coated Bolted Steel Tank	-	Yes	✓	
AWWA D108 Aluminum Dome Roofs for Water Storage Facilities	-	Yes	✓	
Tank sidewall panels shall be glass lined for maximum corrosion resistance	-	Yes	✓	
Personnel Access: sidewall	-	2	✓	
Personnel Access: roof	-	2	✓	
Tank Outlet Anti-Vortex Baffle	-	Yes	✓	
Sanitary Lip	-	Removable baffle at tank outlet	✓	
Tank Drain	-	Drain to Concentrate Equalization Basin	✓	
Level Controls				
Continuous level monitor (pressure transmitter)	-	2 (one at each tank)	✓	
High level switch	-	2 (one at each tank)	✓	
Security Details				
Security devices to prevent climbing of the tank	-	Yes	✓	
Anti-tamper vents	-	Yes		
Check valve on overflow	-	Yes	✓	

8.0 FILTERED WATER PUMP STATION

A filtered water pumping stage will provide sufficient pressure to operate the cartridge filters and supply pressure to the seawater RO feedwater pumpss.

Refer to Section 3.D for drawings; and Table 8-1 for design criteria.

KEY REFERENCE DRAWINGS:

- M-2 PLAN FILTERED WATER, BACKWASH WATER, CARTIDGE FILTER AND FINISHED WATER PUMP PAD 9.6 mgd
- M-3 SECTIONS FILTERED WATER, BACKWASH WATER, CARTIDGE FILTER AND FINISHED WATER PUMP PAD 9.6 mgd
- M-4 SECTIONS FILTERED WATER, BACKWASH WATER, CARTIDGE FILTER AND FINISHED WATER PUMP PAD 9.6 mgd
- I-8 P&ID FILTERED WATER PUMP STATION

Table 8-1. Filtered Water Pump Station Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Type of pump	-	Horizontal End Suction	✓	
Number and Capacity	mgd	2 pumps at 11.8 mgd each (50% rated capacity) 2 pump at 5.9 each (25% rated capacity) VFDs for two smaller pumps	✓	
Materials of Construction	-	Super duplex	✓	
Pump Location	-	Outdoors	✓	
Electrical Starter Location	-	Inside building	✓	
Flow Metering	-	N/A	✓	
Power Metering	-	Power monitoring usinf Schweitzer Engineering Laboratories ("SEL") unit is provided?	✓	Information provided to SCADA via Ethernet Modbus TCP/IP network

9.0 REVERSE OSMOSIS SYSTEM

The reverse osmosis (RO) system removes dissolved solids from the seawater to achieve drinking water quality standards and the water quality goals (e.g., boron, bromide, chloride, and sodium) shown in Table 3-1 of this BODR.

KEY REFERENCE DRAWINGS:

M-2 PLAN FILTERED WATER, BACKWASH WATER, CARTIDGE FILTER AND FINISHED WATER PUMP PAD 9.6 MGD
M-3 SECTIONS FILTERED WATER, BACKWASH WATER, CARTIDGE FILTER AND FINISHED WATER PUMP PAD 9.6 MGD
M-4 SECTIONS FILTERED WATER, BACKWASH WATER, CARTIDGE FILTER AND FINISHED WATER PUMP PAD 9.6 MGD
M-5 RO LAYOUT 9.6 MGD BASE CASE
M-6 SWRO LAYOUT – SECTIONS 1 9.6 MGD BASE CASE
M-7 SECOND PASS SWRO EQUIPMENT ELEVATION 9.6 MGD BASE CASE
M-10 SATURATED LIME SYSTEM AND PERMEATE FLUSH TANK SYSTEM
I-8 P&ID FILTERED WATER PUMP STATION
I-9 P&ID CARTIDGE FILTERS
I-10 P&ID RO FEED PUMPS
I-11 THROUGH I-17 P&ID FIRST PASS SWRO TRAIN 1 THROUGH FIRST PASS SWRO TRAIN 7
I-18 THROUGH I-21 P&ID SECOND PASS BWRO TRAIN 1 THROUGH SECOND PASS BWRO TRAIN 4
I-22 P&ID RO PERMEATE FLUSH AND CIP

The RO System consists of:

1. First pass SWRO
2. Second pass BWRO (at least a 40% partial or complete second pass)
3. Energy recovery device (“ERD”) and associated booster pumps
4. Cartridge filters
5. High pressure RO feed pumps with variable frequency drives
6. Second pass RO feed pumps with variable frequency drives
7. Pressure vessels and RO train support structure
8. Clean-In-Place (“CIP”) system
9. Flush system

Drawings for these systems are provided in Section 3.D. The following paragraphs provide brief descriptions and design criteria tables.

9.1 RO Feedwater Quality

The RO System has been designed to meet the both the specified average and maximum raw water concentrations listed in Table 9-1below.

Table 9-1. RO System Feedwater Quality Design Criteria

Parameter	Units	Design Criteria Average	Maximum	Per RFP	Notes/Assumptions
Salinity	PSS	33.57	37.00	✓	
Temperature	ºC	12	8 to 20	✓	
Chloride	mg/L	19,030	21,000	✓	
Sodium	mg/L	10,604	11,700	✓	
Sulfate	mg/L	2,667	2,900	✓	
Magnesium	mg/L	1,262	1,400	✓	
Calcium	mg/L	405	500	✓	
Potassium	mg/L	392	570	✓	

Parameter	Units	Design Criteria: Average	Design Criteria: Maximum	Per RFP	Notes/Assumptions
Bicarbonate	mg/L	105	150	✓	
Carbonate	mg/L	16	-	✓	
Bromide	mg/L	71	110	✓	
Silica	mg/L	1.3	30	✓	
Barium	mg/L	0.013	0.16	✓	
Strontium	mg/L	7.81	15	✓	
Fluoride	mg/L	1.28	2	✓	
Boron	mg/L	4.8	5.4	✓	
pH	mg/L	8	8.3	✓	

It should be noted that small adjustments have been made to the water analyses to achieved balanced feed water analyses for the membrane projections for establishing the design basis for this project.

9.2 Finished Water Quality

The RO system has been design to achieve the Combined RO Permeate Concentration limits specified in Table 9-2. The RO system will achieve the Maximum Average Combined RO Permeate Concentrations listed in Table 9-2 based on the Average Raw Water Quality specified in Table 9-1 at the average age specified for the SWRO and BWRO membranes in our membrane projection model at 5 years at a temperature of 12 C. In addition, the Not-to-Exceed Combined RO Permeate Concentrations specified in Table 9-2 will be achieved at the average age specified for the SWRO and BWRO membranes in our membrane projection model at 5 years over the temperature range of 8 to 20 C.

Table 9-2. RO System General Basis of Design Standards and Requirements

Parameter	Units	Design Criteria: Maximum Average	Design Criteria: Not to Exceed	Per RFP	Notes/Assumptions
TDS Reduction					
TDS	mg/L	300	300	✓	
First Pass RO System and First Pass Train Performance					
Virus	Log removal credit	2	2	✓	
Giardia	Log removal credit	2	2	✓	
Cryptosporidium	Log removal credit	2	2	✓	
Combined RO Permeate Concentration					
Turbidity	NTU	0.1 [1]	0.5	✓	
Boron	mg/L	0.5	0.7	✓	
Chloride	mg/L	60	100	✓	
Bromide	mg/L	0.3	0.5	✓	
Sodium	mg/L	35	60	✓	
Construction Material					
NSF Standard 61	-	All materials in contact with water approved for		✓	

Parameter	Units	Design Criteria Maximum Average	Design Criteria Not to Exceed	Per RFP	Notes/Assumptions
		contact with potable water			

[1] Measured values must be less than the "maximum average" concentration 95% of the time.

9.3 Monitoring and Permitting Requirements

The Sand City Water Treatment Plant established a precedent for designating pathogen removal credits for RO membranes in California using conductivity as a surrogate measurement. During preliminary start-up, a correlation curve was developed between conductivity and TDS. CDPH then granted 2-log pathogen removal credits for Giardia, Cryptosporidium, and viruses, under the condition that continuous monitoring of conductivity be maintained, demonstrating a minimum 2-log reduction in TDS. The design criteria identified in the RFP follows this same approach, assuming 2-log pathogen credits for the RO membranes. The design will maintain this approach and will include continuous monitoring of conductivity for each RO train and the feed water, along with a logic loop within the SCADA software to determine the estimated log reduction of TDS for each RO train. The system will be alarmed in the event that the calculated log reduction drops below 2.

In the base alternative, where UV is included, excess log-reduction credits will be achieved through the UV units (see Section 12), allowing the desalination facility to continue producing potable water even in the event that the TDS reduction across the RO membranes drops below 2 log units. A minimum log reduction of 1.5 units will be established before a critical alarm occurs, resulting in shut-down of the associated RO unit. This design approach allows flexibility in operation, which will be beneficial to operators as the membranes age and TDS reduction lessens. Section 12 of this BODR discusses the pathogen reduction requirements for the desalination facility in greater detail.

In addition to conductivity, turbidity of the RO permeate will be continuously monitored and reported to CDPH in compliance with requirements of the surface water treatment rule and CDPH filtration policy.9.4 Power Consumption

The RO system shall be designed to meet the power consumption provided in the bid forms and the proposed membrane warranty. Electrical energy use was estimated for the desalination system and ancillary systems based on the descriptions, drawings and design criteria summarized in this report. The projection includes energy use for filtered water transfer pumping, plant treatment systems, product water distribution and concentrate disposal for average water quality conditions and 12 C at startup and maximum power consumption operating at the maximum raw water quality conditions and 8 C at the design membrane life. The projected average energy use is anticipated to range from approximately 12.6 to 14.6 kWh per 1,000 gallons of finished water as summarized in Table 9-3.

Table 9-3. Projected Electrical Energy Use

Process/System Description	Average Conditions at Startup[1]		Maximum Consumption[2]	
	(kWh/kgal)	(% of total)	(kWh/kgal)	(% of total)
Pretreatment, Backwashing and Filtered Water Transfer Pumping	0.98	8%	1.22	8%
Reverse Osmosis including RO Feed Pumps and Energy Recovery System	8.16	65%	9.74	67%
Post-Treatment	0.34	3%	0.34	2%

Product Distribution	1.38	11%	1.38	9%
Concentrate Disposal System	0.11	1%	0.11	1%
Building Fixed Loads	0.42	3%	0.42	3%
10% contingency & losses	1.21	10%	1.23	10%
Total Estimated Energy Use	12.6	100%	14.6	100%

[1] Average raw water concentrations at 12 C and Startup

[2] Extreme raw water concentrations at 8 C and Design Membrane Age

This energy consumption estimate includes transformer losses of 0.55 percent and a contingency of 10 percent. Final numbers for energy consumption are contained in Proposal Form 17 and the associated backup calculations.

The RO system power consumption calculations reflect the specific design criteria included in this report, including the following equipment in operation to produce 9.6 mgd of permeate capacity: six (6) first pass RO units sized for 1.6 mgd each using horizontal multistage centrifugal pumps; three (3) second pass RO units sized for 1.28 mgd each using multistage vertical turbine pumps; isobaric PX-300 energy devices; and a hybrid combination of higher rejection and low energy SWRO membrane elements in the first pass. Selecting different pumps, RO unit size, membranes, or energy recovery devices will change estimated energy use for the proposed plant.

9.4 RO Equipment Manufacturer

Table 9-4 summarizes the qualifications of the RO equipment manufacturer (ROEM) in accordance with the requirements set forth in Appendix 2 of the Design-Build Agreement.

Table 9-4. ROEM Qualifications

Criteria	How Met	Per RFP
ROEM Firm Name	H2O Innovation USA, Inc.	✓
Corporation, joint venture, or partnership	Corporation , a wholly owned subsidiary of H2O Innovation, Quebec, Canada	✓
Experience in the design, construction, and startup of RO systems	13 years as H2O Innovation plus 10 years as Membrane Systems. Please see reference list of projects executed as an ROEM	✓
Years in business (minimum three years)	Yes, Over 13 years as H2O Innovation	✓
Service location in US (i.e., name, address, and telephone number)	H2O Innovation, 1048 La Mirada Court, Vista, CA 92081. (760) 598-2206 H2O Innovation, 8900 109th Ave. N, Champlin, MN 55316, (763) 566-8961 H2O Innovation, 3227 Old Burnt Store Road, Cape Coral, FL 33993, (239) 283-8590	✓
Service need notification response time	1 days	✓
Designed, fabricated, and installed at least two seawater RO systems	Yes. For reference information on Sand City and Cost Azul, please refer to Proposal Form 1 Attachment 4.	✓
Designed, fabricated, and installed at least two RO systems that each have a permeate capacity of the same modular size or greater	Yes. For reference information on Terminal Island and City of Fort Pierce, please refer to Proposal Form 1 Attachment 4.	✓

9.5 Space Requirements

Approximately 20 feet is provided as a center aisle between groups of RO units and 6 feet of clearance has been provided between adjacent RO units to allow for routine maintenance and equipment replacement, including but not limited to: the changing out of membrane elements, RO pressure vessels, and pumps.

9.6 RO System Components

The following section identifies the details of design criteria and equipment selection for the individual RO system components.

9.6.1 Cartridge Filters

Cartridge filters remove particulate matter and serve as a protective barrier for the RO membranes. The pressure filters remove most particulates, but filter backwashing can cause particulate breakthrough that must be mitigated by the cartridge filters. Table 9-5 summarizes the design criteria for the cartridge filters.

Table 9-5. Cartridge Filters Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Effluent SDI		≤ 2 min-1 95% of the time, < 4 min-1 at all times	✓	
Maximum effluent turbidity	NTU	0.5	✓	
Pressure vessel reference standard		ASME Boiler and Pressure Vessel Code, Section VIII	✓	
Type of filter vessel		Horizontal configuration	✓	
Filter vessel material		AL-6XN stainless steel	✓	It is assumed that super duplex and other high moly stainless steel with PRE>4 would also be acceptable
Minimum vessel design pressure	psi	150	✓	
Number of filter vessels		7	✓	
Vessel o-rings/gaskets		Buna-N	✓	
Filter pore size	µm	5 (nominal, minimum 90% efficiency)	✓	
Filter type		string-wound depth cartridges	✓	
Filter materials		polypropylene (FDA grade and ANSI/NSF 61 certified)	✓	
Filter o-rings		Buna-N	✓	
Filter outside diameter (OD)	inches	2 3/8 or 2 1/2	✓	
Filter inside diameter (ID)	inches	1	✓	
Filter flow configuration		outside-in	✓	
Filter length	inches	40	✓	
Maximum design loading rate/10” cartridge	gpm	4	✓	
Maximum differential pressure of clean filter	psi	4	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
element at design loading rate				
Differential pressure to trigger replacement of filter element	psi	20	✓	
Filter element replacement interval	months	Not less than 2		Typical cartridge filter replacement interval is expected to be 3 months or longer
Clearance around each vessel	ft	As shown on Dwg M-2, cartridge filter vessels are spaced at 12 ft on center	✓	As shown on the drawing this provides ample room for access and maintenance
Other Parameters				
Filter vessel meet or exceed ASME Section VIII Code for high pressure vessels			✓	
Vessels are designed so one person, at ground level, can easily open and close it to access the entire vessel interior for filter replacement or other maintenance activities			✓	Horizontal filter vessels offered provide the best access for filter replacement
Pressure differential indicators and transmitters across the inlet and outlet of the vessels are provided and relayed to the RO system PLC.			✓	

9.6.2 RO System Trains

This section provides information related to the proposed SWRO system for the MPWSP consisting of both a 1st Pass SWRO membrane system and a 2nd Pass Permeate brackish water reverse osmosis (BWRO) membrane system.

The RO system will treat filtered water from the pressure filters and cartridge filters. The primary purpose of the RO process will be the reduction in total dissolved solids (TDS), particularly chloride and sodium to produce potable water as well as the removal of other parameters of interest such as boron and bromide. The RO system is designed in a "split partial" second pass arrangement in which the first pass permeate is split into a lower TDS permeate stream that is extracted from the feed end of the first pass vessels and a higher TDS portion that is extracted from the tail end of the first pass vessels. The higher TDS permeate is further treated in a partial second pass, while the lower TDS water from the first pass is allowed to bypass the second pass. The high purity permeate from the second pass is then blended with the lower TDS permeate from the first pass. This arrangement results in a more efficient and lower cost design as compared to a full second pass design, since the size of the second pass can be optimized to only treat higher TDS first pass permeate that requires further treatment. This arrangement minimizes the size of the second membrane system capacity while still meeting the required product water quality standards. For the base case design, the second pass has been designed to treat 40 percent of the total permeate capacity as required by the specifications. For the base case, a hybrid membrane array is proposed for the first pass that utilizes a sufficient number of higher rejection seawater membrane elements in the lead membrane positions to achieve the combined permeate water quality goals while using higher flow seawater membrane elements in the tail membrane positions to lower the power consumption of the RO system.

Membrane projections for the base case design demonstrating conformance with the three design conditions outlined in Addendum 4:

Condition 1: for compliance with the RO combined permeate maximum average concentrations:

1. Average Raw Water quality conditions shown in Appendix 2, Attachment 2
2. Average age of SWRO membranes in the model at 5 years
3. Average age of BWRO membranes in the model at 5 years
4. Temperature of 12°C

Condition 2: for compliance with the RO combined permeate not-to-exceed concentrations:

1. Maximum water quality conditions shown in Appendix 2, Attachment 2
2. Average age of SWRO membranes in the model at 5 years
3. Average age of BWRO membranes in the model at 5 years
4. Temperature of20°C

Condition 3: for compliance with the RO combined permeate not-to-exceed concentrations and maximum first pass feed pressure:

1. Maximum water quality conditions shown in Appendix 2, Attachment 2
2. Average age of SWRO membranes in the model at 5 years
3. Average age of BWRO membranes in the model at 5 years
4. Temperature of 8°C

RO system performance computer projection results are included in Attachment A. In addition, a membrane projection is provided for the Average Raw Water conditions, 12 C, at 0 years for both the SWRO and BWRO membranes to reflect baseline performance during the Acceptance Testing.

Table 9-6 summarizes the general design criteria for the RO system trains. The remainder of the section details the design criteria and requirements for the first pass and second pass components.

Table 9-6. RO System Trains Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Materials for bolts, nuts, washers, anchors, and support systems		Corrosion resistant 316 stainless steel	✓	
All parts in contact with raw seawater are designed to accommodate raw water chlorides (includes first pass SWRO, ERD, cartridge filters, and pumps)	mg/L	24,000 (minimum)	✓	High alloy SS with PRE>40 is offered for wetted parts for the high pressure piping in the SWRO and ERD system as well as the cartridge filters and pumps for these systems. HDP, FRP, and other corrosion resistant materials are provided for

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
				low pressure service
All parts in contact with the RO concentrate are designed to accommodate raw water chlorides (includes first pass SWRO, ERD, and pumps)	mg/L	24,000 (minimum)	✓	The high quality corrosion resistant materials used for seawater service above are also suitable for service for components handling RO concentrate
Frame capacity of first pass and second pass trains	percent	10 (additional)	✓	
Pressure vessel height		6 vessels high	✓	
Material for frame and miscellaneous brackets		Epoxy coated carbon steel	✓	
Other Parameters				
All trains within each pass are identical.			✓	
All equipment and the trains themselves are provided by the same manufacturer			✓	
Each train is capable of operating independently of the other trains.			✓	
Each train is modular such that a total of either 6.4 or 9.6 mgd rated capacity can be achieved.			✓	
Frame and miscellaneous brackets are designed and constructed to meet structural and seismic code.			✓	The team has extensive experience in providing RO frames conforming to California standards
Appropriate isolation of the RO system from the pretreatment is provided, such that chlorination of the pretreatment granular media filters may be performed without damage to the RO membranes			✓	
Appropriate provisions are provided to ensure that any sealed tanks within the RO system have ventilation systems that control microbiological activity (e.g. HEPA filters).			✓	

9.6.3 First Pass SWRO

For the base case, seven first pass membrane trains with a capacity of 1.6 mgd per train will be provided. Six first pass RO units will normally be in operation to produce 9.6 mgd of combined permeate capacity with the seventh RO unit acting as an installed standby unit providing "n+1" system redundancy. Table 9-7 summarizes the design criteria for the first pass SWRO system train.

Table 9-6. First Pass SWRO Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Maximum train size	mgd	2 (as permeate water)	✓	1.6 mgd/train
First pass recovery	percent	42 (minimum) / 45 (maximum)	✓	42% for lower power consumption
First pass maximum membrane flux rate	gfd	8.75	✓	Nominal 7.9 gfd for lower power consumption
First pass maximum feed pressure for membranes ages 0 to 5 years operating on the	psi	1,000	✓	1,000 guarantee 932 projected including safety factor

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
maximum feed water quality as defined in **Table 3-1** and for temperatures as low as 8°C				
Elements per pressure vessel		7 (not to exceed)	✓	7
Membrane surface area per element	ft2	400	✓	
Other Parameters				
The skid shall have the ability to receive the following chemicals for pretreatment prior to the first pass: Sulfuric acid to reduce the pH of the feed water Scale inhibitor to prevent precipitation of sparingly soluble salts such as calcium carbonate, calcium sulfate, barium sulfate, and strontium sulfate				

9.6.4 Second Pass BWRO

The second pass RO system is designed to treat 40 percent of the combined RO permeate as specified. To optimize the size of the second pass units in relationship to the first pass units and reduce the capital cost of the second pass while retaining "n+1" system redundancy, the second pass has been configured with a total of 4 membrane units. Three second pass units will normally be in operation to produce 9.6 mgd of combined RO permeate with the fourth unit providing "n+1" redundancy. Second pass units will be configured in a two stage array. Table 9-8 summarizes the design criteria for the second pass BWRO system train.

Table 9-8. Second Pass BWRO Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Maximum Capacity/train	mgd	1.28	✓	Maximum 2 mgd RO skids specified
Second pass maximum recovery	percent	90	✓	90
Second pass maximum membrane flux rate	gfd	18	✓	18
Elements per pressure vessel		7 (not to exceed)	✓	7
Maximum pH		10 or maximum specified in membrane warranty	✓	10
Membrane surface area per element	ft2	400	✓	400 or 440 ft2 allowed
Other Parameters				
The skids have the ability to receive the following chemicals for pretreatment prior to the first pass: Caustic soda to increase the pH of the feed water and enhance boron removal, in order to meet the maximum average concentration for boron as defined in Table 9-2. Scale inhibitor to prevent precipitation of sparingly soluble salts such as calcium carbonate, calcium sulfate, barium sulfate, and strontium sulfate.			✓	
Second pass concentrate recycle line to the RO first pass feed is provided.			✓	

9.6.5 RO Membrane Elements

Table 9-9 summarizes the design criteria for the RO membrane elements.

Table 9-9. RO Membrane Elements Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Type of first pass RO membrane elements		SWRO	✓	SWRO
SWRO salt rejection	percent	99.6	✓	99.7 to 99.8
SWRO boron rejection	percent	90.0	✓	91 to 92
Type of second pass RO membrane elements		BWRO	✓	BWRO
BWRO rejection	percent	99.0	✓	99.5 to 99.6
RO membrane element diameter (SWRO and BWRO)	inches	8	✓	8
First pass SWRO membrane element surface area	square feet	400 (maximum)	✓	400
Second pass BWRO membrane element surface area	square feet	440 (maximum)	✓	400
Differential pressure across membrane elements over the minimum membrane warranty period	percent	5 (not to exceed)	✓	This is not guaranteed. It is primarily a function of the actual raw water quality and pretreatment effectiveness. CAW can clean the membranes if differential pressure increases by 5 percent. Membrane manufacturers typically recommend cleaning if differential pressure increases by 10%
Spiral wound membrane elements membrane type		thin film composite polyamide membranes	✓	
SWRO warranty	years	RFP base bid is 3 year prorated warranty and a price for an optional 5 years extended warranty	✓	The CDM Smith proposal provides a 5 year prorated warranty as standard
BWRO warranty	years	RFP base bid is 3 year prorated warranty and a price for an optional 5 year extended warranty	✓	The CDM Smith proposal provides a 5 year prorated warranty as standard
Demonstrated track record of operation at a full-scale seawater RO facility for drinking water application and of the	years	2	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
comparable modular train size				
Membrane Factory Testing				
Each membrane element will be factory tested by the manufacturer and certified test data for each membrane element will be supplied to California American Water prior to shipment. Shipment will not be processed until the manufacturer receives CAWs written acceptance of the test data.			✓	
The elements shall be tested under the manufacturer's standard published test conditions.			✓	
The elements shall meet the performance stated in the manufacturer's standards.			✓	
Each membrane element must have a salt rejection greater than the minimum specified salt rejection defined in the membrane manufacturer's specification sheets for that membrane type.			✓	
Certified test data will be provided for each element and will consist of the element serial number, the feed flow, recovery, productivity, and rejection.			✓	
Other Parameters				
All membrane elements installed within a train are of a single manufacturer			✓	Hydranautics
The elements shall be suitable for high pressure seawater RO treatment in the first pass and brackish water RO in the second pass.			✓	

9.6.6 RO Pressure Vessels

Table 9-10 summarizes the design criteria for the RO pressure vessels.

Table 9-10. RO Pressure Vessels Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Maximum working pressure	psig	1,200 (not less than)	✓	
Code Stamp		Rated pressure in accordance to the ASME Boiler and Pressure Vessel Code – Fiberglass-Reinforced Pressure Vessels	✓	
Pressure vessel coating		Ultraviolet light resistant	✓	
Feed and concentrate port location		Vessel sidewall	✓	
First pass pressure vessel port material		Super duplex stainless steel	✓	
Second pass pressure vessel material		High grade stainless steel	✓	
Factory Testing				
Pressure vessels will be tested at facility for compliance with these requirements. A certified copy of the production test data for the pressure vessels shall be submitted to CAW prior to shipment.			✓	The vessels are tested at the vessel manufacturer's facility. Only a percentage of the vessels are tested.

9.6.7 RO First Pass High Pressure Pumps

The first pass high pressure RO pumps will be horizontal multistage centrifugal pumps. For the base case one dedicated first pass pump will be provided for each first pass RO unit. The first pass high pressure RO pumps are provided with variable frequency drives as specified. Table 9-11 summarizes the design criteria for the RO First Pass High Pressure Pumps.

Table 9-11. RO First Pass High Pressure Pumps Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
First pass RO feed pump type		High-pressure and centrifugal pumps	✓	Horizontal, multistage high pressure centrifugal pumps
Minimum efficiency	percent	80	✓	See Power Consumption data for actual efficiency
Construction materials		Super duplex stainless steel	✓	
Temperature	ºC	8 to 20	✓	
Other Parameters				
One high pressure feed pump, with variable frequency drive, is provided for each first pass membrane train.			✓	
Design of the high pressure pump takes into account the specific RO train configuration and energy recovery device to ensure proper operation and appropriate energy recovery and efficiency over the entire specified range of water quality parameters.			✓	
Equipment Factory Testing				
Factory testing will be performed for each high pressure RO feed pump. Testing will comply with the latest version of the Hydraulic Institute/American National Standard for Rotodynamic Pumps for Hydraulic Performance Tests (14.6), referred to as HI Standard 14.6.			✓	
Measurement accuracy will be Grade 1 as defined by the HI Standard 14.6. Pump performance test acceptance grade will be 1E.			✓	
Pump tests will be performed to verify the initial performance of new pumps. Performance testing will include measurement of flow, head, and power input to the pump or test motor. NPSH testing will be performed. Factory testing will be performed at a dedicated test facility.			✓	
Tests will be conducted on actual equipment to be furnished to the job site, including pump discharge heads and barrels, as applicable.			✓	
Certified test reports will be furnished which include test data sheets, performance test logs, and equipment performance curves, as applicable. Indicate separately equipment guaranteed operating points identified in the specifications, including efficiency. Testing will provide data for a minimum of five (5) flows			✓	
Factory testing of each high pressure pump motor will be performed as listed below. Certified test results will be submitted. (a) Dielectric test on armature (b) Insulation resistance (c) No load current at rated voltage (d) Efficiency and power factor calculated at 100 percent of full load at full load speed (e) Locked rotor current (f) Over speed test (g) Winding resistance (h) Balance (i) Bearing inspection			✓	

9.6.8 RO Second Pass Pumps

Multistage vertical turbine pumps are proposed for the second pass high pressure pumps due to the significantly higher efficiency of these pumps and due to the wide range of operating conditions for the second pass. Table 9-12 summarizes the design criteria for the RO Second Pass Pumps.

Table 9-12. RO Second Pass Pumps Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Minimum efficiency	percent	70	✓	
Construction materials		316 SSL	✓	
Temperature	ºC	8 to 20	✓	
RO fouling conditions				
Other Parameters				
One second pass feed pump, with variable frequency drive, shall be provided for each second pass membrane train.			✓	
Equipment Factory Testing				
Factory testing will be performed for each second pass RO feed pump. Testing will comply with the latest version of the Hydraulic Institute/American National Standard for Rotodynamic Pumps for Hydraulic Performance Tests (14.6), referred to as HI Standard 14.6.			✓	
Measurement accuracy will be Grade 1 as defined by the HI Standard 14.6. Pump performance test acceptance grade will be 1E.			✓	
Pump tests will be performed to verify the initial performance of new pumps. Performance testing will include measurement of flow, head, and power input to the pump or test motor. NPSH testing will be performed. Factory testing will be performed at a dedicated test facility.			✓	
Tests will be conducted on actual equipment to be furnished to the job site, including pump discharge heads and barrels, as applicable.			✓	
Certified test reports will be furnished which include test data sheets, performance test logs, and equipment performance curves, as applicable. Indicate separately equipment guaranteed operating points identified in the specifications, including efficiency. Testing will provide data for a minimum of five (5) flows			✓	
Factory testing of each second pass pump motor will be performed as listed below. Certified test results will be submitted. (a) Dielectric test on armature (b) Insulation resistance (c) No load current at rated voltage (d) Efficiency and power factor calculated at 100 percent of full load at full load speed (e) Locked rotor current (f) Over speed test (g) Winding resistance (h) Balance (i) Bearing inspection			✓	

9.6.9 Energy Recovery Device

The isobaric energy recovery device ("ERD") system proposed for this project will reduce the RO system's power consumption by recapturing the energy present in the first pass concentrate stream. Overall, the ERDs will recover over 95 percent of the energy from the concentrate, corresponding to a net recovery of approximately 45 to 50 percent of the overall energy required to operate the SWRO membranes. Filtered seawater from cartridge filters will be split between the feed to the high pressure RO pumps and the low pressure feed to the energy recovery system. The feed flow to the high pressure RO pumps will be approximately the same as the permeate flow from the first pass RO system. The remaining balance of the feed water flow to the energy recovery system will be approximately equal to the RO concentrate flow. The isobaric pressure exchanger energy recovery system will pressurize the RO feed water at energy recovery efficiency of greater than 95 percent. The pressurized RO feed water stream leaving the ERDs will require minor pressure boosting by an ERD booster pump (typically 30 to 35 psig) to compensate for the pressure losses experienced from the feed/concentrate stream passing through the feed water channels of the RO membranes and any pressure losses in the piping and energy recovery system. The pressurized feed water from the ERD booster pumps will be combined with pressurized RO feed water from the high pressure RO pumps for treatment by the SWRO membranes. Table 9-13 summarizes the design criteria for the ERDs.

Table 9-13. ERD Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
ERD type		positive displacement	✓	
ERD booster pump acceptable materials for wetted parts		non-corrosive, AL6XN, or Titanium	✓	
ERD booster pump type		horizontal multistage centrifugal design	✓	
ERD booster pump seal		cartridge type mechanical seal	✓	
ERD booster pump lubricant		pumped fluid / no oil lubrication	✓	
Number of ERD per train		1 (assumed this means CAW didn't want an ERD on the common brine discharge)	✓	Six – ERI PX-Q300 Pressure Exchanger cylinders per SWRO unit
ERD expected lifetime	years	20 (minimum)	✓	
ERD Efficiency	percent	95	✓	
Mixing			✓	
Other Parameters				
Design of the ERD shall take into account the specific RO train configuration and high pressure pump and associated booster pumps to ensure proper operation and appropriate energy recovery.			✓	
Mixing will be no more than three percent (3%) when the ERD low pressure flow rate equals the ERD high pressure flow rate and the membrane recovery rate is less than 50%.			✓	The salinity increase on the feed to the RO membranes will not increase by more than 3% as a result of mixing between the concentrate and feed in the ERD system
Conductivity of the flows into and out of the ERD shall be relayed to the main plant control system for continual calculation of ERD mixing percent. Sample ports shall also be provided at the same locations as the conductivity sensors.			✓	
The ERD must be able to operate within all the parameters of this Project (e.g., temperature, flow, pressure,).			✓	

9.6.10 RO System Piping and Valves

Interconnecting pipe manifolds for operation and sampling of the RO trains shall be provided that include but are not limited to connections for feed line, permeate line, brine line, CIP feed and return lines, and flush feed and waste lines. Table 9-14 summarizes the design criteria for the RO system piping and valves.

Table 9-14. RO System Piping and Valves Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP	Notes/Assumptions
Return lines	Off the permeate headers of each train	✓	CIP return lines are provided on the permeate header from each train
Backflow prevention or air gap separation	On CIP waste, CIP recirculation and flush waste lines, as required by CDPH	✓	Block and bleed valves will be used for isolation
Sample ports and backflow prevention devices	As required by CDPH	✓	
Permeate sample points	On all vessels and are such that a probe tube may be passed through for profiling and sampling within a vessel	✓	
Sample port panel	For each train, such that the operator can sample the permeate of each vessel, the feed and concentrate of each train, and any inter-stage header lines.	✓	
RO Train Manifolds	Use vertical feed/concentrate manifolds and vertical permeate manifolds	✓	
Side ported vessels (without a multiport, close coupled arrangement)	Used for ease of maintenance	✓	
Piping location	Run at the ends or alongside the trains in easily accessible piping trenches	✓	Please refer to Dwg M-5
Horizontal piping	Runs shall be located beneath trench grating	✓	Please refer to Dwg M-5
Permeate backpressure	Does not exceed the concentrate pressure more than 5 psi to prevent damage to the RO membranes	✓	

9.6.11 Flush System

The flush system shall be able to flush the entire RO system and each individual RO train including ERDs. The Design-Builder shall provide the ability to flush each train independently of the plant to allow for individual train shutdown and flushing. The first pass system shall be able to be flushed separately from the second pass. Table 9-15 summarizes the design criteria for the flush system.

Table 9-15. Flush System Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP	Notes/Assumptions
Flush water source	RO permeate from the flush tank	✓	
Automated flushing event	First and second pass RO systems are designed and will be constructed with piping, valving, and instrumentation for an automated flushing event to occur if a train is taken offline.	✓	
Manual flushing event	Ability to manually initiate a flushing event is provided in addition to automated flushing.	✓	
Flush feed connections along with automated flush supply and waste valves for each train	▪ System shall be activated automatically through the RO system PLC on shutdown of the RO train to flush residual low pH feed and concentrate from the high pressure pump and pressure vessels. ▪ On initiation of a flush cycle, flush water shall be pumped to the flush feed valve on the suction side of the high pressure pump. ▪ A flush to waste valve shall be opened off the concentrate line ahead of the control valve, routing the flush water to waste.	✓	Flush will go through the concentrate valve to brine outfall or brine equalization basin
Flush feed connections proximity	Placed in close to the train itself without excess piping.	✓	
Flush tank volume	There is enough volume in the flush tank such that each train can be flushed in the event of a plant shut down.	✓	43,000 gal
Preservative solution	Can be added to the flush system.	✓	Connection to the sodium bisulfite feed system is provided
Flush pumps	One standby pump is available to flush the first or second pass RO train.	✓	
Duty and standby pumps	Are connected to the standby power generator bus such that a single pump could operate during a power outage.	✓	
Flush waste pumps sizing	Sized to flush an entire first or second pass RO train, including the ERD.	✓	780 gpm at 158 ft
Flush system flexibility	Can flush the first pass RO feed pumps	✓	
Sanitization	Allow for proper sanitization of the flush tank to control microbiological activity.	✓	Ability to feed sodium hypochlorite for sanitation and draining to waste is provided

9.6.12 Clean-In-Place System

A chemical cleaning system that includes CIP pumps, tanks, tank heater, and cartridge filter(s) shall be provided by the Design-Builder. This CIP system, including storage, make-up, piping, connections, and feed facilities, shall be permanently installed. Table 9-16 summarizes the design criteria for the flush system.

Table 9-16. Clean-In-Place System Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Piping and Valving		Sufficient to clean each entire stage within each train individually.	✓	
Chemical storage area within CIP area		Chemical containment and feed system design is consistent with the American Water Engineering Standard T2: Liquid Chemical Storage, Feed, And Containment (Attachment 1 to the Design-Build Agreement Appendix 2)	✓	
CIP Chemical System Type		Dry or Liquid	✓	Liquid – an eductor has been included on the CIP recirculation line
Dry CIP chemical system		CIP tanks shall be installed with a dry chemical feed system and submersible tank mixer.	✓	
Tankage				
Tank size	gallons	Adequate volume to perform a CIP for either the first or second pass train, assuming heavily fouled conditions, and for chemical addition to neutralize the CIP solution and the minimum volume of one CIP tank shall be sufficient to allow filling of all pressure vessels in the first pass RO train or second pass RO train (whichever is larger) as well as the piping to and from the train.	✓	15,600 gal
Solution storage	pH	2 to 12	✓	
Material for tanks larger than 1,000 gallons		FRP	✓	
CIP pumps to perform the cleaning of the entire first pass		1 pump (minimum)	✓	1 pump 3120 gpm at 161 ft
CIP pump to perform the cleaning of the second pass		1 pump (minimum)	✓	1 pump 720 gpm at 161 ft
Piping type between CIP system and RO train		Permanent piping with block and bleed valves at connections.	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
CIP cartridge filter pore size	µm	5	✓	
Cartridge filter material		Suitable for a cleaning solution with pH between 2 and 12.	✓	Polypropylene
Local control panel (LCP) height	feet	4 above the building floor	✓	
Control system display		temperature, pH, pump status, and flow and pressure during a CIP (minimum)	✓	
Other Parameters				
CIP tanks shall be installed with a drain at the tank bottom			✓	
The CIP system shall be supplied with a heating system to raise the temperature of the CIP solution for a heavily fouled condition up to 45 °C in 8 hours or less.			✓	
Sufficient number of pumps provided to allow each stage to be cleaned individually with the provided pumps(s).			✓	
The CIP system shall be manually initiated.			✓	

9.6.13 Neutralization Tank

A neutralization tank, separate from the CIP tank, shall be provided to receive CIP waste. Table 9-17 summarizes the design criteria for the neutralization tank.

Table 9-17. Neutralization Tank Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Tank size	gallons	Large enough to receive 150% of the volume needed to clean one entire train.	✓	15,600 gal
Equipment		▪ mixer ▪ neutralization chemical equipment ▪ drain for disposal of the contents via trucking	✓	Recirculation pump and eductor used for mixing
Level monitor and an independent high level switch		Provided for monitoring level and alarm on high level	✓	

9.6.14 RO Membrane Storage and Preservation

The RO System shall be delivered to allow for proper storage and preservation of the RO elements.

9.6.15 RO System Control and Instrumentation

The RO system shall be controlled by a programmable logic controller ("PLC") based control system. Table 9-18 summarizes the design criteria for the RO system control and instrumentation.

Table 9-18. RO System Control and Instrumentation Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP	Notes/Assumptions
PLC type	Allen Bradley	✓	Control Logix with 1734 point I/O

Parameter	Design Criteria	Per RFP	Notes/Assumptions
Operator graphical interface	Provided to communicate with system	✓	GE Intellution iFIX 5.5
Minimum RO system feed information feed (downstream of cartridge filter(s))	Temperature, conductivity, pH, turbidity, flowrate, pressure, and ORP.	✓	PLC will calculate flows from SWRO high and low permeate and concentrate and present the sum of all SWRO trains feed flow and sum of Pass 2 BWRO concentrate streams
RO system operation	Constant permeate flow rate	✓	
Minimum RO train information to be relayed to the main plant control system	1. Train Status	✓	
	2. First Pass Feed: a. Pressure b. Flowrate	✓ ✓	
	3. Second Pass First Stage Feed: pressures before and Second Pass First Stage Feed: after feed pump a. Flowrate b. Temperature c. Conductivity d. pH	✓ ✓ ✓ ✓	
	4. Second Pass Second Stage Feed: a. Pressure b. Flowrate c. Conductivity d. pH	✓ ✓ ✓ ✓	
	5. First Pass Permeate: a. Pressure b. Flowrate c. Conductivity d. pH	✓ ✓ ✓ ✓	
	6. Second Pass First and Second Stage Permeate: a. Pressure b. Flowrate c. Conductivity d. pH	✓ ✓ ✓ ✓	
	7. Second Pass By-pass: a. Pressure b. Flowrate	✓ ✓	
	8. Combined Permeate: a. Pressure b. Flowrate c. Conductivity d. pH	✓ ✓ ✓ ✓	
	9. First pass concentrate: a. Pressure b. Flowrate c. Conductivity	✓ ✓ ✓	
	10. Second pass second stage concentrate:		

Parameter	Design Criteria	Per RFP	Notes/Assumptions
	a. Pressure b. Flowrate c. Conductivity d. pH	✓ ✓ ✓ ✓	
	11. Combined concentrate: a. Flowrate b. Conductivity c. pH d. Turbidity e. Temperature	 ✓ ✓ ✓ ✓ ✓	
	12. Differential Pressure (Train, Passes and Stage)	✓	
	13. Valve Positions a. Feed b. Permeate c. Brine	 ✓ ✓ ✓	
	14. RO Feed Rate and Calculated Recovery Rate	✓	
	15. Alarm Condition for RO Feed Pumps and Energy Recovery Device	✓	
	16. Energy Recovery Device of all streams a. Flowrate b. Pressure c. Conductivity	 Partial Partial Partial	
Monitoring at common influent location	RO feed temperature, conductivity, and pH	✓	
Real-time online normalization provided	Specific flux, differential pressure, and conductivity	✓	
Sample points	Sufficient number to be provided on process system to allow the operator to determine the performance of the RO system.	✓	
Each stage of multistage trains shall be instrumented.		✓	
Common monitoring location	RO feed parameters, rather than require the operator to visit each train.	✓	Each Permeate ports of each pressure vessel, Membrane Feed, Interstage, Each train combined permeate (1st stage, 2nd stage, combined), Each ERD stream, Final concentrate.
Meters and sampling points	Compliant with the provisions of Appendix 2 and Appendix 7.	✓	

9.6.16 Spare Parts

Table 9-19 provides a master list of spare parts recommended by the manufacturer.

Table 9-19. RO System Spare Parts Recommended by the Manufacturer

Part Description
One mechanical seal of each type used for the RO systems
One set of pump bearings of each type used for the RO system
One set seals and gaskets for anERD unit
10 RO pressure vessel seals foe the end caps, permeate connectors, brine seals, couplings

9.6.17 Special Tools

No special tools are anticipated.

A single element test unit will be provided at the plant for testing of individual membrane elements. The single element test unit meets the requirements outlined in Table 9-21.

Table 9-21. Single Element Test Unit Requirements

Use	Per RFP	Notes/Assumptions
The unit includes a 5-micron cartridge filter, high pressure feed pump, and one 8-inch single element pressure vessel, and instrumentation.	✓	
The unit is capable of operating up to 1200 psi	✓	
A concentrate recycle line is included.	✓	
Instrumentation is panel mounted, and includes instruments for: ▪ monitoring raw feed pressure ▪ post-cartridge filter pressure ▪ permeate pressure ▪ pressure differential across the single element pressure vessel ▪ feed flow ▪ permeate flow ▪ recycle flow ▪ concentrate flow ▪ feed, permeate and concentrate conductivities	✓	
Sample ports are provided for the RO feed water (before and after the concentrate recycle line), permeate, and concentrate flows.	✓	

9.6.18 Factory Testing

Factory tests will be conducted on all actual equipment to be furnished to the job site. Test reports will be provided to CAW documenting the performance of each piece of equipment. Equipment guaranteed operating points will be indicated.

9.6.19 RO System 14-day Run-In Test

A 14-day performance test will be conducted on the complete RO system to demonstrate its competent operation. Testing activities will include:

- As applicable to the equipment furnished, it will be stated in writing that all necessary hydraulic structures, piping systems, and valves have been successfully tested; that all necessary equipment systems and subsystems have been checked for proper installation, started, and successfully tested to indicate that they are all operational; that the systems and subsystems are capable of performing their intended functions; and that the facilities are ready for startup and intended operation.

- After the facility is operating, but prior to initiation of the 14-day run-in test, testing of those items of equipment, systems, and subsystems which could not be or were not adequately or successfully tested prior to plant startup will be completed. This includes verification of proper membrane element installation by conducting a conductivity profile on the pressure vessels of each RO train while the train is operating.
- The profiles by sampling permeate from the sample valves on each pressure vessel within a given train will be conducted.
- Those vessels not meeting pre-established conductivity criteria will be opened up and examined for proper installation of end connectors and element interconnectors, damaged o-rings, misaligned brine seals, and other like causes.
- Any observed deficiencies will be corrected and the vessel retested.
- Successful checkout of the RO system and performance testing of related ancillary systems will constitute grounds for substantial completion of the RO system and allow it to proceed to the Acceptance Test.
- The test will be considered complete when, in the opinion of CAW, the complete treatment system has operated in the manner intended at plant design capacity for 14 continuous days without significant interruption. This period is in addition to any training, functional, or performance test periods specified elsewhere. A significant interruption will require the test then in progress to be stopped and restarted after corrections are made.

Significant interruption may include any of the following events

- Failure to maintain qualified on-site startup personnel as scheduled.
- Failure of any equipment item or treatment subsystems to meet specified performance requirements for more than 2 consecutive hours.
- Failure of any critical equipment unit, system, or subsystem that is not satisfactorily corrected within 5 hours after failure.
- Failure of noncritical unit, system, or subsystem that is not satisfactorily corrected within 8 hours after failure.
- As may be determined by CAW.

The following events will not be considered cause for significant interruption:

- Loss of feed water delivered to the RO System for reasons beyond control
- Loss of power to the plant for reasons beyond control

- As may be determined by CAW.

Minimum prerequisites prior to initiation of the 14-Day Run-In Test include the following:

- Successful completion of the performance tests for the reverse osmosis trains.
- Completion of membrane element loading and checkout for the reverse osmosis trains.
- Completion of initial startup operations, including successful completion of performance testing on remaining equipment items as specified herein.

9.6.19.1 RO System 14-day Run-In Test Report
At the end of the 14-day run-in test, a test report will be prepared which shall include daily operating and normalized performance data for each day of the test, for each RO train and the system as a whole.

9.6.19.2 Acceptance Testing
Final Acceptance Testing is described in Appendix 7 and in Article 4 of the Design-Build Agreement.

9.6.20 RO System Performance Warranty
Per the Design-Build Agreement

9.6.20.1 Membrane Elements
A separate warranty is furnished for the RO membrane elements. This warranty is a pass-through type, directly between the Hydranautics and CAW. This warranty will be signed by an individual authorized to execute contracts on behalf of the membrane manufacturer and states the following provisions with no additional conditions or exceptions:

1) The membrane elements supplied under these specifications shall be warranted by the manufacturer to be free of liens and encumbrances, and against defects in materials and workmanship for a period of twelve (12) months in accordance with Article 6 of the Design-Build Agreement.

2) The manufacturer shall warrant the performance of the membrane elements for a period of three (3) years from completion of the Acceptance Tests described in Appendix 7 (the "Extended Membrane Warranty Period"). The manufacturer shall guarantee the membrane elements during the Extended Membrane Warranty Period in accordance with the performance requirements specified herein and the following prorated replacement conditions if the elements fail to meet the warranted performance:

    a. The elements shall at all times during the Extended Membrane Warranty Period have a minimum flow of 90 percent of the minimum product flow specified on the membrane manufacturer's specification sheet for the elements furnished when tested at standard conditions as defined herein.

    b. During the Extended Membrane Warranty Period, the element salt passage shall not exceed one hundred and fifty percent (150%) of the maximum salt passage specified on the membrane manufacturer's specification sheet for the elements furnished when tested at standard conditions as defined herein.

3) At all times during the Extended Membrane Warranty Period, when the system is operated with feed water consistent with the conditions applicable for the RO system in Table 1 in Attachment 2 of Appendix 2:

   a. Each RO train shall require no more than 1,000 psi feed pressure to the first pass to produce design permeate capacity.

   b. The RO permeate from each train shall meet both the maximum-average and not-to-exceed concentrations for boron, chloride bromide and sodium listed in Table 2C-1 in Attachment 3 of Appendix 2.

9.6.20.2 Validity of Warranty Conditions

The warranty conditions specified above shall be valid under the following conditions:

1) Each RO train has been operated as designed in terms of product water recovery, flux, array configuration, and feed water pH.

2) The feed water does not contain chemicals that chemically or physically destroy the elements.

3) The membrane elements are periodically cleaned with an effective cleaning solution to remove colloidal matter inherent in ocean water.

4) The membrane elements are cleaned using standard cleaning solutions prior to performance testing for warranty purposes.

5) Biological matter or sparingly soluble substances in the feed water have not irreversibly fouled the membrane elements.

9.6.20.3 RO Train Performance Issues

Should the RO train performance not meet the warranty requirements, the membrane element manufacturer will provide sufficient replacement elements to achieve the specified train performance. The replacement elements will be provided at the current market price, less a credit of 1/36 of the purchase price for each unused month of the Extended Membrane Warranty Period. The manufacturer will guarantee that future replacement elements will be sold to CAW at a price not to exceed $650 per 8-inch 40-inch element at any time within three years from Acceptance of each RO train.

10.0 HANDLING OF TREATMENT RESIDUALS

This section details the design criteria and requirements for the handling of treatment residuals. Drawings are provided in Section 3.D and design criteria tables are presented for each residual system in the paragraphs that follow.

KEY REFERENCE DRAWINGS:
G-6 RESIDUAL PROCESS FLOW DIAGRAM
M-12 BRINE EQUALIZATION PUMP STATION
M-13 BACKWASH RECLAMATION BASIN PUMP STATION
I-41 P&ID BACKWASH RECLAMATION BASIN AND PUMP STATION
I-42 P&ID BRINE CONVEYANCE SYSTEM

10.1 Types of Residuals

Table 10-1 summarizes the types of residual streams.

Table 10-1 Residuals Summary

Residual Stream	Disposal Method	Frequency of Disposal	Per RFP	Notes/Assumptions
CIP waste, neutralized	Neutralization holding tank, Trucking offsite (to MRWPCA)	Intermittent,	✓	
Sanitary waste	Leachfield	Continuous, variable	✓	
Special laboratory waste	Discharge through neutralization pot to Holding tank, Trucking offsite	Intermittent (expect no more than twice per year)	✓	
Sample streams	Recycle to the extent possible; minimize discharge to sanitary		✓	
Spent Granular Media Filter Wastewater	Settling followed by recycle, or discharge to concentrate/MRWPCA Concentration/treatment process then Trucking offsite	Periodic; no more than twice per year	✓	
Settled Solids from Granular Media Filtration	Concentration in settling basins; mechanical or non-mechanical dewatering ; landfill disposal	Not to exceed once per year	✓	
Lime Sludge Blowdown	Comingle with granular media filtration waste; Concentration/treatment process then Trucking offsite		✓	
First Pass RO Concentrate	Pipeline to MRWPCA	Continuous	✓	
Second Pass RO Concentrate	Pipeline to MRWPCA	Continuous	✓	

10.2 RO Reject Water

If RO permeate that does not meet the finished water quality criteria can be temporarily diverted to the Brine Equalization Basin for disposal with RO Concentrate or Brine at the MPWPF outfall.

10.3 RO Concentrate Disposal

Table 10-2 summarizes the design criteria for the RO concentrate disposal. This project only includes piping from the desalination facility to the Project Site boundary. Piping from the Project Site boundary to the MRWPCA tie-in will be constructed by others.

Table 10-2. RO Concentrate Disposal

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Concentrate flows from both the first pass and the second pass of the RO system		Conveyed to the MRWPCA site via a proposed concentrate pipeline and disposed of via the existing MRWPCA outfall using residual pressure from the RO system.	✓	
Digital communication with MRWPCA for sharing of limited data		Spread spectrum radio link protected by a firewall	✓	
Concentrate Flow Equalization				
Lagoon capacity	gallons	3,000,000	✓	
Lagoon embankment width	feet	12	✓	
Lagoon embankment suitable for service road		Support weight of service vehicles	✓	
Lagoon Freeboard	feet	3 (minimum)	✓	
Lagoon Surface runoff protection			✓	The site is graded to prevent run-off from entering the Brine Equalization Basin
Lagoon Continuous level measurement		ultrasonic level monitor and high level switch to alarm	✓	
Lagoon lining		Double-lined, leak collection material between liners; textured on exposed side, protected from wind uplift, oxidation and sharp objects	✓	
Provide seepage collars; provide erosion protection at inlet			✓	
Security/Fencing		Lagoon will be fenced in with gates for vehicles and personnel	✓	
Lagoon sump pump size	mgd	6	✓	
Pump type		End suction centrifugal with vacuum priming system	✓	
Pump material		Super duplex		
Number of pumps		1 duty, 1 reserve	✓	
Drainage time	hours	12	✓	
Discharge flow metering		Continuously measured for leakage	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Sampling station		1 automatic sampler, roof, and drain	✓	
Sampling station continuous monitoring		pH, conductivity, turbidity, and dissolved oxygen	✓	
Elimination of backflow concerns		1 air break between RO system and wastewater outfall	✓	
Expected Revised NPDES Permit Conditions				
Dissolved oxygen value proposed by California American Water Coastal Water Project Final EIR (2009)	mg/L	5.0	✓	Diffusion of oxygen into the brine by injecting air into the brine discharge pipeline using a positive displacement blower

10.4 Dewatering of Settled Solids from Granular Media Filtration

Table 10-3 summarizes the design criteria for the dewatering of settled solids from granular media filtration and lime system blowdown.

Table 10-3. Solids Dewatering

Parameter	Units	Design Criteria	Per RFP	Notes/Assumption
Settled solids accumulation location		Granular media filtration wastewater basins	✓	
Dewatering		non-mechanically	✓	One basin taken off-line for gravity thickening and solar drying
Dewatering frequency	year	1	✓	
Operations during dewatering		Continuous	✓	
Contract dewatering		Power supply and water supply to be provided	✓	

11.0 Product Water Stabilization

This section presents detailed information on the systems to provide post-stabilization treatment and meet the goals summarized in Table 11-1. Reference drawings are provided in Section 3.D and the following paragraphs present descriptions and design criteria tables for the required options and alternatives.

KEY REFERENCE DRAWINGS:

M-8 CHEMCIAL SYSTEMS PLAN AND SECTIONS
M-10 SATURATED LIME SYSTEM AND PERMEATE FLUSH TANK SYSTEM
M-11 CO2 (CALCIUM DIOXIDE) – FOR 6.4 AND 9.6 MGD
I-27 P&ID CARBON DIOXIDE STORAGE AND FEED SYSTEM (CALCITE CONTACTOR)
I-27A P&ID CARBON DIOXIDE STORAGE AND FEED SYSTEM (CALCIUM HYDROXIDE)
I-36 P&ID OPTION 2 - POST TREATMENT FOR CALCITE CONTACTOR STABILIZATION PROCESS
I-36A P&ID OPTION 1 AND ALTERNATIVE TO OPTION 1 - POST TREATMENT FOR CALCIUM HYDROXIDE STABILIZATION PROCESS
I-43 P&ID OPTION 1 POST TREATMENT - SATURATED LIME SYSTEM
I-44 P&ID ALTERNATIVE TO OPTION 1 POST TREATMENT – LIME SLURRY BATCHING SYSTEM – SHEET 1
I-45 P&ID ALTERNATIVE TO OPTION 1 POST TREATMENT – LIME SLURRY BATCHING SYSTEM – SHEET

Table 11-1. Finished Water After Stabilization Basis of Design Standards and Requirements

Parameter	Units	Target Range	Per RFP
Hardness, total	mg/L as $CaCO_3$	40 to 100	✓
pH	pH units	7.7 to 8.7	✓
Alkalinity, total	mg/L as $CaCO_3$	40 to 100	✓
Langelier Saturation Index (LSI)	–	0 to 0.2	✓
Calcium Carbonate Precipitation Potential (CCPP)	mg/L	0 to 5	✓

11.1. Post-Stabilization Treatment Processes

This section describes the three post-stabilization treatment processes [i.e. the Hydrated Lime System (Option 1), the Carbon Dioxide System, and the Sodium Hydroxide System; the Lime Slurry System (Alternative to Option 1), the Carbon Dioxide System, and the Sodium Hydroxide System; and the Calcite Contactor System (Option 2), the Carbon Dioxide System, and the Sodium Hydroxide System] required by the RFP. Each post-stabilization treatment process is designed to maximize the Owner's operational flexibility and control. As stipulated in the RFP, each post-stabilization treatment process is designed to give the Owner the ability to produce a finished water with calcium hardness and total alkalinity contents as low as 40 mg/L to as high as 100 mg/L as calcium carbonate. Furthermore, each post-stabilization treatment process is designed to give the Owner the ability to produce a finished water product with the same full range of calcium hardness and total alkalinity contents (i.e. 40 mg/L to 100 mg/L as calcium carbonate) while maintaining a finished water pH value of 7.7 to facilitate the effective use of phosphoric acid as a corrosion inhibitor. Regardless of the post-stabilization treatment process selected, the Owner will have the flexibility of operating at any point within the full range of finished water quality values identified in Table 11-1 and will have the confidence that the finished water will meet all United States Environmental Protection Agency Lead and Copper Rule (LCR) requirements and will not result in red water events.

11.1.1. Hydrated Lime (Option 1), Carbon Dioxide, and Sodium Hydroxide Systems

Table 11-2 summarizes the design criteria for the Hydrated Lime System.

Table 11-2. Hydrated Lime System Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Hydrated Lime Storage and Feed System				
Basis of Flow				
Maximum flow	mgd	11.2	✓	This capacity must be provided for post-stabilization treatment process to enable the Owner to produce a stable finished water product with all installed reverse osmosis units in operation. Providing a capacity of 9.6 mgd will limit the Owner's calcium hardness and total alkalinity operating range when "catching up" to annual production goals.
Average flow	mgd	9.6	✓	Capacity which corresponds to desired annual average production rate of 10,671 afy.
Minimum flow	mgd	3.2	✓	Capacity which corresponds to reverse osmosis system minimum production rate of 3.2 mgd.
Calcium Hydroxide Dose				
Application Point		Composite Reverse Osmosis Permeate Downstream of UV Disinfection and Carbon Dioxide Application Point	✓	
Maximum hydrated lime dose	mg/L as $Ca(OH)_2$	74.0	✓	
Average hydrated lime dose	mg/L as $Ca(OH)_2$	28.7		Based upon relevant CDM Smith experience (i.e. Santa Cruz finished water coupon testing) a minimum alkalinity of 30 mg/L as calcium carbonate was sufficient to prevent the occurrence of red water events. As such, the minimum water quality requirements identified in Table 11-1 were assumed to be appropriate for average operating conditions.
Minimum hydrated lime dose	mg/L as $Ca(OH)_2$	28.7		A reduction of the minimum calcium hydroxide dosage indicated in the RFP

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
				[30 mg/L as $Ca(OH)_2$] was required to allow the Owner to produce finished water with a calcium hardness of 40 mg/L as calcium carbonate. This reduction was necessitated by the presence of calcium in the reverse osmosis permeate.
Calcium Hydroxide Consumption Rate				
Maximum flow-Maximum dose	lb/day as $Ca(OH)_2$	6,912		The calcium hydroxide consumption range indicated in the RFP [2,370 to 5,925 lb/day as Ca(OH)2] restricts the Owner from operating within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. Appropriate range provided to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP.
Average flow-Average dose	lb/day as $Ca(OH)_2$	2,298		Same as above.
Minimum flow-Minimum dose	lb/day as $Ca(OH)_2$	766		Same as above.
Maximum flow-Average dose	lb/day as $Ca(OH)_2$	2,681		Same as above.
Average flow-Maximum dose	lb/day as $Ca(OH)_2$	5,925		Same as above.
Bulk Storage Silo				
Number of Silos	Number	1 (1 Active)		
Capacity of Silo	Tons [96.8% $Ca(OH)_2$]	47	✓	Bulk storage silo sized to provide no less than 31 days of storage at maximum flow-average dose consumption rate
Storage Time at Maximum flow-Average dose Consumption Rate	Days	31		Same as above.
Storage Time at Average flow-Maximum dose Consumption Rate	Days	31	✓	Same as above.
Materials of Construction		Steel Construction; Ancillary Systems (Lime Feeder, Slurry Tank, Slurry Pumps, etc.)		
Lime Feeder				
Number of Feeders	Number	1 (1 Active)		
Maximum Feeder Capacity	lb/hr as $Ca(OH)_2$	317		The hydrated lime slurry tank feed rate range indicated in the RFP [99 to 247 lb/hr as Ca(OH)2] restricts the Owner

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
				from operating within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. Appropriate range provided to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. The lime feeder is sized to deliver 110% of the maximum usage rate.
Minimum Feeder Capacity	lb/hr as $Ca(OH)_2$	32		Same as above.
Materials of Construction		Steel Construction		
Hydrated Lime Slurry Feed Tank				
Number of Hydrated Lime Slurry Feed Tanks	Number	1 (1 Active)		
Source of water for hydrated lime slurry feed tank		Second Pass Reverse Osmosis Permeate	✓	
Target Hydrated Lime Slurry Tank Feed Concentration	Percent	8.0	✓	
Acceptable Range for Hydrated Lime Slurry Tank Feed Concentration	Percent	±5 of target concentration	✓	
Materials of Construction		Steel Construction		
Hydrated Lime Slurry Feed Pumps				
Number of Hydrated Lime Slurry Feed Pumps	Number	2 (2 Active)		Hydrated Lime Slurry Feed Pumps are configured to match required Lime Saturator configuration (i.e. 2 Active)
Type of Hydrated Lime Slurry Feed Pumps	Type	Tubular Diaphragm, Peristaltic, or Lined Centrifugal		To be determined during final design.
Maximum Hydrated Lime Slurry Feed Pump Capacity (Each)	Gpm of 8.0% $Ca(OH)_2$ Slurry	3.8		
Minimum Hydrated Lime Slurry Feed Pump Capacity (Each)	Gpm of 8.0% $Ca(OH)_2$ Slurry	0.4		
Total Installed Maximum Hydrated Lime Slurry Feed Pump Capacity	Gpm of 8.0% $Ca(OH)_2$ Slurry	7.6		The hydrated lime slurry tank flow rate range indicated in the RFP [3.1 to 7.7 gpm] restricts the Owner from operating within the full range of

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
				production rates and calcium hardness/total alkalinity values required by the RFP. Appropriate range provided to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. The hydrated lime slurry feed pumps are sized to deliver 110% of the maximum usage rate.
Total Installed Minimum Hydrated Lime Slurry Feed Pump Capacity	Gpm of 8.0% $Ca(OH)_2$ Slurry	0.8		Same as above.
Motor Size (Each)	HP	Less than 1		To be determined during final design.
Drive Type (Each)	Type	Constant Speed		
Lime Saturators				
Number of Lime Saturators	Number	2 (2 Active)	✓	
Type of Saturator	Type	Upflow Contactor		
Maximum Upflow Rate	Gpm/ft2	1.0		Maximum upflow rate selected to comply with saturated lime water turbidity requirement.
Source of water for lime saturators		Second Pass Reverse Osmosis Permeate	✓	
Saturated limewater concentration	g/L as $Ca(OH)_2$	1.8 at 12°C	✓	
Maximum turbidity of saturated limewater	NTU	5	✓	
Maximum Saturated Lime Water Flow Rate (Each)	Gpm	176		
Minimum Saturated Lime Water Flow Rate (Each)	Gpm	17.5		
Total Installed Maximum Saturated Lime Water Flow Rate	Gpm	352		The saturated lime water flow rate range indicated in the RFP [114 to 286 gpm] restricts the Owner from operating within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. Appropriate range provided to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. The lime saturators are sized to deliver 110% of the maximum usage rate.
Total Installed Minimum Saturated	Gpm	35		Same as above.

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Lime Water Flow Rate				
Materials of Construction		Steel Construction		
Lime Water Equalization Tanks				
Number of Lime Water Equalization Tanks	Number	2 (2 Active)	✓	
Capacity of Lime Water Equalization Tank (Each)	Gal	17,200	✓	
Total Installed Lime Water Equalization Tank Capacity	Gal	34,400		
Materials of Construction		Steel, HDXLPE, or FRP		To be determined during final design.
Lime Water Feed Pumps				
Number of Lime Water Feed Pumps	Number	2 (2 Active)		Lime Water Slurry Feed Pumps are configured to match required Lime Saturator configuration (i.e. 2 Active)
Type of Lime Water Feed Pumps	Type	Centrifugal		
Maximum Lime Water Feed Pump Capacity (Each)	Gpm of Saturated Lime Water	176		
Minimum Lime Water Feed Pump Capacity (Each)	Gpm of Saturated Lime Water	17.5		
Total Installed Maximum Lime Water Feed Pump Capacity	Gpm of Saturated Lime Water	352		The saturated lime water flow rate range indicated in the RFP [114 to 286 gpm] restricts the Owner from operating within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. Appropriate range provided to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. The lime water feed pumps are sized to deliver 110% of the maximum usage rate.
Total Installed Minimum Lime Water Feed Pump Capacity	Gpm of Saturated Lime Water	35		Same as above.
Maximum Line Pressure Lime Water Feed Pumps must Pump Into	Psi	10		Pressure requirement based upon finished water storage tank dimensions and piping/equipment configuration.
Motor Size (Each)	HP	Less than 5		To be determined during final design.
Drive Type (Each)	Type	Variable Frequency Drive		

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Additional Hydrated Lime System Features				
The hydrated lime system, specifically the lime water feed pumps, is designed to be controlled based on the flow rate (primary control variable) and trimmed on target alkalinity of the product water downstream (secondary control variable) using a PID feedback control loop.			✓	
The hydrated lime system is designed to incorporate cleanouts and flushing connections at all lime slurry and/or lime sludge pipeline transition points.			✓	
The hydrated lime system is designed to utilize long radius elbows and fittings along the lime slurry and/or lime sludge pipelines.			✓	
The hydrated lime system is designed to specifically eliminate vertical piping runs on all lime slurry and/or lime sludge pipelines.			✓	
The hydrated lime system is designed to incorporate flexible hose and quick disconnect fittings on lime slurry and lime sludge pipelines to facilitate replacement/cleanout of pipelines.			✓	
The hydrated lime system is designed to minimize the aeration of lime solutions to prevent uptake of carbon dioxide and formation of calcium carbonate.			✓	

Table 11-3 summarizes the design criteria for the Carbon Dioxide System.

Table 11-3. Carbon Dioxide System Basis of Design Standards and Requirements

Carbon Dioxide Storage and Feed System				
Basis of Flow				
Maximum flow	mgd	11.2		This capacity must be provided for post-stabilization treatment process to enable the Owner to produce a stable finished water product with all installed reverse osmosis units in operation. Providing a capacity of 9.6 mgd will limit the Owner's calcium hardness and total alkalinity operating range when "catching up" to annual production goals.
Average flow	mgd	9.6	✓	Capacity which corresponds to desired annual average production rate of 10,671 afy.
Minimum flow	mgd	3.2	✓	Capacity which corresponds to reverse osmosis system minimum production rate of 3.2 mgd.
Carbon Dioxide Dose				
Application Point		Composite Reverse Osmosis Permeate Downstream of UV Disinfection and		

Carbon Dioxide Storage and Feed System				
		Upstream of Calcium Hydroxide Application Point		
Maximum carbon dioxide dose	mg/L as CO_2	91.3		Dosage determined by water quality modeling. Model designed to achieve calcium hardness and total alkalinity values of 100 mg/L as calcium carbonate while meeting other finished water quality requirements identified in Table 11-1.
Average carbon dioxide dose	mg/L as CO_2	33.3		Based upon relevant CDM Smith experience (i.e. Santa Cruz finished water coupon testing) a minimum alkalinity of 30 mg/L as calcium carbonate was sufficient to prevent the occurrence of red water events. As such, the minimum water quality requirements identified in Table 11-1 were assumed to be appropriate for average operating conditions.
Minimum carbon dioxide dose	mg/L as CO_2	33.3		Dosage determined by water quality modeling. Model designed to achieve calcium hardness and total alkalinity values of 40 mg/L as calcium carbonate while meeting other finished water quality requirements identified in Table 11-1.
Carbon Dioxide Consumption Rate				
Maximum flow-Maximum dose	lb/day as CO_2	8,528		
Average flow-Average dose	lb/day as CO_2	2,666		
Minimum flow-Minimum dose	lb/day as CO_2	889		
Maximum flow-Average dose	lb/day as CO_2	3,110		
Average flow-Maximum dose	lb/day as CO_2	7,310		
Bulk Storage Tank				
Number of Tanks	Number	1 (1 Active)	✓	
Capacity of Tank	Tons	120		Bulk storage tank sized to provide no less than 31 days of storage at maximum flow-average dose consumption rate or average flow-maximum dose consumption rate, whichever was larger.
Storage Time at Maximum flow-Average dose Consumption Rate	Days	77		Same as above.
Storage Time at	Days	33	✓	Same as above.

Carbon Dioxide Storage and Feed System				
Average flow-Maximum dose Consumption Rate				
Materials of Construction		Steel Construction; Urethane Insulation; Aluminum Shell; Ancillary Systems (Refrigeration System, Vaporizer System, Vapor Heater System) located within Cabinet		
Refrigeration System				
Number of Refrigeration Units	Number	1 (1 Active)		
Vaporizer System				
Number of Vaporizer Units	Number	2 (1 Active and 1 Standby)	✓	
Capacity of Vaporizer Unit (Each)	Lb/hr as CO_2	391		Sized to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. Each vaporizer is sized to vaporize 110% of the maximum usage rate.
Vapor Heater System				
Number of Vapor Heater Units	Number	2 (1 Active and 1 Standby)	✓	
Capacity of Vapor Heater Unit (Each)	Lb/hr as CO_2	391		Sized to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. Each vapor heater is sized to heat 110% of the maximum usage rate.
Pressure Solution Feed Panel				
Number of Pressure Solution Feed Panels	Number	1 (1 Active)		Single panel will include redundant control valves (one automatic and one manual)
Maximum Capacity	Lb/hr as CO_2	391		Sized to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. The pressure solution feed panel is sized to deliver 110% of the maximum usage rate.
Minimum Capacity	Lb/hr as CO_2	37		Same as above.
Carrier Water Pumps				
Number of Carrier Water Pumps	Number	2 (1 Active and 1 Standby)		
Type of Carrier Water Pumps	Type	Centrifugal		

Carbon Dioxide Storage and Feed System				
Maximum Carrier Water Pump Capacity (Each)	Gpm of Reverse Osmosis Permeate	391		Carrier water pump capacity dictated by maximum capacity of the pressure solution feed panel.
Minimum Discharge Pressure	Psi	65		Based on 55 psi for diffuser assembly and 10 psi for piping/system losses.
Materials of Construction		Stainless Steel		
Motor Size (Each)	HP	30		
Drive Type (Each)	Type	Constant Speed		
Additional Carbon Dioxide System Features				
The carbon dioxide system, specifically the carbon dioxide control valve inside the pressure solution feed panel, is designed to be controlled based on the flow rate (primary control variable) and trimmed on pH of the product water downstream (secondary control variable) using a PID feedback control loop.			✓	
The post-stabilization process, including the physical location of all chemical application points and all control devices (i.e. pH instruments, alkalinity instruments, etc.) is designed such that all chemical reactions will be complete prior to measurement to ensure consistent, accurate, and reliable process control.			✓	

Table 11-4 summarizes the design criteria for the Sodium Hydroxide System. Please note, this post-stabilization process does not require the addition of sodium hydroxide to comply with the finished water quality requirements presented in Table 11-1. Further note, the information presented below only applies to the post-stabilization sodium hydroxide demands.

Table 11-4. Sodium Hydroxide System Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Sodium Hydroxide Storage and Feed System				
Basis of Flow				
Maximum flow	mgd	11.2		This capacity must be provided for post-stabilization treatment process to enable the Owner to produce a stable finished water product with all installed reverse osmosis units in operation. Providing a capacity of 9.6 mgd will limit the Owner's calcium hardness and total alkalinity operating range when "catching up" to annual production goals.
Average flow	mgd	9.6	✓	Capacity which corresponds to desired annual average production rate of 10,671 afy.
Minimum flow	mgd	3.2	✓	Capacity which corresponds to reverse osmosis system minimum production rate of 3.2 mgd.

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Sodium Hydroxide Dose				
Application Point		Composite Reverse Osmosis Permeate Downstream of Saturated Lime Water Application Point (If Required)	✓	
Maximum Sodium Hydroxide Dose	mg/L as NaOH	5	✓	
Average Sodium Hydroxide Dose	mg/L as NaOH	3	✓	
Minimum Sodium Hydroxide Dose	mg/L as NaOH	2	✓	
Sodium Hydroxide Consumption Rate				
Maximum flow-Maximum dose	gal/day as 50% NaOH	80		
Average flow-Average dose	gal/day as 50% NaOH	41		
Minimum flow-Minimum dose	gal/day as 50% NaOH	9		
Maximum flow-Average dose	gal/day as 50% NaOH	48		
Average flow-Maximum dose	gal/day as 50% NaOH	69		
Bulk Storage Tanks				
Number of Tanks	Number	1 (1 Active)	✓	
Capacity of Tank	Gallons	5,200	✓	
Storage Time at Maximum flow-Average dose Consumption Rate	Days	108		Presented storage time accounts for all process demands.
Storage Time at Average flow-Maximum dose Consumption Rate	Days	75	✓	Presented storage time accounts for all process demands.
Materials of Construction		Steel Construction	✓	
Metering Pumps				
Number of Metering Pumps	Number	2 (1 Active and 1 Standby)	✓	
Maximum Capacity	gal/hr as 50% NaOH	3.7		Sized to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. Each metering pump is sized to deliver 110% of the maximum usage rate.
Minimum Capacity	gal/hr as 50% NaOH	0.4		Same as above.
Maximum Line Pressure	Psi	10		Pressure requirement based upon

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Sodium Hydroxide Metering Pumps must Pump Into				finished water storage tank dimensions and piping/equipment configuration.
Additional Sodium Hydroxide System Features				
The sodium hydroxide system, specifically the sodium hydroxide metering pumps, is designed to be controlled based on a PID feedback control loop using pH as the control variable.			✓	
The post-stabilization process, including the physical location of all chemical application points and all control devices (i.e. pH instruments, alkalinity instruments, etc.) is designed such that all chemical reactions will be complete prior to measurement to ensure consistent, accurate, and reliable process control.			✓	

11.1.2 Lime Slurry (Alternative to Option 1), Carbon Dioxide, and Sodium Hydroxide Systems

Table 11-5 summarizes the design criteria for the proprietary RDP Tekkem Lime Slurry System.

Table 11-5. Lime Slurry System Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Lime Slurry Storage and Feed System				
Basis of Flow				
Maximum flow	mgd	11.2		This capacity must be provided for post-stabilization treatment process to enable the Owner to produce a stable finished water product with all installed reverse osmosis units in operation. Providing a capacity of 9.6 mgd will limit the Owner's calcium hardness and total alkalinity operating range when "catching up" to annual production goals.
Average flow	mgd	9.6	✓	Capacity which corresponds to desired annual average production rate of 10,671 afy.
Minimum flow	mgd	3.2	✓	Capacity which corresponds to reverse osmosis system minimum production rate of 3.2 mgd.
Calcium Hydroxide Dose				
Application Point		Composite Reverse Osmosis Permeate Downstream of UV Disinfection and Carbon Dioxide Application Point		
Maximum hydrated lime dose	mg/L as $Ca(OH)_2$	74.0	✓	
Average hydrated lime dose	mg/L as $Ca(OH)_2$	28.7		Based upon relevant CDM Smith experience (i.e. Santa Cruz finished

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
				water coupon testing) a minimum alkalinity of 30 mg/L as calcium carbonate was sufficient to prevent the occurrence of red water events. As such, the minimum water quality requirements identified in Table 11-1 were assumed to be appropriate for average operating conditions.
Minimum hydrated lime dose	mg/L as $Ca(OH)_2$	28.7		A reduction of the minimum calcium hydroxide dosage indicated in the RFP [30 mg/L as $Ca(OH)_2$] was required to allow the Owner to produce finished water with a calcium hardness of 40 mg/L as calcium carbonate. This reduction was necessitated by the presence of calcium in the reverse osmosis permeate.
Calcium Hydroxide Consumption Rate				
Maximum flow-Maximum dose	lb/day as $Ca(OH)_2$	6,912		The calcium hydroxide consumption range indicated in the RFP [2,370 to 5,925 lb/day as Ca(OH)2] restricts the Owner from operating within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. Appropriate range provided to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP.
Average flow-Average dose	lb/day as $Ca(OH)_2$	2,298		Same as above.
Minimum flow-Minimum dose	lb/day as $Ca(OH)_2$	766		Same as above.
Maximum flow-Average dose	lb/day as $Ca(OH)_2$	2,681		Same as above.
Average flow-Maximum dose	lb/day as $Ca(OH)_2$	5,925		Same as above.
Bulk Storage Silo				
Number of Silos	Number	1 (1 Active)		
Capacity of Silo	Tons [96.8% $Ca(OH)_2$]	47		Bulk storage silo sized to provide no less than 31 days of storage at maximum flow-average dose consumption rate. Silo is designed to accommodate 70 tons of quick lime in the event the Owner elects to upgrade the system in the future.
Storage Time at Maximum flow-Average dose	Days	67		Same as above.

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Consumption Rate				
Storage Time at Average flow-Maximum dose Consumption Rate	Days	31	✓	Same as above.
Materials of Construction		Steel Construction; Skirt Supported; Ancillary Systems (Lime Feeder, Batch Slurry Tanks, Slurry Aging Tank, Slurry Pumps, etc.) to be Located within Skirt		
Lime Feeder				
Number of Feeders	Number	1 (1 Active)		
Maximum Feeder Capacity	lb/hr as $Ca(OH)_2$	2,600		Capacity to be confirmed by RDP Tekkem during final design.
Materials of Construction		Steel Construction		
Batch Slurry Tanks				
Number of Batch Slurry Tanks	Number	2 (1 Active and 1 Standby)	✓	
Source of water for batch slurry tanks		Second Pass Reverse Osmosis Permeate	✓	
Target Batch Slurry Tank Feed Concentration	Percent	8.0	✓	
Acceptable Range for Batch Slurry Tank Feed Concentration	Percent	±5 of target concentration	✓	
Materials of Construction		Stainless Steel		Batch slurry tanks to be of stainless steel construction to accommodate future conversion to slaker units. Tanks will also include all necessary provisions to allow use of quick lime in the future. Provisions include the ability of the batch slurry tanks to accommodate insulating/water warming jackets, temperature sensors, thermowells, and washdown systems.
Slurry Aging Tank				
Number of Slurry Aging Tanks	Number	1 (1 Active)	✓	
Source of water for slurry aging tank		Second Pass Reverse Osmosis Permeate	✓	
Target Slurry Aging Tank Feed Concentration	Percent	8.0	✓	
Acceptable Range for Slurry Aging Tank Feed Concentration	Percent	±5 of target concentration	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Materials of Construction		Stainless Steel		Slurry aging tank to be of stainless steel construction to accommodate future use of quick lime. Tank will also include all necessary provisions to allow use of quick lime in the future. Provisions include the ability of the batch slurry tanks to accommodate heat transfer jacket, washdown systems, and a fine grit classification, collection, and removal system.
Hydrated Lime Slurry Recirculation Pumps				
Number of Hydrated Lime Slurry Recirculation Pumps	Number	2 (1 Active and 1 Standby)		
Type of Hydrated Lime Slurry Recirculation Pumps	Type	Tubular Diaphragm, Peristaltic, or Lined Centrifugal		To be determined during final design.
Maximum Hydrated Lime Slurry Recirculation Pump Capacity (Each)	Gpm of 8.0% $Ca(OH)_2$ Slurry	75		Capacity to be confirmed by RDP Tekkem during final design.
Motor Size (Each)	HP	7.5		Motor size to be confirmed by RDP Tekkem during final design.
Drive Type (Each)	Type	Constant Speed		
Precision Hydrated Lime Slurry Dosing Assemblies				
Number of Precision Hydrated Lime Slurry Dosing Assemblies	Number	2 (2 Active)		Precision Hydrated Lime Slurry Dosing Assemblies are configured to match required Lime Saturator configuration (i.e. 2 Active)
Maximum Precision Hydrated Lime Slurry Dosing Assembly Capacity (Each)	Gpm of 8.0% $Ca(OH)_2$ Slurry	3.8		
Minimum Precision Hydrated Lime Slurry Dosing Assembly Capacity (Each)	Gpm of 8.0% $Ca(OH)_2$ Slurry	0.4		
Total Installed Maximum Precision Hydrated Lime Slurry Dosing Assembly Capacity	Gpm of 8.0% $Ca(OH)_2$ Slurry	7.6		The hydrated lime slurry flow rate range indicated in the RFP [3.1 to 7.7 gpm] restricts the Owner from operating within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. Appropriate range provided to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. The precision hydrated lime dosing assemblies are

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
				sized to deliver 110% of the maximum usage rate.
Total Installed Minimum Precision Hydrated Lime Slurry Dosing Assembly Capacity	Gpm of 8.0% $Ca(OH)_2$ Slurry	0.8		Same as above.
Lime Saturators				
Number of Lime Saturators	Number	2 (2 Active)	✓	
Type of Saturator	Type	Upflow Contactor		
Maximum Upflow Rate	Gpm/ft2	1.0		Maximum upflow rate selected to comply with saturated lime water turbidity requirement.
Source of water for lime saturators		Second Pass Reverse Osmosis Permeate	✓	
Saturated limewater concentration	g/L as $Ca(OH)_2$	1.8 at 12°C	✓	
Maximum turbidity of saturated limewater	NTU	5	✓	
Maximum Saturated Lime Water Flow Rate (Each)	Gpm	176		
Minimum Saturated Lime Water Flow Rate (Each)	Gpm	17.5		
Total Installed Maximum Saturated Lime Water Flow Rate	Gpm	352		The saturated lime water flow rate range indicated in the RFP [114 to 286 gpm] restricts the Owner from operating within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. Appropriate range provided to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. The lime saturators are sized to deliver 110% of the maximum usage rate.
Total Installed Minimum Saturated Lime Water Flow Rate	Gpm	35		Same as above.
Materials of Construction		Steel Construction		
Lime Water Equalization Tanks				
Number of Lime Water Equalization Tanks	Number	2 (2 Active)	✓	
Capacity of Lime Water Equalization Tank (Each)	Gal	17,200	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Total Installed Lime Water Equalization Tank Capacity	Gal	34,400		
Materials of Construction		Steel, HDXLPE, or FRP		To be determined during final design.
Lime Water Feed Pumps				
Number of Lime Water Feed Pumps	Number	2 (2 Active)		Lime Water Slurry Feed Pumps are configured to match required Lime Saturator configuration (i.e. 2 Active)
Type of Lime Water Feed Pumps	Type	Centrifugal		
Maximum Lime Water Feed Pump Capacity (Each)	Gpm of Saturated Lime Water	176		
Minimum Lime Water Feed Pump Capacity (Each)	Gpm of Saturated Lime Water	17.5		
Total Installed Maximum Lime Water Feed Pump Capacity	Gpm of Saturated Lime Water	352		The saturated lime water flow rate range indicated in the RFP [114 to 286 gpm] restricts the Owner from operating within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. Appropriate range provided to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. The lime water feed pumps are sized to deliver 110% of the maximum usage rate.
Total Installed Minimum Lime Water Feed Pump Capacity	Gpm of Saturated Lime Water	35		Same as above.
Maximum Line Pressure Lime Water Feed Pumps must Pump Into	Psi	10		Pressure requirement based upon finished water storage tank dimensions and piping/equipment configuration.
Motor Size (Each)	HP	Less than 5		To be determined during final design.
Drive Type (Each)	Type	Variable Frequency Drive		
Additional Lime Slurry System Features				
The lime slurry system, specifically the lime water feed pumps, is designed to be controlled based on the flow rate (primary control variable) and trimmed on target alkalinity of the product water downstream (secondary control variable) using a PID feedback control loop.			✓	
The lime slurry system is designed to incorporate cleanouts and flushing connections at all lime slurry and/or lime sludge pipeline transition points.			✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
The lime slurry system is designed to utilize long radius elbows and fittings along the lime slurry and/or lime sludge pipelines.			✓	
The lime slurry system is designed to specifically eliminate vertical piping runs on all lime slurry and/or lime sludge pipelines.			✓	
The lime slurry system is designed to incorporate flexible hose and quick disconnect fittings on lime slurry and lime sludge pipelines to facilitate replacement/cleanout of pipelines.			✓	
The lime slurry system is designed to minimize aeration of lime solutions to prevent uptake of carbon dioxide and formation of calcium carbonate.			✓	
RDP Tekkem system is designed to allow future upgrading to quick lime.			✓	

Carbon dioxide and sodium hydroxide system requirements for this post-stabilization treatment process are identical to those presented in Section 11.2.1. As such, please refer to the carbon dioxide and sodium hydroxide system design criteria presented in Table 11-3 and 11-4, respectively.

11.1.3 Calcite Contactor (Option 2), Carbon Dioxide, and Sodium Hydroxide Systems

Table 11-6 summarizes the design criteria for the Calcite Contactor System.

Table 11-6. Calcite Contactor System Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Calcite Contactor System				
Basis of Flow				
Maximum flow	mgd	11.2		This capacity must be provided for post-stabilization treatment process to enable the Owner to produce a stable finished water product with all installed reverse osmosis units in operation. Providing a capacity of 9.6 mgd will limit the Owner’s calcium hardness and total alkalinity operating range when “catching up” to annual production goals.
Average flow	mgd	9.6	✓	Capacity which corresponds to desired annual average production rate of 10,671 afy.
Minimum flow	mgd	3.2	✓	Capacity which corresponds to reverse osmosis system minimum production rate of 3.2 mgd.
Calcium Carbonate Dose				
Application Point		Composite Reverse Osmosis Permeate as it Passes Through the Calcite Contactor System. Calcite Contactor System is Downstream of UV		

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Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
		Disinfection and Primary Carbon Dioxide Application Point and Upstream of Secondary Carbon Dioxide and Sodium Hydroxide Application Points.		
Maximum calcium carbonate dose	mg/L as $Ca(CO)_3$	100.0	✓	
Average calcium carbonate dose	mg/L as $Ca(CO)_3$	38.5		Based upon relevant CDM Smith experience (i.e. Santa Cruz finished water coupon testing) a minimum alkalinity of 30 mg/L as calcium carbonate was sufficient to prevent the occurrence of red water events. As such, the minimum water quality requirements identified in Table 11-1 were assumed to be appropriate for average operating conditions.
Minimum calcium carbonate dose	mg/L as $Ca(CO)_3$	38.5		A reduction of the minimum calcium carbonate dosage indicated in the RFP [40 mg/L as $Ca(CO)_3$] was required to allow the Owner to produce finished water with a calcium hardness of 40 mg/L as calcium carbonate. This reduction was necessitated by the presence of calcium in the reverse osmosis permeate.
Calcium Carbonate Consumption Rate				
Maximum flow-Maximum dose	lb/day as $Ca(CO)_3$	9,341		
Average flow-Average dose	lb/day as $Ca(CO)_3$	3,082		
Minimum flow-Minimum dose	lb/day as $Ca(CO)_3$	1,027		
Maximum flow-Average dose	lb/day as $Ca(CO)_3$	3,596		
Average flow-Maximum dose	lb/day as $Ca(CO)_3$	8,006		
Calcite Contactors				
Number of Calcite Contactors	Number	18 (17 Active and 1 Standby)		Two additional contactors (total of 20) will be required for 12.8 mgd operation.
Type of Contactor	Type	Upflow/Gravity		
Contactor Diameter	Ft	12		
Contactor Bed Depth	Ft	11.5		
Upflow Rate for N Units in Service at Maximum Flow Rate	Gpm/ft2	3.7		Upflow rate limited to 4.0 gpm/ft2 with N contactors in service in order to comply with turbidity requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
				identified in RFP.
Upflow Rate for N-1 Units in Service at Maximum Flow Rate	Gpm/ft2	4.0		Upflow rate limited to 4.5 gpm/ft2 with N-1 contactors in service in order to comply with turbidity requirements identified in RFP.
Empty Bed Contact Time for N Units in Service at Maximum Flow Rate	Minutes	22.1		
Empty Bed Contact Time for N-1 Units in Service at Maximum Flow Rate	Minutes	20.4	✓	
Calcite Replenishment Frequency at Maximum Flow-Average Dose Consumption Rate	Days	693		
Calcite Replenishment Frequency at Average Flow-Maximum Dose Consumption Rate	Days	311		
Turbidity	NTU	≤ 0.15 for 95% of the time and ≤ 0.5 at all times. Turbidity cannot exceed 0.25 NTU when limestone is being added to the calcite contactors.	✓	Each contactor includes a “contactor to waste” connection to allow the removal of fine particulates produced by the calcite replenishment process. This feature, in addition to the conservative upflow rates, will ensure compliance with turbidity requirements.
Number of standby calcite contactors		1 (minimum)	✓	Compliance with 20 minute minimum empty bed contact time requirement with N-1 contactors in service confirms compliance with standby contactor requirement.
Additional Calcite Contactors System Features				
To facilitate the dissolution of calcium carbonate in the calcite contactor process, carbon dioxide is added upstream of the contactors.			✓	
To provide the ability to adjust the pH of the finished water, sodium hydroxide and carbon dioxide is added downstream of the contactors.			✓	

Table 11-7 summarizes the design criteria for the Carbon Dioxide System.

Table 11-7. Carbon Dioxide System Basis of Design Standards and Requirements

Carbon Dioxide Storage and Feed System				
Basis of Flow				
Maximum flow	mgd	11.2		This capacity must be provided for post-stabilization treatment process to enable the Owner to produce a stable finished water product with all installed

Carbon Dioxide Storage and Feed System				
				reverse osmosis units in operation. Providing a capacity of 9.6 mgd will limit the Owner's calcium hardness and total alkalinity operating range when "catching up" to annual production goals.
Average flow	mgd	9.6	✓	Capacity which corresponds to desired annual average production rate of 10,671 afy.
Minimum flow	mgd	3.2	✓	Capacity which corresponds to reverse osmosis system minimum production rate of 3.2 mgd.
Carbon Dioxide Dose – Primary Application Point				
Primary Application Point		Composite Reverse Osmosis Permeate Downstream of UV Disinfection and Upstream of Calcite Contactor System	✓	
Maximum carbon dioxide dose – Primary Application Point	mg/L as CO_2	46.9		Dosage determined by water quality modeling. Model designed to dissolve 100 mg/L of calcium carbonate in the calcite contactor system.
Average carbon dioxide dose – Primary Application Point	mg/L as CO_2	16.4		Based upon relevant CDM Smith experience (i.e. Santa Cruz finished water coupon testing) a minimum alkalinity of 30 mg/L as calcium carbonate was sufficient to prevent the occurrence of red water events. As such, the minimum water quality requirements identified in Table 11-1 were assumed to be appropriate for average operating conditions.
Minimum carbon dioxide dose – Primary Application Point	mg/L as CO_2	16.4		Dosage determined by water quality modeling. Model designed to dissolve 38.5 mg/L of calcium carbonate in the calcite contactor system.
Carbon Dioxide Dose – Secondary Application Point				
Secondary Application Point		Composite Reverse Osmosis Permeate Downstream of the Calcite Contactor System	✓	
Maximum carbon dioxide dose – Secondary Application	mg/L as CO_2	4.3		Dosage determined by water quality modeling. Model designed to comply with all water quality requirements

Carbon Dioxide Storage and Feed System				
Point				identified in Table 11-1 at calcium hardness and total alkalinity contents of 100 mg/L as calcium carbonate each.
Average carbon dioxide dose – Secondary Application Point	mg/L as CO_2	0.1		Based upon relevant CDM Smith experience (i.e. Santa Cruz finished water coupon testing) a minimum alkalinity of 30 mg/L as calcium carbonate was sufficient to prevent the occurrence of red water events. As such, the minimum water quality requirements identified in Table 11-1 were assumed to be appropriate for average operating conditions.
Minimum carbon dioxide dose – Secondary Application Point	mg/L as CO_2	0.1		Dosage determined by water quality modeling. Model designed to comply with all water quality requirements identified in Table 11-1 at calcium hardness and total alkalinity contents of 40 mg/L as calcium carbonate each.
Carbon Dioxide Consumption Rate – Primary Application Point				
Maximum flow-Maximum dose	lb/hr as CO_2	182.5		
Average flow-Average dose	lb/hr as CO_2	54.7		
Minimum flow-Minimum dose	lb/hr as CO_2	18.2		
Maximum flow-Average dose	lb/hr as CO_2	63.8		
Average flow-Maximum dose	lb/hr as CO_2	156.5		
Carbon Dioxide Consumption Rate – Secondary Application Point				
Maximum flow-Maximum dose	lb/hr as CO_2	16.7		
Average flow-Average dose	lb/hr as CO_2	0.3		
Minimum flow-Minimum dose	lb/hr as CO_2	0.1		
Maximum flow-Average dose	lb/hr as CO_2	0.4		
Average flow-Maximum dose	lb/hr as CO_2	14.3		
Carbon Dioxide Consumption Rate – Total				
Maximum flow-	lb/hr as	199.3		

Carbon Dioxide Storage and Feed System				
Maximum dose	CO_2			
Average flow-Average dose	lb/hr as CO_2	55.0		
Minimum flow-Minimum dose	lb/hr as CO_2	18.3		
Maximum flow-Average dose	lb/hr as CO_2	64.2		
Average flow-Maximum dose	lb/hr as CO_2	170.8		
Bulk Storage Tank				
Number of Tanks	Number	1 (1 Active)	✓	
Capacity of Tank	Tons	77		Bulk storage tank sized to provide no less than 31 days of storage at maximum flow-average dose consumption rate or average flow-maximum dose consumption rate, whichever was larger.
Storage Time at Maximum flow-Average dose Consumption Rate	Days	100		
Storage Time at Average flow-Maximum dose Consumption Rate	Days	38	✓	
Materials of Construction		Steel Construction; Urethane Insulation; Aluminum Shell; Ancillary Systems (Refrigeration System, Vaporizer System, Vapor Heater System) located within Cabinet		
Refrigeration System				
Number of Refrigeration Units	Number	1 (1 Active)		
Vaporizer System				
Number of Vaporizer Units	Number	2 (1 Active and 1 Standby)	✓	
Capacity of Vaporizer Unit (Each)	Lb/hr as CO_2	219		Sized to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. Each vaporizer is sized to vaporize 110% of the maximum usage rate.
Vapor Heater System				
Number of Vapor Heater Units	Number	2 (1 Active and 1 Standby)	✓	
Capacity of Vapor Heater Unit (Each)	Lb/hr as CO_2	219		Sized to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. Each vapor

Carbon Dioxide Storage and Feed System				
				heater is sized to heat 110% of the maximum usage rate.
Pressure Solution Feed Panel – Primary Application Point				
Number of Pressure Solution Feed Panels	Number	1 (1 Active)		Single panel will include redundant control valves (one automatic and one manual)
Maximum Capacity	Lb/hr as CO_2	201		Sized to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. The pressure solution feed panel is sized to deliver 110% of the maximum usage rate.
Minimum Capacity	Lb/hr as CO_2	18		Same as above.
Pressure Solution Feed Panel – Secondary Application Point				
Number of Pressure Solution Feed Panels	Number	1 (1 Active)		Single panel will include redundant control valves (one automatic and one manual)
Maximum Capacity	Lb/hr as CO_2	18.5		Sized to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. The pressure solution feed panel is sized to deliver 110% of the maximum usage rate.
Minimum Capacity	Lb/hr as CO_2	0.1		Same as above.
Carrier Water Pumps				
Number of Carrier Water Pumps	Number	2 (1 Active and 1 Standby)		
Type of Carrier Water Pumps	Type	Centrifugal		
Maximum Carrier Water Pump Capacity (Each)	Gpm of Reverse Osmosis Permeate	219		Carrier water pump capacity dictated by maximum capacity of the pressure solution feed panel.
Minimum Discharge Pressure	Psi	65		Based on 55 psi for diffuser assembly and 10 psi for piping/system losses.
Materials of Construction		Stainless Steel		
Motor Size (Each)	HP	15		
Drive Type (Each)	Type	Constant Speed		
Additional Carbon Dioxide System Features				
The carbon dioxide system, specifically the carbon dioxide control valve inside the pressure solution feed panel, is designed to be controlled based on the flow rate (primary			✓	

Carbon Dioxide Storage and Feed System		
control variable) and trimmed on pH of the product water downstream (secondary control variable) using a PID feedback control loop.		
The post-stabilization process, including the physical location of all chemical application points and all control devices (i.e. pH instruments, alkalinity instruments, etc.) is designed such that all chemical reactions will be complete prior to measurement to ensure consistent, accurate, and reliable process control.	✓	

Table 11-8 summarizes the design criteria for the Sodium Hydroxide System. Please note, the information presented below only applies to the post-stabilization sodium hydroxide demands

Table 11-8. Sodium Hydroxide System Basis of Design Standards and Requirements

Sodium Hydroxide Storage and Feed System				
Basis of Flow				
Maximum flow	mgd	11.2		This capacity must be provided for post-stabilization treatment process to enable the Owner to produce a stable finished water product with all installed reverse osmosis units in operation. Providing a capacity of 9.6 mgd will limit the Owner's calcium hardness and total alkalinity operating range when "catching up" to annual production goals.
Average flow	mgd	9.6	✓	Capacity which corresponds to desired annual average production rate of 10,671 afy.
Minimum flow	mgd	3.2	✓	Capacity which corresponds to reverse osmosis system minimum production rate of 3.2 mgd.
Sodium Hydroxide Dose				
Application Point		Composite Reverse Osmosis Permeate Downstream of Calcite Contactor System	✓	
Maximum Sodium Hydroxide Dose	mg/L as NaOH	5	✓	

Sodium Hydroxide Storage and Feed System				
Average Sodium Hydroxide Dose	mg/L as NaOH	3	✓	
Minimum Sodium Hydroxide Dose	mg/L as NaOH	0.1		A reduction of the minimum sodium hydroxide dosage indicated in the RFP (2 mg/L as NaOH) was required to allow the Owner to produce finished water with calcium hardness and total alkalinity values of 40 mg/L as calcium carbonate while complying with the other finished water quality requirements identified in Table 11-1.
Sodium Hydroxide Consumption Rate				
Maximum flow-Maximum dose	gal/day as 50% NaOH	80		
Average flow-Average dose	gal/day as 50% NaOH	41		
Minimum flow-Minimum dose	gal/day as 50% NaOH	0.5		
Maximum flow-Average dose	gal/day as 50% NaOH	48		
Average flow-Maximum dose	gal/day as 50% NaOH	69		
Bulk Storage Tanks				
Number of Tanks	Number	1 (Active)	✓	
Capacity of Tank	Gallons	5,200	✓	
Storage Time at Maximum flow-Average dose Consumption Rate	Days	108		Presented storage time accounts for all process demands.
Storage Time at Average flow-Maximum dose Consumption Rate	Days	75	✓	Presented storage time accounts for all process demands.
Materials of Construction		Steel Construction	✓	

Sodium Hydroxide Storage and Feed System				
Metering Pumps				
Number of Metering Pumps	Number	2 (1 Active and 1 Standby)	✓	
Maximum Capacity	gal/hr as 50% NaOH	3.7		Sized to allow the Owner to operate within the full range of production rates and calcium hardness/total alkalinity values required by the RFP. Each metering pump is sized to deliver 110% of the maximum usage rate.
Minimum Capacity	gal/hr as 50% NaOH	0.02		Same as above.
Maximum Line Pressure Sodium Hydroxide Metering Pumps must Pump Into	Psi	10		Pressure requirement based upon finished water storage tank dimensions and piping/equipment configuration.
Additional Sodium Hydroxide System Features				
The sodium hydroxide system, specifically the sodium hydroxide metering pumps, is designed to be controlled based on a PID feedback control loop using pH as the control variable.			✓	
The post-stabilization process, including the physical location of all chemical application points and all control devices (i.e. pH instruments, alkalinity instruments, etc.) is designed such that all chemical reactions will be complete prior to measurement to ensure consistent, accurate, and reliable process control.			✓	

12.0 DISINFECTION REQUIREMENTS

Disinfection requirements must be set prior to construction and startup of the treatment facilities. These requirements will be dictated by CDPH, based on provisions in the Surface Water Treatment Rule (SWTR), the Long Term 2 Enhanced Surface Water Treatment Rule (LT2), and state specific regulations. While in theory it could be possible to obtain a groundwater classification for the wells, it is assumed that any beach well design will be classified as under the direct influence of surface water, based on discussions CDM Smith has had with CDPH in regards to the Dana Point slant well project. Current regulations therefore require that a Watershed Sanitary Survey and a Source Water Assessment be conducted in order to classify the wells as non-impaired, impaired, or highly impaired, and to designate the *Cryptosporidium* bin classification. The level of disinfection required will depend on the final classification of the source water.

12.1 Source Water Characterization

In the absence of a watershed sanitary survey and source water assessment, it has been assumed that the disinfection requirements would be similar to that of the Sand City Water Treatment Plant. While the (2010) CDPH permit for the Sand City Water Treatment Plant set a precedent for how CDPH views disinfection requirements for seawater desalination, the drinking water regulations have changed since this permit was issued, and the LT2 requirements are now in place. These new requirements dictate that additional removal for Cryptosporidium may be required beyond what was provided for Sand City.

Table 12-1 summarizes CDPH's disinfection requirements for the Sand City Water Treatment Plant, as identified in the RFP. It should be noted that in discussions with CDPH staff in Monterey, it was confirmed that Sand City was not designated a Bin 2 classification for LT2, as the LT2 was not in place at the time of permitting and no subsequent classifications have been issued for the facility. The Cryptosporidium reduction requirements (4-log) are identical to Bin 2 requirements, but were based on the previous rules in place at the time of permitting. Table 12-2 summarizes the disinfection credits the CDPH permit for the Sand City Water Treatment Plant provides.

Table 12-1. Sand City Water Treatment Plant Disinfection Requirements Identified in RFP

Disinfection type	Units	Design Criteria	Per RFP	Notes/Assumptions
LT2 Rule Bin Classification		2	✓	CDPH has clarified that Sand City did not have an LT2 bin classification
Cryptosporidium Treatment	log	4	✓	
Giardia Treatment	log	5	✓	
Virus Treatment	log	6	✓	

Table 12-2 Disinfection Credits per the Sand City Water Treatment Plant CDPH Permit

Credit type	Units	Credits			Per RFP	Notes/Assumptions
		Giardia	Crypto	Virus		
RO membranes	log	2	2	2	✓	With continuous demonstration of log reduction of conductivity and correlation of data with TDS
UV Disinfection	log	3	3	0	✓	Based on maximum allowable credit for UV unit validated under German DVGW standards (40 mJ/cm^2 dose)
Free chlorine	log	0	0	4	✓	Provided minimum CT requirements are met

12.2 UV Disinfection

CAW submitted a source water characterization plan to CDPH in June 2013 with the goal of eliminating the need for UV disinfection. Based on the outcome of discussions with CDPH and future testing results, it may be possible to avoid constructing the UV disinfection facilities, with the pathogen reduction requirements reduced to 4-log virus, 3-log Giardia, and 2-log Cryptosporidium. For the purposes of this BODR, it is assumed that UV disinfection will be included. Refer to the design criteria provided in the subsection 13 - UV Disinfection.

12.3 Disinfection Design Criteria

Table 12-3 summarizes the proposed disinfection design criteria. Note that the credits for UV are higher than required in the RFP in order to comply with new requirements of the LT2 not in place at the time that the Sand City plant was permitted. These higher dose requirements will limit which UV systems can be employed, as many UV systems have not been validated using USEPA guidelines to receive more than 3-log inactivation credits for *Giardia and Cryptosporidium*.

Table 12-3 Disinfection Basis of Design Standards and Requirements

Parameter	Units	RO	UV	Chlorine	Total	Per RFP	Note/Assumptions
		Design Criteria					
Cryptosporidium	log	2	4	0	6	✓	Complies with LT2 Bin 4
Giardia	Log	2	4	1	7	✓	
Virus	log	2	0	4	6	✓	

13.0 UV DISINFECTION

CAW submitted a source water characterization plan to CDPH in June 2013 with the goal of eliminating the need for UV disinfection. For purposes of this BODR, it is assumed that UV disinfection will be included in the design. Tables 13-1 and 13-2 summarize the UV disinfection design criteria and drawings are provided in Section 3.D.

KEY REFERENCE DRAWINGS:
M-9 UV SYSTEM PLAN AND SECTIONS
I-35 P&ID UV SYSTEM

Table 13-1. UV Disinfection Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Giardia/Cryptosporidium Inactivation	log	4 each	✓	RFP requires 2-log
Maximum Flow	mgd	11.2 (at least)	✓	
Process Location		Downstream of RO membranes; upstream of post-stabilization	✓	
Number of Reactors		N+1	✓	
UV Lamp Technology		Medium pressure high output (MPHO) lamps	✓	
Minimum UV Dose	mJ/cm^2	22		
Supplier		Trojan or Calgon		
Model		UVSwift 2L12 or Sentinel 12		
Diameter	inch	12		
Number of units		3		
Lamps per unit		2		
Total lamp power	kW	6 (Trojan) or 8 (Calgon)		
Power supply	VAC	480		
Other Parameters				
Design in accordance with the USEPA UV Design Guidance Manual (2006).			✓	
Validation of UV reactor performance reactors must have been previously validated off-site in accordance with USEPA requirements identified in the UV Design Guidance Manual (2006). CFD analysis is not a substitute for validation.			✓	DVGW certification, while allowed by USEPA, is not sufficient for 4-log credits

Table 13-2. Additional UV Disinfection Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP
Cooling requirements	30°C max water temperature 18 gpm minimum flow	
Mass of mercury in one lamp	200 mg	
Mass of mercury in one reactor	400 mg	
Mass of mercury in all reactors	1200 mg	
Startup and shutdown requirements	5 min warm up, 2 min cool down Max 600 on/off cycles in 5,000 hour lifetime	
Intensity sensor verification and calibration methods	DVGW-certified UV Intensity sensor (one per lamp)	
Minimum UVT	95% transmittance	✓
Submergence	UV lamps shall be inherently submerged at all times by the location within the hydraulic gradeline	✓
Power Supply	UPS to provide 10 minutes of ride through upon power failure for UV reactors, controls, and instrumentation. The UPS is provided with a remote maintenance by-pass switch to allow isolation of the unit for servicing and testing. UPS status will be monitored through SCADA	✓
Flow Distribution and Measurement	Each UV reactor is paired with a magnetic flow meter to document flow through UV reactor	✓
UV Dose Control Strategy	Control strategy minimizes power consumption through monitoring of UV transmittance and flow rate	✓
UV Transmittance Monitoring	An on-line UV transmittance monitor is provided with appropriate sample delivery/conditioning system	✓
Automated Start-up and Shutdown Sequence	Is in accordance with CDPH requirements as well as UV supplier requirements. Provides a “bumpless” sequence that allows for the spare UV unit to be brought on-line and an on-line unit to be taken out of service. Automatic plant shutdown, in a controlled fashion, occurs if the UV reactor(s) fails to achieve any UV performance standards for more than 15 (fifteen) consecutive minutes.	✓
Housing for UV reactors, associated electrical supply equipment, and instrumentation	Inside a building protected from the weather	✓
Spare Parts	Two years’ worth of spare parts are provided including: UV lamps, UV sensors, quartz sleeves, seals, ballasts, and fuses	✓
Service Contract provided by vendor following Acceptance	24 months	✓
Number of service visits	12	✓
Service visit trip reports submitted to CAW following each visit	Will identify “as found” conditions, work performed, and “as left” conditions. Will also include recommendations for improved operation and maintenance.	✓
Service technician services	Calibration, repair/replacement, and instruction to CAW staff.	✓

14.0 FINISHED WATER STORAGE

Finished Water storage is an important plant asset and serves multiple functions. Table 14-1 provides the design criteria for the Finished Water Storage and drawings are provided in Section 3.D.

KEY REFERENCE DRAWINGS:
M-16 FINISHED WATER STORGE TANKS PLAN
M-17 FINISHED WATER STORGE TANKS SECTIONS
I-37 P&ID TREATED WATER TANKS

Table 14-1. Finished Water Storage Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Disinfection – Giardia inactivation	log	1	✓	
Rate of flow	mgd	9.6	✓	
Free chlorine residual	mg/L	1.2	✓	
pH		8.0	✓	
Baffling factor		0.5	✓	
Temperature	°C	10	✓	
CT compliance	-	Based on the highest flow, minimum clearwell/tank level, lowest chlorine residual, lowest temperature, and highest pH value recorded for each day	✓	
Number of Tanks	-	2	✓	
Volume	gallons	750,000 (each)	✓	
Operation	-	Tanks operate in series	✓	
Operation with One Tank Out of Service	-	Tanks must be taken out of service for inspection, cleaning, and maintenance. When operating with only one tank in service, operational adjustments may be required to provide reliable disinfection, including increasing chlorine residual, decreasing flow, and operating within a more narrow level band.	✓	
Tank Type (Above Ground)	-	Steel (AWWA D100 Standard for Welded Steel Tanks for Water Storage)	✓	
Level Controls	-	Continuous level and independent high level switch for alarm in each tank	✓	
Drain	-	Energy dissipation and infiltration.	✓	
Access	-	At least two points of secure access to each tank	✓	
Overflow	-	Provide overflow at maximum capacity. Provide overflow secure from tampering.	✓	
Vents	-	Appropriately sized for inlet/outlet flows, screened, highly corrosion resistant, and	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
		secure against tampering.		

15.0 SALINAS VALLEY DESALINATED WATER RETURN PUMPING AND CONVEYANCE

A portion of the desalinated product water will be conveyed to the Salinas Valley groundwater basin via the Castroville Seawater Improvement Project (CSIP). The Finished Water is to be pumped from the Finished Water storage tanks through a proposed 1.2-mile¬long, 12-inch-diameter Salinas Valley return pipeline to the existing CSIP pond at the southern end of the MRWPCA regional wastewater treatment plant. The CSIP pond has a storage capacity of 80 acre-feet. From the CSIP pond, water is to be delivered to agricultural users in the Salinas Valley through existing infrastructure. Drawings are provided in Section3.D and Table 15-1 summarizes the design criteria for the pumping and conveyance required within the fence line of the CAW facility.

KEY REFERENCE DRAWINGS:

M-2 PLAN - FILTERED WATER, BACKWASH WATER, CARTIDGE FILTER AND FINISHED WATER PUMP PAD AND TREATED WATER PUMP – 9.6 mgd

M-3 SECTIONS - FILTERED WATER, BACKWASH WATER, CARTIDGE FILTER AND FINISHED WATER PUMP PAD AND TREATED WATER PUMP – 9.6 mgd

I-39 P&ID SALINAS VALLEY PUMP STATION

Table 15-1. Salinas Valley Desalinated Water Return Pumping and Conveyance Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Number of Pumps	-	2	✓	
Size of Pumps	mgd	1.2 (each)	✓	
Head	feet	30 (or less)	✓	
Type of Pumps	-	End suction pump	✓	
Capacity Control	-	variable frequency drives for variable speed operation	✓	
Housing	-	Pump may be located outdoors. Electrical equipment shall be located in secure building located near the pumps	✓	
Flow Metering	-	one flow meter with input to SCADA	✓	
Water Quality Monitoring	-	analyzers for conductivity	✓	
Appurtenances	-	Valves, check valves, electrically actuated shutoff butterfly valve to isolate pump from finished water storage upon pump shutdown, air gap at discharge to eliminate backflow concerns.	✓	

16.0 FINISHED WATER PUMPING AND PRESSURE TRANSIENT CONTROL

Four Finished Water pumps provide a minimum capacity of 9.6 mgd with the largest capacity unit out of service. The BODR covers Finished Water piping within the Project Site boundary. Table 16-1 summarizes the design criteria and drawings are provided in Section 3.D.

KEY REFERENCE DRAWINGS:

M-2 PLAN - FILTERED WATER, BACKWASH WATER, CARTIDGE FILTER AND FINISHED WATER PUMP PAD AND TREATED WATER PUMP – 9.6 mgd

M-3 SECTIONS - FILTERED WATER, BACKWASH WATER, CARTIDGE FILTER AND FINISHED WATER PUMP PAD AND TREATED WATER PUMP – 9.6 mgd

I-38 P&ID TREATED WATER PUMP STATION

Table 16-1. Finished Water Pumping and Pressure Transient Control Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Pumping				
Number of Pressure Gradients Served	-	1	✓	
Gradient Served	-	Monterey	✓	
Distribution System Hydraulic Grade Line at Project Site (Maximum)	feet	425	✓	
Number of Pumps	-	4	✓	
Housing	-	Pumps may be located outdoors. Electrical gear is to be housed in a secure building located near the pumps.	✓	
Pump Capacity	mgd	2 pumps at 4.8 each (50% rated capacity) 2 pumps at 2.4 each (25% rated capacity) Pump rating shall be at the maximum head anticipated. Sufficient electrical capacity is provided to allow any three pumps (including two largest pumps) to operate concurrently.	✓	
Type of Pump (finished water	-	Horizontal split case centrifugal	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
storage above ground)				
Pump Starters and Controls	-	4.8 mgd pumps – constant speed with soft-starters. 2.4 mgd pumps – adjustable frequency drives.	✓	
Finished Water Flow Meters	-	Flow meter on each of 2.4 mgd pumps. One common flow meter.	✓	
Pump Control Valve	-	Each pump has a rubber seated ball valve with hydraulic (water) actuator to provide two speed closure, sized for up to 14 fps full open velocity. A manually operated butterfly type isolation valve is provided downstream of pump control valve.	✓	
Hydraulic Transient Control				
Number of hydro-pneumatic tank(s)	-	1	✓	
Size of hydro-pneumatic tank(s)	gallons	25,000	✓	
Appurtenances	-	Including access manhole, drain, pressure release valve, lifting lugs, and other appurtenances as recommended by the manufacturer.	✓	
Design for Maintenance				
A concrete slab and unobstructed access to pump and pump motor with mobile A-frame gantry is provided. One A-frame gantry and manual chain fall rated for largest pump and			✓	

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Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
pump motor is provided.				
Appurtenances				
Design includes all necessary appurtenances including air release valves, pressure gages and motor controls and protection devices.			✓	

Hydraulic Transient Control Evaluation

An evaluation of hydraulic transient conditions will be performed and will identify recommended control devices at the treatment plant and along transmission pipeline. The normal slow closure time and emergency fast close time for the pump control valve will be identified in the hydraulic transient study.

17.0 YARD PIPING AND VALVES

Yard piping and valves is defined as piping and valves outside of structures. Table 17-1 provides the design criteria for the yard piping and valves.

KEY REFERENCE DRAWINGS:

C-4 YARD PIPING ULITMATE CONDITIONS 9.6 MGD BASE CASE

Table 17-1. Yard Piping and Valves Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Avoidance of electrical equipment		No yard piping is allowed within 25 feet of primary electrical service transformers or switchgear.	✓	
Finished Water				
Pipe material		Ductile iron pipe (Class 52), steel, or HDPE.	✓	
Valves less than 12 inch pipe size		resilient seated gate valves	✓	
Valves 12 inches and larger		butterfly type	✓	
Valve open direction		Left	✓	
Valve box and lid		A concrete collar shall be poured at the top of the valve box. A stainless steel valve identification tag shall be embedded in the concrete collar listing the Valve ID, type of valve, and number of turns.	✓	
Permeate (prior to stabilization)				
Pipe material (below grade)		HDPE pipe	✓	
Pipe material (above grade)		FRP	✓	
Valves less than 12 inch pipe size		resilient seated gate valves	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Valves 12 inches and larger		butterfly type	✓	
Valve open direction		Left	✓	
Raw/Saline water				
Pipe material (Below ground, less than 100 psi)		HDPE	✓	
CIP waste				
Pipe material		CPVC	✓	
Chemicals				
Liquid chemicals location		Underground	✓	
Liquid chemical pipeline material		flexible PVC tubing, compatible with the specific chemical	✓	
Liquid chemical carrier pipe material		HDPE	✓	
Carrier pipeline chemical tubing limit		One length	✓	
Carrier pipeline encasement		Concrete	✓	

18.0 PROCESS PIPING AND VALVES

This section summarizes the design criteria related to process piping, generally defined as the piping within structures. All piping and valves are NSF 61 listed.

KEY REFERENCE MATERIAL:

VALVE SCHEDULE PROVIDED AS TABLES ATTACHED TO BODR DUE NUMBER OF VALVES LISTED

18.1 Pipeline Schedule

The piping schedule including materials of construction, sizing, pressure rating, and methods of restraint is shown in Table 18-1 below.

Table 18-1 Pipeline Schedule

Duty	Structure	Below Grade/ Buried	Joints	Pressure Rating	Above Grade	Joints	Pressure Rating
Saline Water (<100 psi)	Raw Water, Concentrate	HDPE	Heat fusion	100 psi	FRP	Flanged, glued	100 psi
Saline Water (>200 psi)	RO High Pressure Pump Discharge	n/a			Superduplex	Flanged, welded, grooved	1000 psi
Permeate	RO Building Post Treatment slab	HDPE	Heat fusion	100 psi	FRP	Welded Flanged Grooved	100 psi
RO Flush	RO Building Post Treatment	HDPE	Heat Fusion	100 psi	PVC	Welded Flanged Grooved	100 psi

	slab						
Permeate Following Stabilization	Post treatment Stabilization	DIP	Push-on joints and flanged	150 psi	DIP	Flanged (above ground)	150 psi
Finished	Filtered Water Tank	DIP	Flanged	150 psi	DIP	Flanged	150 psi

18.2 Valve Schedule

The valve schedule includes description, location, type, size, quantity, materials of construction, pressure rating, type of actuation, manufacturer is attached.

18.3 Chemical Piping

Table 18-2 provides a summary of the chemical piping design criteria.

Table 18-2 Chemical Piping Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Pipe type for above-ground pipe		CPVC above ground (generally)	✓	PVC for parts of SHC generator system piping
Pipe type for buried pipe		PVC tubing inside HDPE containment pipe	✓	
Valve type		Tru-union type ball valves	✓	Ball valves for sodium hypochlorite system will be vented type.
Valve type at bulk storage tanks for isolation		Butterfly valves close coupled	✓	

19.0 GENERAL PUMPING EQUIPMENT REQUIREMENTS

This section provides general guidelines on desired pump station design, construction, and operation features. This section does not address chemical pumping. Pumping information described below will be expanded in the BODR as the design progresses.

19.1 Pumping Station Design

Hydraulic design information such as system head curves, pump operating curves, net positive suction head ("NPSH"), hydraulic calculations, transient analysis and surge control, and other pertinent information is to be presented in the BODR as the design progresses. All pumping station designs currently include the considerations presented in Table 19-1.

Table 19-1 General Pumping Station Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Flow Velocities				

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Suction velocity	fps	5	✓	
Discharge velocity at pump discharge nozzle	fps	14	✓	
Typical piping velocities at ultimate plant capacity	fps	9	✓	
Other Parameters				
Pumping design follows Hydraulic Institute standards.			✓	
Pump design and selection, including valve design and selection, is to consider life-cycle costs.			✓	
Pump layout must consider space for maintenance and removal of pump, motor, valves and instrumentation.			✓	
Emergency stop pushbuttons are provided (locally) at each pump.			✓	
Materials of selection/construction are suitable for production of potable water and prevent dezincification.			✓	
Rated capacity is achievable with the largest unit out of service.			✓	
Variable speed drives are used/applied only where energy savings are real or process conditions require variable capacity.			✓	
Pumps systems that require a suction lift are provided with automatic priming systems.			✓	See brine pond pumps..
Mechanical seals are provided			✓	

19.2 Piping and Pipe Joints

All piping and pipe joint designs in relation to pumping stations currently include the considerations presented in Table 19-2. Pipe materials are specified in the piping schedule listed in section18-1 of the BODR. Pipeline materials are also specified for each listed process.

Table 19-2 General Pumping Station Piping and Pipe Joint Basis of Design Standards and Requirements

Parameter / Design Criteria	Per RFP	Notes/Assumptions
Pipe materials are suitable for fluid and pressure conditions.	✓	
Pipe joints shall allow disassembly for pump repair and replacement, and future piping modifications	✓	
Piping and valves are supported independently of the pump	✓	
Fittings for differential settlement are provided where differential settlement is a concern	✓	

19.3 Vibration Control

Table 19-3 lists the considerations that have been implemented to minimize vibration and resonance in the design.

Table 19-3 General Pumping Station Vibration Control Basis of Design Standards and Requirements

Parameter / Design Criteria	Per RFP	Notes/Assumptions
Suction and discharge piping are properly designed	✓	
Pumps selected operate within a stable range to prevent cavitation	✓	
Mounting pedestals, floors or inertial blocks are of sufficient mass	✓	

Parameter / Design Criteria	Per RFP	Notes/Assumptions
(typically five times greater than the mass of the pump)		
Level installation of the pump base and anchor bolts will be required and dynamically balanced pumps will be provided	✓	
Vibration amplitude that is no more than 75% of the limits set by Hydraulic Institute standards has been specified	✓	
Unit responsibility and a single manufacturer for all pump components has been specified.	✓	

19.4 Pump Characteristic and System Head Curves

System head curves and pump performance curves for minimum flow, maximum flow, and expected average flow conditions are provided including assumptions for pipe roughness, curves for efficiency, NPSH and BHP. The following has been carefully reviewed and confirmed:

- The pump characteristic curve is not "flat" where a small change in total dynamic head results in a large change in pump flow.
- The operating point on the system curve, for prevailing operating conditions is near the maximum efficiency point (optimally just to the right of this point) of the pump characteristic curve. The maximum efficiency point is also known as the best efficiency point.
- The pumps can operate, even with compromised efficiency, for both minimum and maximum operating conditions.
- The pump/impeller combination is located near the center of the pump operating curve to allow modifying the pump with a different impeller to change pump performance. The maximum diameter impeller shall not be selected for a pump housing unless no other alternative is possible.

Table 19-5 shows the calculation of the NPSH available (NPSHA) for maximum flow and maximum temperature operating conditions (pumps operating alone, and together). The NPSHA is compared to the NPSHR of the selected pumps at maximum flow conditions. As shown, the NPSHR is less than the NPSHA under all conditions with a reasonable margin of safety, not less than 6 feet. There are no process flows with significant entrained air that impact the NPSHR.

Table 19-5 NPSH Calculations

Structure/Pump	Maximum Flow	Maximum Temperature	NPSHA	NPSHR
Filtered Water Pumps	15 mgd	20C	30 ft	10
First Pass Seawater RO Feed pumps	2 mgd	20C	82	50
ERD Booster Pump	2 mgd	20C	500 psi	20
Second Pass Brackish Water RO feed water pump	1.5 mgd	20C	30 ft	20
Finished Water Pumps	6 mgd	20C	40 ft	20
Pressure Filter Backwash Pumps	14 mgd	20C	30	20

20.0 ROTATING EQUIPMENT MONITORING

Pumps and motors that are 200 hp or above will be equipped with temperature and vibration data collection systems as described in Table 20-1.

Table 20-1. Rotating Equipment Monitoring Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Manufacturer		Ludeca	✓	
Model		Vibnode	✓	
Dynamic Range		96dB 16 bit A/D converter	✓	
Frequency Range	Hz	2-1000	✓	
Frequency Resolution	lines	3200	✓	
RPM Tracking			✓	
Measurement Functions		Fast Fourier Transform (FFT), Time signal, High frequency envelope FFT, overall values, narrow and broadband alarms, process parameters	✓	
Band Analysis	bands per spectrum	12	✓	
High Frequency Enveloping		Band pass filters for low, medium and high speed machines	✓	
Digital Output		for external trigger	✓	
Analog Output	ma	4-20	✓	
Digital Input	volt	5-30	✓	
Ethernet Capable				
License:		Provide licenses for each processor as needed	✓	
Power supply		15 minute UPS on power supply to multichannel processor and monitoring devices	✓	
Analysis Software		1. Provide OMNITREND software by Ludeca 2. Band Analysis capable 3. Narrowband and broadband alarm capable 4. Real time overall values 5. Email alarm capable 6. Built in reporting features 7. Web based for remote access 8. Built in Fault Frequency Markers	✓	
Local Personal Computer for display of overall vibration levels and alarm notifications		1. Processor: 4G RAM; 2.5 GHz 2. USB and Ethernet ports 3. 24 inch monitor	✓	
Tachometer		Inductive type; vendor to be Ludeca. Device shall be suitable for outdoor installation.	✓	
Cabling		Cables from sensors to multi-	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
		channel monitor shall be of the type and length with connectors needed for each application. Cables shall be provided by CTC. Cables shall be installed in conduit where physical protection is needed.		
Device Driver		Provide the device driver for the Project Site		
On-site Commissioning		A minimum of 2 days of on-site startup service will be provided with the Ludeca application engineer	✓	
Accelerometers				
Vendor to be CTC. Coordinate accelerometer installation with pump vendor. Install accelerometers per California American Water's recommendations. Device shall be suitable for outdoor installation.			✓	
Vertical pumping systems		5 measured points each	✓	
Single stage horizontal split case pumps		10 measured points each	✓	
Accelerometer Mounting				
1. Remove paint and mount transducer on flat metal surface. Stud mount preferred. Epoxy mounted pads to be used where stud mounting is not possible. 2. Mount on bearing housing in location with best available direct path to bearing and shaft vibration. 3. Two accelerometers shall be mounted at two perpendicular planes on each bearing housing. One accelerometer per machine shaft mounted parallel to the axis of rotation.			✓	
Other Parameters				
Motor windings, motor bearings, and pump bearing temperatures are to be continuously monitored through 100 ohm platinum RTD's and input to Schweitzer Engineering Laboratories ("SEL") devices provided for power monitoring and motor protection. Values are to be available for trending and monitoring through the California American Water Business Network			✓	
Vibration data is gathered and made available for off-site analysis through the internet			✓	
Online vibration data collection system is provided based on multichannel continuous processor. Processors are located in a suitably protected area. Enclosures suitably rated for the environment in which they are installed are provided.			✓	

21.0 CHEMICAL SYSTEMS

KEY REFERENCE DRAWINGS:
M-8 CHEMCIAL SYSTEMS PALN AND SECTIONS 9.6 MGD BASE CASE
I-23 P&ID SODIUM BISULFITE FEED SYSTEM
I-24 P&ID ANTISCALANT FEED SYSTEM
I-25 P&ID ORTHOPHOSPHATE FEED SYSTEM
I-26 P&ID SODIUM HYDROXIDE FEED SYSTEM
I-28 P&ID NON-IONIC POLYMER FEED SYSTEM
I-29 P&ID SULFURIC ACID FEED SYSTEM
I-30 P&ID SODIUM HYPOCHLORITE BRINE TANKS
I-31 P&ID SODIUM HYPOCHLORITE GENERATOR 1
I-32 P&ID SODIUM HYPOCHLORITE GENERATOR 2
I-33 P&ID SODIUM HYPOCHLORITE GENERATOR 3
I-34 P&ID SODIUM HYPOCHLORITE METERING PUMPS FEED SYSTEM

Chemicals addressed in this section are listed below. Tabulation of chemical dosages and storage volumes included in Attachment 10 are assumed to be reasonable due to the limited amount of water quality information available. Sodium hypochlorite doses need to be verified using chlorine demand test when a test well is available.

1. Sodium Hypochlorite (liquid) for pre-oxidation and disinfection by chlorination
2. Sodium Bisulfite (liquid) for quenching chlorine residual in RO feed water
3. Sulfuric Acid (liquid) for pH adjustment of RO feed water
4. Threshold Inhibitor (liquid) to inhibit scale formation in RO membranes
5. Non-Ionic Polymer (dry or emulsion) for settling of granular media wastewater
6. Sodium Hydroxide (liquid) for pH adjustment
7. Phosphoric Acid (liquid) for corrosion control

Lime, calcite, and carbon dioxide requirements are addressed in Section 11 Post-Stabilization. Clean-in-place chemicals are addressed in Section 9.6.10 Clean-In-Place System.

General design criteria for chemical systems are provided in Table 21-1 and drawings are provided in Section 3.D.

Table 21-1. Chemical System Basis of Design Standards and Requirements

Parameter / Design Criteria	Per RFP	Notes/Assumptions
Design of liquid chemical systems shall comply with the intent of American Water Engineering Standard T2 to contain leaks and spills, prevent unintentional overfeed, and provide prudent process control. 1. 2. Secondary containment of the liquid chemical delivery area is to be provided to capture leakage from delivery trucks. Containment volume shall be 125% of a full bulk delivery.	✓	Flow meters will be added to each chemical feed line to prevent overfeeding of chemicals.
HDXLPE chemical tanks are supplied by Poly Processing.	✓	
Tanks are NSF 61 listed.	✓	
A 5 year warranty on sodium hypochlorite tanks is provided	✓	
Diaphragm metering pumps are accurate, reliable, heavy duty, and motor driven.	✓	
Solenoid type metering pumps are acceptable for intermittent use but not for continuous duty.	✓	No solenoid metering pumps will be used for

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Parameter / Design Criteria	Per RFP	Notes/Assumptions
		continuous duty
For critical applications, non-lost motion type pumps are provided to minimize pulsing and provide continuous feed.	✓	
Provide insulation and heat tracing for chemical feed piping where freezing is possible	✓	Insulation and heat tracing are provided for sodium bisulfite system and sodium hydroxide system.

21.1 Layout

Chemical storage and feed systems will be located within the SWRO Chemical Building at the north end, in the following order from Northwest to Northeast: Sodium hypochlorite, Caustic Soda, Sodium Bisulfite, Antiscalant, Polymer, Orthophosphate, and Sulfuric Acid. The sodium hypochlorite generation system will be located in a room separate from the sodium hypochlorite storage and feed systems, at the far Northwest corner of the SWRO Chemical Building. Since sodium hydroxide and sodium bisulfite are compatible chemicals, the two systems will be located in the same room but in separate secondary containment areas. Since sodium hydroxide is also compatible with sodium hypochlorite, it will be located between sodium hypochlorite and sodium bisulfite systems, which are incompatible. Threshold inhibitor and orthophosphate systems will be located in the same room separated by the polymer system. The three chemical systems will each have separate secondary containment. Sulfuric acid system, which is a strong acid, will be located at the far Northeast corner of the building in a separate room and secondary containment.

21.2 Sodium Hypochlorite

Table 21-2 provides the design criteria for the sodium hypochlorite chemical system.

Table 21-2. Sodium Hypochlorite Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Product		Liquid form	✓	
Concentration	percent	0.8 to 12.5	✓	
Specific gravity		1.00 to 1.22	✓	
Application Points		1. Raw Water 2. Spent Filter Backwash Storage 3. Post Treatment	✓	
Chlorine equivalent dose				
Dose (min, avg, max) – Raw Water	mg/L	0.5, 2, 3	✓	Doses to be verified through chlorine demand test when test well becomes available.
Dose (min, avg, max) – Spent Filter Backwash Storage	mg/L	0.5, 1, 1.5	✓	
Dose (min, avg, max) – Post Treatment	mg/L	1, 1.5, 2	✓	
Onsite Generation				

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Number of Units		Three 500 ppd units 1,500 ppd total	✓	
Equipment sizing sufficient for necessary dosage	ppm	3 (Raw Water) 2 (Finished Water)	✓	
Power supply		Sufficient power supply to allow operation of three units concurrently	✓	
Delivery and Storage		High quality salt shall be delivered in bulk, transferred pneumatically, and stored in dissolvers to create a brine supply to the generation equipment	✓	
Generator type		Onsite generator using electrolytic equipment	✓	
Generator location		Room separate from hypochlorite storage and feeders	✓	
Redundant hydrogen in air monitors		in generation and hypochlorite storage rooms	✓	
Service Contract provided by Onsite sodium hypochlorite vendor following Acceptance	years	1 (plus one additional year of operation)	✓	
Number of service visits by qualified technicians scheduled upon request of CAW		6	✓	
On-site service visit duration per visit	hours	6	✓	
Service technician services		Preventive maintenance, testing, cleaning, repairs, and instruction to staff	✓	
Service visit trip reports submitted to CAW following each visit within 7 days of visit		Describe the work performed and the “as-left” condition as well as the “as-found” condition	✓	
Brine System				
Number of salt dissolvers		2	✓	
Salt dissolver usable capacity	tons	23 (each)	✓	
Salt dissolver location		Outdoors; provide secondary containment curbing to capture leaks.	✓	
Supply water to brinemakers and to generators		Low hardness reverse osmosis permeate	✓	
Online conductivity meter		Reads in percent NaCl, to monitor the brine concentration in the feed to the generators	✓	

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Storage Tanks				
Number of dilute sodium hypochlorite storage tanks		2	✓	
Dilute sodium hypochlorite storage tanks size	Gallons	6,500	✓	
Sodium hypochlorite storage tank type		High density cross linked polyethylene HDXLPE type with a fixed medium density linear polyethylene lining	✓	
HDXLPE Tank outlet		IMFO type for complete drainage	✓	
HDXLPE Tank supplier		Poly Processing	✓	
Secondary containment		Concrete located within a secure building. A means must be provided to readily replace storage tanks with either a roof hatch or removable wall section.	✓	
Feed Pumps				
Dilute hypochlorite solution feed to application point		By use of sealless magnetic drive gear pumps with variable speed capacity control	✓	
Number of units for Raw Water dosing		2 (one duty, one spare)	✓	
Number of units for post-treatment dosing		2 (one duty, one spare)	✓	
Feed Control		Control modes shall be local manual, remote manual, remote flow pace, and remote compound loop with chlorine residual	✓	
Other Parameters				
Provide capability to receive bulk sodium hypochlorite (12.5%) in both tanks should the generators not be operating. Provide a manual adjustable dilution panel to continuously dilute bulk hypochlorite to 0.8 percent for storage in the second storage tank.			✓	

21.3 Sodium Bisulfite

Table 21-3 provides the design criteria for the sodium bisulfite chemical system.

Table 21-3. Sodium Bisulfite Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Product		Liquid form	✓	
Concentration	percent	38	✓	
Specific gravity		1.33	✓	
Application Points		1. GMF discharge 2. Concentrate Discharge	✓	

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Dose				
Dose (min, avg, max) – GMF Discharge	mg/L	1.5, 3, 6	✓	Based on assumed raw water chlorine dose. Doses to be adjusted based on field verification of chlorine doses
Dose (min, avg, max) – Concentrate Discharge	mg/L	TBD	✓	
Bulk Storage				
Bulk Storage Tanks, Number Required		1	✓	
Bulk delivery Volume	gallons	4,000	✓	
Bulk storage tank size	gallons	6,000 (1.5 x bulk delivery volume minimum)	✓	
Bulk Tank Material		HDXLPE	✓	
Bulk Tank Nozzles		Fill, outlet, vent, overflow, level sensor (ultrasonic), high level switch	✓	
Bulk Tank Outlet Valves		Butterfly with lever actuator; electric actuator on ball valve	✓	
Metering Pumps				
Number of pumps required per application point		2	✓	
Type of Pump		Diaphragm metering pumps	✓	
Anticipated Discharge Pressure	psi	< 30	✓	
Piping				
Bulk Tank to Metering Pump		CPVC	✓	
Discharge of Metering Pump		CPVC above ground	✓	
Below Ground Piping		Reinforced flexible PVC tubing inside secondary HDPE containment pipe	✓	
Continuous Dilution Water (post metering pump)				
Dilution water from UV disinfected permeate water supply	gpm	0.5-2.0	✓	UV product water will be pumped from RO Permeate Flush Tank.
Other Parameters				
Provide ORP sensor following bisulfite feed to provide feedback that dechlorination has occurred to prevent membrane oxidation.			✓	
Provide tank heater and insulation to maintain minimum temperature of 65 deg F to prevent crystallization of chemical. Heat trace above grade piping to prevent crystallization of chemical.				

21.4 Sulfuric Acid

Table 21-4 provides the design criteria for the sulfuric acid chemical system.

Table 21-4. Sulfuric Acid Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Product		Liquid form	✓	
Concentration	percent	50	✓	
Specific gravity		1.4	✓	
Application Points		1. GMF filtered water	✓	
Dose (min, avg, max)	mg/L	5, 10, 30	✓	
Bulk Storage				
Bulk Storage Tanks, Number Required		1	✓	
Bulk delivery Volume	gallons	3,800	✓	
Bulk storage tank size	gallons	10,000 (1.5 x bulk delivery volume minimum)	✓	
Bulk Tank Material		XLHDPE	✓	
Bulk Tank Nozzles		Fill, outlet, vent, overflow, level sensor (ultrasonic), high level switch	✓	
Bulk Tank Outlet Valves		Butterfly with lever actuator; electric actuator on ball valve	✓	
Metering Pumps				
Number of pumps required per application point		2	✓	
Type of Pump		Diaphragm metering pumps	✓	
Anticipated Discharge Pressure	psi	< 30	✓	
Piping				
Bulk Tank to Metering Pump		CPVC	✓	
Discharge of Metering Pump		CPVC above ground	✓	
Below Ground Piping		Reinforced flexible PVC tubing inside secondary HDPE containment pipe	✓	
Continuous Dilution Water (post metering pump)				
Dilution water	gpm	0.5-2.0	✓	

21.5 Threshold Inhibitor

Table 21-5 provides the design criteria for the threshold inhibitor chemical system.

Table 21-5. Threshold Inhibitor Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Product		Liquid form	✓	
Concentration	percent	100	✓	
Specific gravity		1.25	✓	
Application Points		1. Inlet to First Pass RO 2. Inlet to Second Pass RO	✓	
Dose (min, avg, max) – First Pass RO	mg/L	2, 3, 6	✓	

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Dose (min, avg, max) – Second Pass RO	mg/L	2, 3, 6	✓	
Bulk Storage				
Bulk Storage Tanks, Number Required		1	✓	
Bulk delivery Volume	gallons	4,200	✓	
Bulk storage tank size	gallons	6,300 (1.5 x bulk delivery volume minimum)	✓	
Bulk Tank Material		HDXLPE	✓	
Bulk Tank Nozzles		Fill, outlet, vent, overflow, level sensor (ultrasonic), high level switch	✓	
Bulk Tank Outlet Valves		Butterfly with lever actuator; electric actuator on ball valve	✓	
Metering Pumps				
Number of pumps required per application point		2	✓	
Type of Pump		Diaphragm metering pumps	✓	
Anticipated Discharge Pressure	psi	< 30	✓	
Piping				
Bulk Tank to Metering Pump		CPVC	✓	
Discharge of Metering Pump		CPVC above ground	✓	
Below Ground Piping		Reinforced flexible PVC tubing inside secondary HDPE containment pipe	✓	
Continuous Dilution Water (post metering pump)				
Dilution water	gpm	0.5-2.0	✓	

21.6 Non-Ionic Polymer

Table 21-6 provides the design criteria for the non-ionic polymer chemical system.

Table 21-6. Non-Ionic Polymer Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Product		Liquid (emulsion) form	✓	
Concentration	percent	35	✓	
Specific gravity		1.1	✓	
Application Points		1. GMF wastewater clarification	✓	
Dose (min, avg, max)	mg/L	0.2, 0.2, 0.8	✓	
Storage				
Pails (within secondary containment)	gallons	5	✓	
Batch tank and feed tank (over under configuration)				
Batches		Prepare manually	✓	
Transfer to feed tank		Gravity	✓	
Metering Pumps				

CDM Smith

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Number of pumps required per application point		2	✓	
Type of Pump		Peristaltic tubing pump	✓	
Anticipated Discharge Pressure	psi	< 30	✓	
Piping				
Bulk Tank to Metering Pump		CPVC	✓	
Discharge of Metering Pump		CPVC above ground	✓	
Below Ground Piping		Reinforced flexible PVC tubing inside secondary HDPE containment pipe	✓	
Continuous Dilution Water (post metering pump)				
Dilution water	gpm	0.5-2.0	✓	

21.7 Sodium Hydroxide

Table 21-7 provides the design criteria for the sodium hydroxide chemical system.

Table 21-7. Sodium Hydroxide Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Product		Liquid form	✓	
Concentration	percent	50	✓	
Specific gravity		1.4	✓	
Application Points		1. RO Second Pass 2. Finished Water for stabilization	✓	
Dose (min, avg, max) – RO Second Pass	mg/L	5, 10, 20	✓	
Dose (min, avg, max) – Finished Water	mg/L	2, 3, 5	✓	
Bulk Storage				
Bulk Storage Tanks, Number Required		1	✓	
Bulk delivery Volume	gallons	3,500	✓	
Bulk storage tank size	gallons	5,200 (1.5 x bulk delivery volume minimum)	✓	
Bulk Tank Material		Steel	✓	
Bulk Tank Nozzles		Fill, outlet, vent, overflow, level sensor (ultrasonic), high level switch	✓	
Bulk Tank Outlet Valves		Butterfly with lever actuator; electric actuator on ball valve	✓	
Metering Pumps				
Number of pumps required per application point		2	✓	
Type of Pump		Diaphragm metering pumps	✓	

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Anticipated Discharge Pressure	psi	< 30	✓	
Piping				
Bulk Tank to Metering Pump		CPVC	✓	
Discharge of Metering Pump		CPVC above ground	✓	
Below Ground Piping		Reinforced flexible PVC tubing inside secondary HDPE containment pipe	✓	
Continuous Dilution Water (post metering pump)				
Dilution water from UV disinfected permeate (low hardness) water supply	gpm	0.5-2.0	✓	
Other Parameters				
Provide low power density (external) heating of tanks; provide insulation jacket to maintain temperature of not less than 80 deg F in tanks. Pipe insulation is not required.			✓	

21.8 Zinc Orthophosphate/Phosphoric Acid Corrosion Inhibitor

Table 21-8 provides the design criteria for the Zinc Orthophosphate/Phosphoric Acid Corrosion Inhibitor chemical system.

Table 21-8. Zinc Orthophosphate/Phosphoric Acid Corrosion Inhibitor Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Product		Liquid form; zinc orthophosphate	✓	
Concentration		5:1 ratio of PO4 to Zn; Future conversion to phosphoric acid	✓	
Specific gravity of Zinc Orthophosphate		1.4	✓	
Zinc Orthophosphate Percent Phosphate	percent	32.5	✓	
Specific Gravity of Phosphoric Acid (75%)		1.57	✓	
Dose (as PO4 (min, avg, max))	mg/L	0.5, 1.0, 4.0	✓	
Bulk Storage				
Bulk Storage Tanks, Number Required		1	✓	
Bulk delivery Volume (zinc orthophosphate)	gallons	3,700	✓	
Bulk storage tank size	gallons	5,500 (1.5 x bulk delivery volume minimum)	✓	
Bulk Tank Material		HDXLPE	✓	

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Bulk Tank Nozzles		Fill, outlet, vent, overflow, level sensor (ultrasonic), high level switch	✓	
Bulk Tank Outlet Valves		Butterfly with lever actuator; electric actuator on ball valve	✓	
Metering Pumps				
Number of pumps required per application point		2	✓	
Type of Pump		Solenoid driven diaphragm pumps	✓	
Anticipated Discharge Pressure	psi	< 30	✓	
Piping				
Bulk Tank to Metering Pump		CPVC	✓	
Discharge of Metering Pump		CPVC above ground	✓	
Below Ground Piping		Reinforced flexible PVC tubing inside secondary HDPE containment pipe	✓	
Continuous Dilution Water (post metering pump)				
Dilution water	gpm	0.5-2.0	✓	

22.0 ARCHITECTURE

The architectural design has been developed in character, style, form, color and materials to harmonize effectively with the surrounding environment. The design also takes into consideration the conceptual design of site layout, building arrangement, building features, landscaping, and xeriscaping prepared by the College of Architecture and Environmental Design of California Polytechnic State University. Table 22-1 summarizes the overall architectural considerations for the project and drawings are provided in Section D.

KEY REFERENCE DRAWINGS:
A-1 CODE PLANS
A-2 NOT INCLUDED IN SET
A-3 ELEVATIONS
A-4 ELEVATIONS
A-5 ADMINISTRATION BUILDING PLAN
A-6 SECTIONS
A-7 FINISH SCHEDULES
A-8 RENDERINGS

Table 22-1. General Architectural Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP	Notes/Assumptions
Height of Structures	The Design-Build Improvements should be kept as low in profile as is functionally possible. Where appropriate, the design shall de-emphasize verticality and encourage the grounding of planar elements of the Design-Build Improvements into the natural landscape. Low, horizontal site walls, berming, and the use of sloping wall planes shall be considered in achieving balance.	✓	The buildings are single story and each program is no higher than the function of each program requires. We have used native plants and planted hedgerows to integrate the facility into the site and have provided a river viewing area for visitors and staff.
Reflective	Visible and highly reflective materials and	✓	Although metal, Zincalume is not

Parameter	Design Criteria	Per RFP	Notes/Assumptions
Exterior Finishes	surface finishes shall be avoided on the exterior of the Design-Build Improvements.		highly reflective. The design uses natural features, such as wood trellises, to soften the reflective nature of the façade in the garden area.
Exterior Walls	The use of low maintenance material, surface textures and horizontal banding of harmonious colors are some of the techniques to be considered in blending the Design-Build Improvements with its environment. Material coloration should be achieved through the use of integral coloration rather than applied coloration such as paint.	✓	Zincalume is specified for all façade treatments. It is a highly durable and corrosion resistant material. Where possible, material coloration will be achieved through integral coloration rather than applied coloration.
Roofs	The design of roof systems shall be carefully developed to harmonize with the visual context of the Design-Build Improvements. Where flat roofs are appropriate, they shall be predominately hidden by parapet walls. Where pitched roofs are desired, consideration shall be given to selecting, pitch, materials, and coloration to harmonize with surroundings. Highly reflective roof materials shall not be visible from adjacent properties. Mansard and jogging roof lines shall be employed only when appropriate to the setting. The use of securable skylights for natural lighting is encouraged where feasible.	✓	Flat pitched roofs are appropriate for this site because it is not in a residential area. Skylights daylight the circulation spaces in the administration building.
Windows	Where windows are appropriate to the design, they shall be selected carefully for energy efficiency, acoustic characteristics, and security. Glazing systems are designed to avoid light leakage to adjacent as direct glare or reflected glare from sunlight. Glass tinting and window frame colors shall be chosen for their consistency with the palette of materials and colors selected for the Design-Build	✓	Energy efficient tinted windows have been used in the project, and the Trellis in the garden area reduces the reflective nature of the windows while visually connecting the interior space to the garden.
Exterior Insets, Grills, Trim and Accents	Insets, grills, trim material, and accents shall be employed judiciously and only where necessary or appropriate for compatibility with adjacent structures. Insets, grills, trim, and accents shall be consistent with the color palette chosen for the facility and shall avoid bold, strong, or reflective colors.	✓	We have placed grills, trim material and accents carefully and only where necessary. The color of all trim material is complementary to the color of the other elements.
Exterior Doors and Frames	Door and frame colors shall be compatible with the wall surface in which they are located	✓	Door and frame elements are compatible with all trim and cladding elements
Exterior Lighting	Lighting shall satisfy functional and security needs while not creating light pollution in the form of point sources of direct glare visible from a distance. Lighting shall be sensitive to	✓	Lighting design satisfies all functional and security needs while avoiding light pollution Lighting is sensitive to the privacy of adjacent land uses.

Parameter	Design Criteria	Per RFP	Notes/Assumptions
	the privacy of adjacent land uses. Fixtures shall be carefully selected for efficiency, cutoff, consistent lamp coloration throughout the project, and effectiveness in delivering only the light necessary to the task, while avoiding unnecessary spill lighting beyond site boundaries. Low level light fixtures that light immediate areas are encouraged.		Fixtures have been carefully selected for efficiency, cutoff, consistent lamp coloration throughout the project, and effectiveness in delivering only the light necessary to the task, while avoiding unnecessary spill lighting beyond site boundaries. Low level light fixtures that light immediate areas have been used throughout the design.
Natural Lighting	Natural lighting of building interiors in the form of skylights and clerestory windows is encouraged	✓	The administration building utilizes skylights and high windows to facilitate natural lighting.
Equipment and Service Areas	All mechanical and electrical equipment should be located and screened from public view	✓	We have screened all mechanical and electrical equipment from public view.
Materials of Construction	Construction materials and methods are established and defined in terms of their physical appearance and overall visual effect in harmonizing with the surrounding environment, their emergence from the basic structural system, and their appropriateness in accommodating the deployment of mechanical and electrical systems within the facility. Materials used in the construction of the Design-Build Improvements shall conform in composition and application to all applicable regulations, including those concerning volatile organic content, lead, mercury, CFCs and asbestos. Materials used for the roofing system and the building perimeter envelope shall be established for optimum durability over the full range of climatic variations typical to the region.	✓	We have used materials that harmonize with the colors and textures of the local environment and meet California Building Code. The occupied area consists of a 25,400 SF desalination plant and a 5,900 SF associated office building. Both buildings to be equipped with Automatic Sprinkler systems. The Desalination Building will be a mix of H4 and F2 occupancies. The office building will be B occupancy. Both buildings require type 5B construction with fire rated walls between occupancies. Both buildings will be pre-engineered steel frame construction. (Questions: should we shoot for a LEED certification or equivalent?)

22.1 Anticipated Structures

Table 22-2 provides additional architectural design criteria for the facility structures.

Table 22-2. Facility Structure Architectural Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Administration Facilities				
Included areas in structure		Visitor reception area, control room, laboratory, offices, locker rooms, restrooms, and maintenance area.	✓	
Number of Levels		Single level	✓	
Location		Adjacent to RO Systems	✓	
Applicable Laws		Compliance with all Applicable Law, including the Americans with Disabilities Act.	✓	
Security		Areas available to public tours and visitors are separated from secure process areas	✓	
Administration Facilities – Visitor Reception / Exhibits				
Public access and viewing of exhibits related to water supply, treatment, distribution and conservation	sf	600	✓	
Number of restrooms for visitors		2 (one male, one female)	✓	
Visitor restroom features		Sink, mirror, toilet, and waste receptacle	✓	
Offices				
Number of Plant Manager Offices		1	✓	
Size of Plant Manager Office	sf	150	✓	
Plant Manager Office features		Small conference table with four chairs; four drawer file cabinets for records	✓	
Number of Operation and/or Maintenance Supervisor offices		2	✓	
Size of Operation and/or Maintenance Supervisor offices	sf	120 (each)	✓	
Security		Offices are secured	✓	
Cubicles for Clerks				
Number of cubicles		2	✓	
Size of cubicles	sf	50	✓	
Restrooms and Locker Rooms				
Staff locker room and restrooms		Separate from visitor/public restrooms	✓	
Type of lockers in locker rooms		metal	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Size of lockers in locker rooms	inch	12 (width) / 6 (height)	✓	
Number of lockers in male locker room		10	✓	
Number of lockers in female locker room		5	✓	
Features in male locker room		bench; double sink and countertop; two urinals, one toilet; shower	✓	
Features in female locker room		bench, double sink and countertop; two toilets; shower	✓	
Finishes		Tile floor	✓	
Conference Room				
Size		Suitable for 12 people	✓	
Features		Ceiling mounted computer projector and electric coiled project screen	✓	
Break Room				
Sized		Suitable for 12 seated people	✓	
Features		kitchenette with sink, microwave oven, and 25 cf refrigerator/freezer	✓	
Countertop and cabinetry	lf	8	✓	
Flat screen monitor/television for training	inch	46	✓	
Laboratory and Storage Room				
Size	sf	200	✓	
Countertop and Casework Size	lf	25	✓	
Casework type		Metal	✓	
Storage room	sf	125	✓	
Features		Safety eyewash and shower, dishwasher, sample sink, sanitary sink (with hot/cold water)	✓	
Wastewater from sample sink		Recycled to plant inlet	✓	
Sanitary sink discharge		Sanitary sewer following acid neutralization tank	✓	
Deionized Water supply		Replaceable tank system	✓	
Furniture		Desk for computer use and four filing drawers	✓	
Laboratory testing equipment, supplies, and glassware		To be supplied by CAW	✓	
Maintenance Shop				
Size	sf	240	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Workbench	lf	i20	✓	
Vehicle access		Overhead door	✓	
Compressed air supply compressor	hp	5	✓	
Compressed air supply receiver	gallon	80	✓	
Equipment and Tool Storage				
Size: equipment storage room	sf	80	✓	
Size: large equipment/tools area	sf	150	✓	
Security: equipment storage room		Locked	✓	
Security: large equipment/tools area		Locked fenced area	✓	
Control Room				
Size	sf	300; Suitable for two persons working concurrently	✓	
Location		Adjacent to laboratory	✓	
Public access		Viewing panels to allow views of the RO units and control room	✓	
Security		Secured	✓	
Secured Telecom Room				
Size	sf	150	✓	
Security		Secured	✓	
Janitorial Room				
Size	sf	40	✓	
Features		water supply and sink, storage for mop bucket, mops, brooms, buffer, and maintenance supplies	✓	
File and Drawing Room				
Size	sf	125	✓	
Filing drawer type		Flat file	✓	
Filing drawer size	inch	24 x 36	✓	
Features		water supply and sink, storage for mop bucket, mops, brooms, buffer, and maintenance supplies	✓	
Copier, printer area in coordination with Clerk Area				
Area size		Open area that fits copier, printer, and associated office machines	✓	
Worktable	feet	5	✓	
RO Building				
Materials of construction		Braced Steel Frame	✓	
Electrical equipment		Located in separate room	✓	
RO piping location		Trenches	✓	
Equipment removal and		Overhead door	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
replacement				
Center hallway size		Adequately sized for a forklift and scissors lift	✓	
Chemical Rooms in RO Building				
Chemical separation		Generally, each chemical is located in a separate room	✓	
Commonly located chemicals (non-hazardous)		Polymers and scale inhibitors	✓	
Lighting/HVAC		Provided in each room	✓	
Secondary containment		Floors are depressed in each chemical room relative to the central hallway	✓	
Chemical equipment location		Chemical equipment (tanks, metering pumps, etc.) are located on the lower level	✓	
Stairs		Provided for access from central hallway to lower level of each room	✓	
UV Disinfection Room in RO Building				
Secure building		Houses UV reactors, flow meters, and associated valves and piping	✓	
Electrical equipment location		Room separate from UV piping	✓	
Filter Building				
Materials of construction for walls		Zincalume metal panels	✓	
Materials of construction for floors		Concrete	✓	
Electrical Buildings				
Indoor electrical equipment		motor starters (greater than 10 hp), motor control centers, and switchgear	✓	
Lighting / ventilation / security		Exhaust fans	✓	
Access		Generous to meet arc flash space requirements	✓	

23.0 GEOTECHNICAL AND STRUCTURAL DESIGN

The design of all facilities shall conform to the codes, standards, and references listed in Table 23-1. Additionally, the design of tank, equipment and nonstructural component anchorage shall conform to the standards and references listed in Table 23-2. In case of conflicting requirements, the requirements most applicable to the work will be used. Additional references and standards will also be used if needed for specific design components. The proposed soil boring locations drawing is provided in Section 3.D.

KEY REFERENCE DRAWINGS:

C-3 PROPOSED SOIL BORING LOCATIONS

Table 23-1 Governing Codes and Standards for Structures

Governing Codes and Standards for Structures
California Building Code (CBC) – 2013 (based upon the International Building Code 2012)
ASCE/SEI 7-10 Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers
ACI 318-11 Building Code Requirements for Structural Concrete, American Concrete Institute
ACI 350-06 Code Requirements for Environmental Engineering Concrete Structures, American Concrete Institute
ACI 350.3-06 Seismic Design of Liquid-Containing Concrete Structures, American Concrete Institute
CRSI Design Handbook, 2008, 10th Edition, Concrete Reinforcing Steel Institute
AISC 341-10 Seismic Provisions for Structural Steel Buildings, American Institute of Steel Construction
AISC 360-10, Specification for Structural Steel Buildings, American Institute of Steel Construction
AWS D1.1-08 Structural Welding Code – Steel, American Welding Society
AWWA D100-05 Welded Carbon Steel Tanks for Water Storage, American Water Works Association
AWWA D103-09 Factory-Coated Bolted Carbon Steel Tanks for Water Storage, American Water Works Association
AASHTO Standards – 2011 Standard Specifications for Transportation Materials and Methods of Sampling and Testing, American Association of State Highway and Transportation Officials

Table 23-2 Additional Standards for Tank, Equipment and Nonstructural Component Anchorage

Additional Standards for Tank, Equipment and Nonstructural Component Anchorage
ACI 355.2-07 Qualification of Post-Installed Mechanical Anchors in Concrete & Commentary
ACI 355.4-11 Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary
ICC AC308 Post-installed Adhesive Anchors in Concrete Elements—Approved June 2013
ICC AC193 Mechanical Anchors in Concrete Elements—Approved June 2012, Editorially Revised May 2013

23.1 Design Loads

Structures are designed for loads on the completed structures as listed below. During construction, structures will be supported by bracing or shoring wherever excessive loads may occur.

Table 23-3 Risk Categories

Facility	Risk Category	Per RFP	Notes/Assumptions
Finished water storage tank and related equipment	IV	✓	Addendum No. 3
All other structures	III	✓	Addendum No. 3

23.1.1 Dead Loads

Dead loads consist of the self-weight of the structure and all equipment of a permanent or semi-permanent nature, including but not limited to: HVAC equipment and ductwork, and electrical wiring and lighting.

23.1.2 Live Loads

Uniform live loads need not be applied in addition to equipment loads to floor areas permanently covered with equipment. Equipment room floors are designed for the greater of uniform live loads or actual equipment loads.

Table 23-4 Uniform and Concentrated Live Loads(1)

Use or Occupancy	Uniform Load, psf	Concentrated Load, lb	Per RFP	Notes/Assumptions
Roofs	20	–	✓	
Office Areas	50	–	✓	
Stairways	100	300(2)	✓	
Personnel Assembly Areas, Lobbies and Exits	100	–	✓	
Building Mechanical Equipment Areas	100	–(3)	✓	
Other Equipment Areas	250	–(3)	✓	

(1) Live loads may be reduced as allowed by the CBC

(2) Apply concentrated load to stair tread only

(3) Refer to equipment manufacturer's drawings for concentrated load

23.1.3 Wind Loads

Wind loads are determined in accordance with the CBC and ASCE 7.

Table 23-5 Wind Load Criteria

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Basic Wind Speed, 3 sec gust V_{3S}	mph	115	✓	V_{3S} is substituted for V in ASCE 7 eq 27.3-1
Exposure Category		C	✓	
Importance Factor, I_w		1.15	✓	

23.1.4 Seismic Loads

Seismic loads are determined in accordance with the CBC and ASCE 7.

Table 23-6 Seismic Load Criteria

Seismic Design Parameter	Short Period	Long Period	Per RFP	Notes/Assumptions
Mapped Spectral Acceleration	S_s = 1.58	S_1 = 0.56	✓	Per draft geotechnical report
Site Coefficients	F_a = 1.0	F_v=1.5	✓	Per draft geotechnical report
Maximum Considered Earthquake Acceleration	S_{MS} = 1.58	S_{M1}= 0.84	✓	Per draft geotechnical report
Design Acceleration	S_{DS}=1.06	S_{D1}=0.56	✓	Per draft geotechnical report
Site Class	D		✓	Per draft geotechnical report
Seismic Design Category	D			ASCE 7-10
Importance Factor for Finished Water clearwells, tanks, and pumping systems	I_e = 1.5 I_p = 1.5		✓	Risk Category IV per Addendum No. 3
Importance Factor for all other structures	I_e = 1.25 I_p = 1.0		✓	Risk Category III per Addendum No. 3

23.1.4 Soil Loads

Soil loads will be determined in accordance with the recommendations provided in the final geotechnical report (which to be developed during the final design phase). Structures are preliminarily designed with the following soil parameters. .

Table 23-7 Soil loads

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Active pressure – level backfill	pcf	40	✓	Per draft geotechnical report
Active pressure – 3H:1V backfill	pcf	50	✓	Per draft geotechnical report
At-rest pressure – level backfill	pcf	55	✓	Per draft geotechnical report
At-rest pressure– 3H:1V backfill	pcf	70	✓	Per draft geotechnical report
Allowable bearing pressure	psf	2,000	✓	Per draft geotechnical report for dead plus live loads

23.2 Geotechnical investigation

Geotechnical investigation will be performed during the final design phase to obtain all soil parameters needed for design. The plan for the geotechnical investigation is provided in Section 3.0 B – Scope of Geotechnical Investigation. The plan identifies the number of soil borings and describes the associated laboratory testing program. The planned soil borings locations can be found in the 9.6 mgd and 6.4 mgd drawings sets as C-3 PROPOSED SOIL BORING LOCATIONS in Section 3.D.

23.3 Seismic design

Seismic performance of the facilities and associated equipment will be designed in accordance with the criteria presented in Table 23-7.

Table 23-8 Seismic Performance Expectations

Item	Level of Damage at Seismic Shaking Hazard Level			Per RFP	Notes/Assumptions
	Low	Moderate	High		
Structures	No Significant Damage	Repairable Damage; No Evacuation	Repairable Damage; Evacuation	✓	For pricing purposes, the design uses code-based seismic loads. Final design shall address performance based design.
Nonstructural Components	No Significant Damage	Repairable Damage; No Evacuation	Repairable Damage; Evacuation	✓	Equipment required to remain operable following the design earthquake ground motion shall be certified as such by the equipment manufacturer per ASCE 7-10 Section 13.2.
Time to Reoccupy and Restart Facility / Function Continuance (Structural/Nonstructural)	Immediate	Up to 2 weeks	Up to 2 months	✓	For pricing purposes, the design uses code-based seismic loads. Final design shall address performance based design.
Spectral Acceleration (Short period or 0.2 sec)	<0.167 g	≥ 0.167 g and < 0.50 g	≥ 0.5 g	✓	
Spectral Acceleration (long period or 1.0 sec)	< 0.067 g	≥ 0.067 g and < 0.20g	≥ 0.2 g	✓	

23.4 Materials

Table 23-7 provides design criteria for building construction materials.

Table 23-9 Structure Materials Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Concrete				
Compressive strength (f'_c) for concrete exposed to salt water	psi	5,000		
Compressive strength (f'_c) for all other concrete	psi	4,000		
Reinforcing steel yield strength (f_y)	ksi	60		ASTM A615 Grade 60 Or ASTM A706 Grade 60
Waterstops - water containment		PVC		
Waterstops - chemical containment		TPV		
Masonry				
Masonry compressive strength (f'_m)	psi	1,500		ASTM C90, Type 1, medium weight concrete masonry units, open-end, laid in

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
				running bond, solid-grouted and reinforced
Reinforcing steel yield strength (f_y)	ksi	60		ASTM A615 Grade 60
Steel				
Structural W shapes yield strength: (F_y)	ksi	50		ASTM A992
Other structural shapes and plates yield strength: (F_y)	ksi	36		ASTM A36
Hollow structural sections yield strength: (F_y)	ksi	46		ASTM A500, Grade B
High strength bolt tensile strength	ksi	120 for dia ≤ 1.0 in 105 for dia > 1.0 in		ASTM A325, 3/4-in dia min
Cast-in place anchor tensile strength	ksi	58-80		ASTM F1554, 5/8-in dia min
Welding filler metal strength	ksi	70		AWS D1.1

23.6 Special Inspection

Special inspection shall be conducted per Chapter 17 of the CBC. Qualified personnel from an independent agency shall perform inspections and prepare inspection reports. The items identified in Table 23-9, as a minimum, shall receive special inspection:

Table 23-10 Special Inspection

Special Inspection Element	Per Code
Steel construction	CBC section 1705.2
Concrete construction	CBC section 1705.3
Masonry construction	CBC section 1705.4
Soils	CBC section 1705.6
Wind resistance	CBC section 1705.10
Seismic resistance	CBC section 1705.11

24.0 HVAC SYSTEM

The HVAC systems design is based on site and process specific conditions. Outdoor design conditions for the Administration Building are based on ASHRAE 99.6% for heating and 0.4% for cooling, which is customary for this type of building. For locations relying on 100% OA for ventilation on a continuous basis, specifically the Electrical Chemical Storage Areas, the historical winter extreme lows and highs were used, based on published Monterey County Site Data. For the Electrical Room and process areas, ventilation-only cooling is provided in accordance with the RFP.

Temperature Design Conditions				
Building	**Outdoor Heating (°F)**	**Outdoor Cooling (°F)**	**Indoor Heating (°F)**	**Indoor Cooling (°F)**
Administration	36.7	77.3	70	75
RO Process	20.0[3]	77.3	50[1]	10 deg above ambient[2]
Filter	20.0[3]	77.3	N/A[4]	10 deg above ambient[2]

Notes:

1. This can be achieved without installation of Unit Heaters. There is sufficient heat rejection from the process to offset the winter heating load; R.O Building will be insulated to Title 24 standards for climate zone.
2. Ventilation only cooling relies on the ambient outside air temperature to displace the warmer indoor air. Sufficient ventilation air will be introduced to allow indoor average temperature up to a maximum temperature of 10 deg F above ambient.
3. Lowest temperature on record, Dec 22, 1990 per multiple sources.
4. Area will not be heated. Freeze-sensitive components will be heat traced. Filter building will be insulated to Title 24 standards for climate zone.

24.1 Governing Codes and Standards

The HVAC system will be designed as required by the design codes and standards shown in Table 24-1.

Table 24-1 Governing Codes and Standards

Governing Codes and Standards
2013 California Mechanical Code based on the 2012 Uniform Mechanical Code of the International Association of Plumbing and Mechanical Officials (IAPMO)
2013 California Energy Code
CALGreen 2010: CBC Title 24, Part II, Mandatory Measures
American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Standards 90.1-2010 for Energy Conservation
American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Standards 62-2013 for Ventilation of buildings
NFPA Standard 90A - Installation of Air-Conditioning and Ventilation Systems
UL: Underwriters Laboratories, Inc.
U.S. Green Building Council LEED-NC Reference Guide 2.2
Sheet Metal and Air Conditioning Contractors National Association (SMACNA). Standards
Air Moving and Conditioning Association (AMCA)
National Environmental Balancing Bureau (NEBB)

24.2 Energy Efficiency and Sustainable Design Considerations

In addition to Building Envelop and Lighting high efficiency design and use of high efficiency motors throughout the site, Building HVAC systems will meet or exceed the energy efficiency standards as stipulated by the Local, State and Federal Standards. The governing codes and standards indicated in Table 24-1 relating to energy efficiency shall apply.

In section 24.3, Table 24-3, many of the efficiencies stipulated by Title 24 have not only been met, but have been exceeded. Refer to High Efficiency Heat Pumps, High Efficiency Condensing Boilers below.

In addition to keeping with the High Energy Efficiency design practice, sustainable design considerations are being utilized by not installing Unit Heaters which would otherwise expend additional fossil-fuel based heating resources and instead relying on the waste heat being generated by the motors and drives to heat the building to acceptable temperature levels for this generally mild area.

By determining that the installation of the Unit Heaters, associated piping, insulation, supports, wiring, conduit and controls, a significant impact to sustainable design is being implemented through not only a capital cost avoidance, but also the avoidance of the construction of these new materials and the energy to produce, install and operate these components.

24.3 HVAC System Design

Table 24-2 provides the design criteria for the HVAC system.

Table 24-3. HVAC System Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
General				
Ventilation definition		Outdoor air brought into a building to maintain the space temperature, control moisture, replace exhaust air, protect building components, and remove indoor pollutants	✓	
Ventilation noise		Non-objectionable levels	✓	
Ductwork material		Non-corrosive area: Galvanized Steel Corrosive Area: Fiberglass Resin Polymer (FRP)		Galvanized steel will be used for all areas except for the Chemical Storage Areas, where ductwork will be FRP.
Equipment location		Located where it can be readily and safely maintained	✓	
Installation/Support		Coordinated with other disciplines, including seismic design	✓	
Administration				
Control for temperature and humidity		A/C and heat	✓	The Maintenance Shop will only have ventilation and heating.
Thermostat		1 in each room for local control	✓	File Room on Office #3 thermostat. Male and Female toilets on the Break Room thermostat.
High efficiency split system heat pump. EER = 14.7 & 15.1.		CA Building Energy Efficiency Standards: Min. EER = 11.0	✓	Units exceed (are more efficient than) minimum EER required Ref: HVAC

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Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
				Equipment
Split system air handler with air-side economizer.		CA Building Energy Efficiency Standards: Economizer required.	✓	Ref: HVAC Equipment
VAV system with reheat.		AC & Heat to control temperature and humidity.	✓	
High efficiency condensing boiler . AFUE = 95%.		CA Building Energy Efficiency Standards: Min. AFUE = 82%	✓	Ref: HVAC Equipment Condensing Boiler exceeds minimum required AFUE.
Constant minimum fresh air supply to system.		Ventilation for exhaust air make-up and removal of pollutants.	✓	Ref: HVAC Sequence of Operation.
Equipment/Systems selected for max. NC of 30.		Limit noise to non-objectionable levels.	✓	Ref: HVAC Equipment Cuts
Galvanized Steel Ductwork		Appropriate ductwork materials.	✓	Ref: Admin. Bldg. HVAC Duct Plan.
Equipment, Ductwork and Piping to be supported and braced.		HVAC Systems coordinated for seismic design.	✓	
Electrical Rooms				
Control temperature to within electrical manufacturer limits		Air ventilation system	✓	
Identify ventilation and temperature control design criteria		Staged, multiple, single speed exhaust fan operation with Room thermostat control.	✓	Capacity of ventilation-only cooling: limit average temperature rise to within 10 deg F above ambient temperature. See explanation of indoor design temperatures above.
Rooms with Large Pumping Units and Heat Rejection				
Makeup air ventilation system size		Multiple, single speed fan operation with local thermostat control.		Capacity is based on a 10 deg F differential above ambient
Freeze protection		Provide heating, if required to maintain space temperature above freezing.	✓	Heating to prevent freeze protection determined as not being required. Heat rejection from equipment exceeds/meets the

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
				heating load for winter conditions. See room design criteria above.
Identify design criteria		Maintain between minimum and maximum temperatures.		Heating load is offset by heat rejection from equipment. Cooling load is met by ventilation exhaust.
Chemical Storage and Feed Rooms				
Ventilation duration		Year round	✓	
Ventilation type		Low rate continuous	✓	
High rate ventilation triggers		1) high temperature, 2) personnel entry, and 3) operator manual initiation	✓	
High rate ventilation control		Operator need not enter the room to initiate high rate ventilation	✓	
Minimum temperature maintenance		Heat is only provided to the tanks needing to be kept at a minimum temperature.	✓	These tanks will be insulated and heat traced. No room heating is provided.
Hydrogen Gas Generated by Onsite Hypochlorite Generation Process				
Venting		Outdoors	✓	
Ventilation duration		Continuous	✓	
Number of hydrogen gas detectors		Four total including (2) for generator room and (2) for Storage Tank room.	✓	Refer to P&IDs I-31,I-32, I-33 and I-34
Type of hydrogen gas detectors		Conspec CN0642-1 or equal	✓	

25.0 PLUMBING SYSTEM

Plumbing systems include domestic cold and hot water, sanitary, vent, natural gas, laboratory de-ionized water supply and laboratory waste handling, and includes in-plant service water, and in-plant permeate water supply. Plumbing also includes water supply to micro-irrigation system.

Table 25-1 Governing Codes and Standards

Governing Codes and Standards
California Health and Safety Code Sections 116875-116880
Public Law 111–380

25.1 Domestic Hot and Cold Water, Nonpotable Water, and Pressure Drain Piping

The following section provides the design criteria for domestic hot and cold water, nonpotable water, and pressure drain piping.

25.1.1 Above Grade Piping

Table 25-2 provides the design criteria for above grade domestic hot and cold water, nonpotable water, and pressure drain piping.

Table 25-2. Above Grade Piping Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Piping type		Type L hard drawn copper tubing, ASTM B88	✓	
Pipe fittings type		Wrought copper solder type fittings conforming to ANSI B16.22, or cast copper alloy solder joint fittings conforming to ANSI B16.18, or cast copper alloy flanged fittings Class 150 conforming to ANSI B16.24	✓	
Screwed joints in piping size		Restricted to pipe sizes 2" and smaller	✓	
Pressure-Seal Fittings				
Type		ASME B16.18 and B16:22, ASTM B88, and D 2000	✓	
Brand		Rigid ProPress™, or Stadler-Viega, or NIBCO® INC	✓	
Housing type		Copper or bronze housing	✓	
Sealing element		factory installed Ethylene Propylene Diene Terpolymer sealing element	✓	
Working pressure	psi	200 lbs	✓	
Temperature rating	°F	0 to 250	✓	

25.1.2 Below Grade Piping

Table 25-3 provides the design criteria for below grade domestic hot and cold water, nonpotable water, and pressure drain piping.

Table 25-3. Below Grade Piping Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Piping type		Type K copper tubing	✓	
Piping installation within a building and within or under a concrete slab		Without joints	✓	
When joints are unavoidable		Brazed	✓	
Protective pipe covering		Factory- or field-applied according to manufacturer's written instructions.	✓	
Piping 2½ Inches and Larger				
Coating type		Polyken No. 1027 primer and Polyken No. 930-35 tape coating	✓	as manufactured by Tyco adhesives, Corrosion Protection Group
Coating thickness	mil	35	✓	as manufactured by Tyco adhesives, Corrosion Protection Group
Coating strength		21kV dielectric strength	✓	as manufactured by Tyco adhesives, Corrosion Protection Group
Overlap	inch	1 (minimum)	✓	
Piping 2 Inches and Smaller				
Coating type		Plastic sleeve-protector	✓	
Coating thickness	mil	27	✓	
Coating brand		LSP® Products Group, Plasti-Sleeve or equivalent	✓	

25.2 Soil, Waste, Drain, and Vent Piping

The following section provides the design criteria soil, waste, drain, and vent piping.

25.2.1 Below Grade Piping

Table 25-4 provides the design criteria for below grade soil, waste, drain, and vent piping.

Table 25-4. Below Grade Piping Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Piping type		Service weight hub and spigot (with gasket) coated cast iron and must conform to ASTM A74	✓	

25.2.2 Above Grade Piping

Table 25-5 provides the design criteria for above grade soil, waste, drain, and vent piping.

Table 25-5. Above Grade Piping Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Piping type		Schedule 40, galvanized steel pipe, ASTM A53	✓	
Fittings		Threaded, galvanized cast iron Durham drainage fittings, ANSI B16.12; or drainwaste-vent (DWV) copper pipe with solder joint DWV wrought copper fittings; or service weight hub-spigot (with gasket) coated cast iron pipe and fittings conforming to ASTM A74; or hubless cast iron pipe and fittings conforming to CISPI 301	✓	

25.3 Backflow prevention

Table 25-6 provides the design criteria for backflow prevention.

Table 25-6. Backflow Prevention Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Domestic water system protection		single reduced pressure zone (RPZ) type backflow preventer	✓	
Potable water supply to process facilities protection		RPZ backflow preventers in parallel	✓	
RPZ bypass		Not allowed	✓	
RPZ device installation		Not to be installed in below grade pits	✓	

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Flooding prevention		Suitable drains and curbs for water at a high rates.	✓	Funnels may not be adequate
Pressure indicators		Required upstream and downstream of RPZ devices	✓	
Hose bib back-siphonage prevention		Equip with vacuum breakers	✓	
In-plant water system backflow and contamination prevention		Design of continuous dilution water for chemical systems	✓	

25.4 Metering

Process flow meters are indicated on the P&IDs and are integrated into the SCADA system. In-plant uses for domestic use in the Administration Building, irrigation in the garden and tour area and chemical dilution water will be metered to allow monitoring and reporting of in-plant water consumption.

25.5 Tempered Water System:

A tempered water system is required to supply emergency eyewash and emergency showers. The tempered water system is designed to provide tempered water quickly after activation of the eyewash/shower valve. Design criteria for the tempered water system includes:

- Long branches of piping with untempered water are not acceptable.
- Drains shall be provided to carry away eyewash or shower water.
- Tempered water systems shall be designed in accordance with the latest version of American National Standard for Emergency Eyewash and Shower Equipment (ANSI Z358.1). The design and installation guidance in Appendix B, provided with the Standard, are to be followed.
- Electric instantaneous heaters are undesirable due to high electric demand.

25.6 Additional Plumbing System Design Criteria

Additional design criteria for the plumbing system includes:

- Water hammer arrestors are provided where solenoid valves are installed.
- A septic system is provided for sanitary wastes.
- Saline waste streams will be sent to the Brine Equalization Basin and ultimately to the 36" diameter Monterey Regional WPA Discharge, not the septic system. Refer to I-42.
- Sanitary drainage system was coordinated with process elements so that the drains are located in appropriate locations.
- Each lavatory includes a floor drain.

- Sump pumps in critical locations are duplex types with high level alarm to SCADA.
- Process wastes such as continuous sample streams, will be recycled or sent to brine discharge rather than discharged to sanitary. Sample streams will not to be discharged onto the floor.
- A laboratory de-ionized water system is provided with a single tap in the laboratory.
- In additional to potable water for the emergency eyewash/showers and the backflow protected plant water pipe throughout the site and chemical rooms, there will a permeate supply line to provide low TDS water for the on-site hypochlorite generation system, the caustic soda carrier water system and other systems as described in more detail in section on chemical feed systems.

26.0 ELECTRICAL SYSTEM

KEY REFERENCE DRAWINGS:

E-1	ELECTICAL SITE PLAN
E-2	TRANSFORMER PLAN AND ELECTRICAL ROOM LAYOUT
E-3	OVERALL SINGLE-LINE DIAGRAM
E-4	SWRO BUILDING AREA CLASSIFICATION AND NEMA DESIGANATIONS
E-5	PRESSURE FILTER GALLERY, ADMINISTRATION BUILDING & PUMP SLAB AREA CLASSIFICATION AND NEMA DESIGNATIONS

The electrical system design portion presented in this proposal is in accordance with the following RFP requirements:

- Appendix 2, 26. Electrical System. Pages 2-76 through 2-79.
- Appendix 2, 27. Standby Power. Pages 2-79 and 2-80.
- Appendix 2, Attachment 6, Typical Electrical Equipment Manufacturers.
- Appendix 2, Attachment 7, General Electrical Design Criteria.
- Appendix 2, Attachment 8, Power System Study Requirements.
- Appendix 2, Exhibit 2, Conceptual Design of Power Distribution System Riser Diagram, Sheet 1 and 2 of 2.

CDM Smith has incorporated the following features into the proposed facilities that exceed the RFP requirements.

- All outdoor electrical enclosures will be non-metallic NEMA 4X, instead of NEMA 3R, to stand up against the salt air.
- Major Electrical equipment located outdoors (21 KV Switchgear and transformers) will have a corrosion resistant coating that can pass a 125 hour salt spray test.
- Motor control centers (MCC's) will be intelligent type and MCC's and VFD's will have ethernet communications to the SCADA system instead of hardwired I/O.

The overall power system loading has been evaluated and considered in selection of appropriate electrical service and distribution. Table 26-1 lists the governing codes and standards used in the development of the electrical system design.

Table 26-1 Governing Codes and Standards

Electric equipment, materials, and installation shall comply with the latest edition of the following codes and standards:

Governing Codes and Standards
National Electrical Code (2011 Edition)
International Building Codes (conduit spacing in structural elements – 3 times diameter spacing
California Title 24 Building Codes (2013)
NFPA-1-1 (emergency lighting for occupied spaces)
IES Lighting handbook
California PUC General Orders 95 (overhead work) and 128 (underground work) in public spaces
IEEE 519-1992 (Recommended Practices and Requirements for Harmonid Control in Electrical Power Systems)

A power factor of 0.93 or greater is anticipated for the Design-Build Improvements when operating at design capacity. Major electrical loads include:

1. Filtered feed water pumping
2. RO high pressure pumping
3. Finished Water pumping

26.1 Electrical Service

The treatment plant will be powered from a single Utility service utilizing the existing 21 KV in the area. Table 26-2 provides the design criteria for backflow prevention.

Table 26-2. Electrical Service Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Number of transformers		2	✓	
Transformer size	MVA	5	✓	
Transformer rating		55/65/65 C rated	✓	
Cooling		liquid-cooled (non-flammable)	✓	
Substation transformer voltage		21 KV (WYE) to 4160 V (WYE)	✓	
Service		Utility metering as a single service application	✓	It is assumed that the utilities existing 21 KV power lines in the area have enough capacity to supply power to the proposed plant as well as the planned future expansion. It is beyond the scope of this proposal to upgrade the existing 21 KV power

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
				lines. CDM Smith's cost estimate starts at the utility meter shown at the top of the 9.6 mgd Base Overall Single-Line Diagram and goes downstream from there. Any costs associated with delivering the power to the utility meter (upstream of the meter) are not included in this proposal. CDM Smith shall coordinate power requirements for the treatment facilities with the utility.
Transformer protection		pad-mounted, outdoor 35 KV fusible disconnect switches	✓	
Transformer, feeder, and breaker capacity at a plant rated capacity of 6.4 mgd	percent	100	✓	Reference Preliminary Electrical Load Table
Transformer, feeder, and breaker capacity at a plant rated capacity of 9.6 mgd	percent	65	✓	Reference Preliminary Electrical Load Table
Transformer, feeder, and breaker capacity at a plant rated capacity of 12.8 mgd	percent	50	✓	Reference Preliminary Electrical Load Table.

26. 2Medium Voltage Switchgear

From the outdoor electrical service transformers, 4,160 VAC is to be extended via concrete-encased conduit duct banks into 5 KV rated MV circuit breaker switchgear located within a building. Automated transfer control of the main-tie-main arrangement is to be incorporated into the operational design requirements; initiated through the SCADA system but capable of being fully automated in the future should dual Utility services eventually be developed. The high pressure pump motors will be supplied power at 4,160 volts from MDS-1.

26.3 Alternate Electric Service

Manual (key-interlocked) provisions are included to allow future utilization of an alternate 5 KV power supply from the adjacent landfill power generation system on one side of MDS-1. It is anticipated that the alternate supply would not be sufficient for the entire facility at all times, but may be capable of supplying a portion of the facility. As the routing and details of a future alternate 5 KV power supply from the adjacent landfill power system was not available at the time of proposal, allowance for routing of the power supply underground via duct bank has been made in the site layout Sheet E-1 in the submittal set

26.4 Supply to Filtered Water Feedwater Pumps and Finished Water Pumps

Table 26-3 provides the design criteria for the power supply to filtered water feed water pumps and finished water pumps.

Table 26-3. Supply to Filtered Water Feedwater Pumps and Finished Water Pumps Basis of Design Standards and Requirements

Parameter/Design Criteria	Per RFP	Notes/Assumptions
Power from MV switchgear (MDS-1) is to be routed via concrete-encased duct banks to two (2) outdoor, dry-type, cast-coil transformers; (4,160 VAC – 480Y277 VAC).	✓	
From transformers, concrete-encased duct banks and cabling to a low voltage, main-tie-main, 480 VAC switchboard assembly (MDS-2) are provided	✓	MDS-2 is low voltage switchboard, not switchgear. Rear access not required.
480 VAC switchboard assembly (MDS-2) to utilize draw-out, power circuit breakers for the main-tie-main and molded-case solid-state trip circuit breakers to supply the sub-distribution to the various loads and motor controllers in this building.	✓	
Manual transfer control (normal power situations only) of the main-tie-main is incorporated into the operational design requirements; initiated through key interlocks on the circuit breakers.	✓	
Main breakers are to be electrically operated in developing an automatic transfer control associated with the 480 VAC standby power generator.	✓	
The standby power source will be used in energizing one side of the double-ended switchboard assembly to allow limited operational capabilities in the event of a Utility power failure as well as for load-testing of the generator unit.		CDM Smith proposes to energize both sides of the double-ended switchboard to allow all the loads listed under "27.Standby Power" to operate if needed. The SCADA system will be used to prevent the generator from being overloaded. This

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Parameter/Design Criteria	Per RFP	Notes/Assumptions
		approach simplifies the design and provides more flexibility for Cal American. Reference the 9.6 mgd Base Overall Single-Line Diagram
Selection of which automated transfer interface will be utilized is provided through SCADA along with manual selection via a three-position selector switch on the switchboard assembly	✓	CDM Smith is not sure of the meaning of this and will discuss this with Cal American to be sure to provide what Cal American wants.
Local building power (480/277 and 208/120 VAC) will be developed within the building(s) as required to serve support system loads.	✓	
General power / lighting loads will be separated from instrumentation and sensitive electronic equipment loads by means of providing separate step-down transformers; 2-78 electrostatically isolated for “clean-power” loads / conventional for general power and lighting equipment.	✓	
Surge protective devices (UL-1449, Rev 3 Listed/Labeled) will be provided on panels serving “clean-power” systems.	✓	

26.5 Owner Metering and Protective Relays

Table 26-4 provides the design criteria for the owner metering and protective relays.

Table 26-4. Owner Metering and Protective Relays Basis of Design Standards and Requirements

Parameter/Design Criteria	Per RFP	Notes/Assumptions
Power quality meters (SEL 735) with fiber optic communications to the SCADA system shall be utilized for monitoring the utility service parameters.	✓	Reference the 9.6 mgd Base Overall Single-Line Diagram Drawing E-3
Feeder protection relays (SEL 751A and medium voltage motor protective relays (SEL 710) where applicable, shall also be interfaced using dual port, fiber optic communications.	✓	Reference the 9.6 mgd Base Overall Single-Line Diagram Drawing E-3
Each RO high pressure pump motor shall be monitored with an appropriate SEL device and ancillary sensors to monitor power consumption data in real time.	✓	Reference the 9.6 mgd Base Overall Single-Line Diagram Drawing E-3
RO pumping power consumption and other electrical parameters shall be monitored through SCADA.	✓	Reference the 9.6 mgd Base PLC Communication Architecture Diagram I-48

Parameter/Design Criteria	Per RFP	Notes/Assumptions
Each pumping stage (Raw Water, filtered feed water, and Finished Water) shall be monitored with an appropriate SEL device and ancillary sensors to determine the power consumption for the pumping stage (not the individual pump).	✓	Reference the 9.6 mgd Base Overall Single-Line Diagram. SEL devices will be provided for individual pumps and the PLC will be programmed to totalize the power consumption for each pumping stage. Drawing I-48
Raw water, filtered feed water, and finished water pumping power consumption and other electrical parameters shall be monitored through SCADA	✓	Reference the 9.6 mgd Base PLC Communication Architecture Diagram Drawing I-48

26.6 Voltage Drop

Conductors will be sized for a maximum voltage drop of 2% for feeder conductors and 3% for branch circuit conductors at full-connected load. Total maximum voltage drop allowed will be 5%.

26.7 Motor Control Centers

NEMA 1, 480 Volt, 3-phase MCCs will be provided for indoor installations. All MCC's will be located indoors. MCC wiring shall be Class II type B. Main horizontal and vertical buses shall be tin plated copper. MCCs will be equipped with the following:

- Motor starters, full voltage, for 125hp and below
- Motor starters will be soft starters (RVSS) for 150hp and above. This value may change based upon the electrical power system study done during the design which is when voltage dip will be evaluated on motor startup.
- 6 pulse variable frequency drives up to 500 HP.
- Circuit breakers sized according to the loads they protect per all applicable codes.

Motor control centers shall be intelligent type and communicate using Ethernet/IP protocol. Ethernet switches located in the MCC's shall be Hirschman.

26.8 Dry Type Transformers

Dry type transformers will be energy efficient, three phase 480 Volt delta primary, with four 2-½% full capacity taps(2 above rated voltage and 2 below rated voltage), 120/208 Volt wye secondary. Open type transformer cases are not allowed. All units located in wet or chemical areas will be of sealed type construction. Provide open ventilated type enclosures for other general dry, environmentally ventilated/conditioned spaces. All transformers to utilize copper windings; 115 degree C rated. The Engineer will examine the need to install transformers with a higher than average Basic Impulse Level (BIL) that is not normally required in the 480V class.

26.9 Panelboards

The panel boards will be rated for 120/208 Volt, 3 phase, four wire, and 10,000 Amp interrupting capacity and will have solid-grounded neutral rated 100% of phase bus and copper buses. Circuit breakers will be of the "Bolt-On" type; "Push-On" / "Plug-On" type circuit breakers are not allowed. Use tin plated copper type bus and ensure U.L. labeling of entire system.

26.10 Surge (transient) Protection

Surge protection will be provided on the MV switchgear, LV switchboard, and the MCC's to provide cascaded protection. The surge protective device will be installed on the load side of a circuit breaker.

26.11 Lighting and Illumination

Interior and exterior lighting will be provided. The interior lighting system will be designed in accordance with IES and Title 24 2013. Exterior lighting will be located above each exterior door and throughout the site.

Interior lighting will consist of high-efficiency T-5 HO, and T8 fluorescent light fixtures with electronic program-start ballasts. The T5-HO fixtures have an efficiency of 0.92 and the T8 fixtures have an efficiency of 0.90. Indoor enclosed and gasketed fluorescent for Damp and Wet Locations (Process and Chemical Rooms), other areas will be rated for indoor dry applications.

Exterior lighting will be designed by the Design-Builder for safety and security purposes in accordance with local requirements and expectations, and to allow proper functioning of security cameras. Exterior Lighting shall satisfy functional and security needs while not creating light pollution in the form of point sources of direct glare visible from a distance. Lighting shall be sensitive to the privacy of adjacent land uses. Fixtures shall be carefully selected for efficiency, cutoff, consistent lamp coloration throughout the project, and effectiveness in delivering only the light necessary to the task, while avoiding unnecessary spill lighting beyond site boundaries. Low level light fixtures that light immediate areas are encouraged. Exterior lighting will utilize pole mounted or wall pack type fixtures with high-pressure-sodium (HPS) lamps. HPS fixtures have an efficiency of 0.75. Exterior lights used to illuminate roads, sidewalks, or traffic areas will be controlled using a photocell switch. Exterior task lighting to illuminate equipment will be switched.

Emergency lighting and exit signs will be provided to identify and illuminate the paths of egress. The emergency lighting will use internal batteries to provide 60 minutes of backup time.

Interior and exterior lighting will be operated on 120 Volts. Roadway lighting will be operated at 480 volts to limit voltage drop.

26.12 Grounding

The electrical system and equipment will be grounded in compliance with the National Electrical Code. A buried grounding grid will be provided for the new switchgear and generators. Conductors shall be No. 3/0 AWG copper, minimum, for interconnecting ground rods and for connection to transformers, MCC's, and other major electrical equipment. Electrical equipment, devices, panel boards, and metallic raceways will be connected to the ground conductors. 480 Volt electrical system neutral will be solidly grounded. 4160 Volt electrical system neutral will be resistance grounded.

26.13 Wiring Methods

26.13.1. Conductors

Conductors for low voltage power and control will be 600 Volt, rated 90 degree C, wet or dry location, moisture resistant, flame-retardant, thermosetting insulation, Type XHHW-2. Conductor sizing shall be based on 30 degree C ambient temperature, and only allowing the conductor to heat up to 75 degrees C, even though the conductor is rated for 90 degrees C. This is to prevent overheating any of the connectors and lugs. Power conductors for medium voltage circuits will be aluminum conductor. Power conductors for low voltage circuits greater than 115 amp shall be aluminum. Power conductors for low voltage circuits 115 amp and less, shall be copper. Conductors for grounding, controls, instrumentation, and communications will be copper.

26.13.2 Raceways

Raceways will be as called for by Appendix 2, Attachment 7, General Electrical Design Criteria in the RFP and as shown on the electrical site plan.

26.13.3 Electrical Enclosures

Electrical enclosures (Control panels) and related enclosures will generally be non-metallic type with non-metallic hardware; NEMA 12 minimum or 4X in corrosive areas. The use of Stainless Steel enclosures will be limited to areas not exposed to a chlorine gas or fluoride areas. Electrical enclosures located outdoors will be non-metallic NEMA 4X. Electrical enclosures and control panels located in electrical rooms and the Admin building will be NEMA 1 and NEMA 12 respectively.

26.14 Receptacles

Receptacles and switches will be heavy-duty rated, 20 ampere minimum rated; material type and configuration to be suitable for the application.

26.15 Variable Frequency Drives

The variable frequency drives shall consist of IGBT modules with PWM output. The VFD's harmonics level shall be IEEE 519-1992 compliant. Low voltage VFD's will be 6 pulse with 3% input line reactors. An active harmonic filter will be provided on each MCC bus that has VFD's connected. The active harmonic filter will mitigate harmonics and correct power factor. Medium Voltage VFD's will be provided with phase shifting transformers and be a minimum of 18 pulse. for MCC-1 and MCC-2. The motors controlled by VFDs will be inverter duty, per NEMA MG-1 Parts 30 and 31.

26.16 Induction Motors

Induction motors shall be 120 or 208 Volt, single phase for fractional horsepower sizes, and 460 Volt, three phase for ½ hp to approximately 500 hp. Motors shall be 4160 volt for approximately 600 hp and above. Three phase motors shall be high efficiency, 1.15 service factor, open drip proof or totally enclosed fan cooled, with a thermal temperature switch in each winding for VFD driven motors smaller than 200 hp. Three phase motors shall have anti-condensation heaters for motors located outside and above 10hp.

Motors that are 200 hp or above will be equipped with temperature and vibration data collection systems as described in the RFP under Appendix 2, 20. Rotating Equipment Monitoring.

SEL 710 motor protective relays will be used for motor loads larger than 100 horsepower, and will be connected to the plant control system for monitoring, trending and archiving.

27.0 STANDBY POWER

Standby power shall be provided to power the following loads:

1. any one (1) Finished Water pump (including largest capacity pump)
2. administration facilities,
3. interior and exterior lighting
4. sump pumps
5. RO flush pumps,
6. instrumentation,
7. compressed air supply for valve actuators,
8. security systems
9. critical valves

Table 27-1 provides the design criteria for standby power.

Table 27-1. Standby Power Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Number of generators		1	✓	750 kW
Type of generator		Diesel fueled, synchronous, four pole, brushless generator, 105 deg temperature rise	✓	
Loss of power		Genset shall start automatically – Interlock with facility switchboard	✓	
Fuel storage		Double wall fuel storage tank with 24 hours run time at full load.	✓	
Genset type		UL 2200 listed packaged genset	✓	
Monitoring of genset performance		SCADA	✓	
Genset testing		Installed so it can be tested under load on a routine basis	✓	
Noise control		Compliance with local ordinances and codes	✓	
Access to controls and		Stairs	✓	

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
equipment				
Enclosure type		Walk-in sound attenuated, weatherproof enclosure	✓	
Enclosure noise rating		designed to reduce noise levels to less than 75 dBA @ 23 feet at 100% load, or local criteria whichever is more stringent	✓	
Exhaust silencer		Super critical grade exhaust silencer mounted internally in enclosure.	✓	
Enclosure wind and seismic rating		IBC	✓	
Corrosion protection		Provide corrosion protection against salt in air	✓	
Sound attenuating type		Weather Proof Genset Enclosure as described in Pritchard Brown Specification No. 2130	✓	
Sound attenuating enclosure color		To be selected by owner	✓	No additional cost to owner
Factory testing		0.8 lagging power factor	✓	
On-site testing		load bank at 0.8 lagging power factor	✓	
Sequencing and interlocking with switchboard and loads.		Central control and metering/monitoring system	✓	

28.0 CONTROL STRATEGY OVERVIEW

Design-Builder is to identify control strategies for all processes, including for the following unit processes:

1. Beach Wells
2. Granular Media Filtration Pretreatment and Break Tank
3. Cartridge Filters
4. Reverse Osmosis – Startup, Operation, Shutdown
5. Reverse Osmosis Clean in Place
6. Post Treatment and Stabilization
7. Finished Water Storage and Pumping

8. Chemical Storage and Feed

9. Concentrate Disposal

The operating requirement for the SWRO plant is continuous operation (24/7/365) at design capacity of 9.6 mgd for the base case. If a train is down for maintenance the redundant unit can be placed in service to maintain production. If the SWRO plant is shutdown or capacity is reduced for a period of time then when the system is restarted it shall have the capability to operate all equipment to produce 11.2 mgd. This will allow the system to produce 10,750 ac ft of treated water per year. A high level overview of how the system is expected to operate is summarized below.

a. Cal Am distribution system needs additional water and the plant operators increase the treated water pumping rate by adjusting the treated water pump station flow setpoint or VFD speed.

b. The level in the Treated Water Tanks decreases and this calls for starting another SWRO unit.

c. Seawater Supply wells are started and pump to waste for several minutes and then are diverted into the raw water supply pipe to an off-site seawater raw water reservoir designed by others

d. When the level in the raw water tank begins to rise then additional offsite raw water transfer pumps are started. Concurrently the next Seawater RO unit is called to start and begins allowing filtered water to flow into the SWRO unit (call to operate to purge air out of the pressure vessels and establish forward flow.)

e. The raw water flow delivery to the desalination site increases and is pumped through the pressure filters to the Filtered Water tanks. Declining rate filtration, in conjunction with a variable service interval to maintain a setpoint differential pressure, provides energy efficient filtration and better effluent quality compared to fixed rate filtration.

f. At a fixed service interval individual filters will be taken out of service mode for backwash. An offline filter will be brought into service as the filter to be backwashed is removed from service. When a pressure filter backwash sequence is initiated, overall filtered water production is not reduced. The filter service interval is the manipulated variable in a control system PID loop which maintains the setpoint media-filtration headloss at a fixed target value consistent with the optimum average media retentate inventory corresponding to minimum filter-effluent fouling potential. In the event of an excursion in headloss outside of allowable deadband around the headloss setpoint, the interval between last and next filter backwash will be shortened or lengthened as a step correction until operation is returned to within the acceptable deadband.

g. The valve sequence for backwashing a pressure filter is as follows:

    i. Close raw water inlet valve

    ii. Close filtered water outlet valve

    iii. Open waste backwash valve to partially drain filter

    iv. Open the air scour inlet valve and simultaneously start air scour blower if provided

    v. Open the backwash supply inlet valve and start backwash supply pump at slow speed

vi. Concurrent air and water backwash

vii. Stop air scour blower and ramp backwash supply pump up to high rate operator set point.

viii. After high rate backwash timer expires than ramp backwash flow rate to low stratification flow rate

ix. Close backwash supply valve and stop backwash supply pump

x. Close backwash waste drain line and open the filter inlet valve

xi. Open the filter to waste valve and discharge filter to waste for a fixed interval corresponding to adequate forward rinse.

xii. Close the filter to waste valve and either open the filtered water discharge valve to return the filter to service or close all valve to put the filter into stand-by

h. As the water level in the Filtered Water Tank rises the next SWRO Train ERD booster pumps start to ramp up to speed. Practically all of the low pressure feed water flow through the pressure vessels and is discharged as brine since the feed pressure is less than the osmotic pressure and there is minimal permeate production. After flow has been established through the SWRO train and ERD system, feed water pump starts at low speed and begins to ramp up to the pre-set speed set point initiating permeate production. As the feed pressure increases the ERD transfers pressure from the brine to the ERD feed water flow and the ERD booster raises the pressure to match the feed water pump discharge pressure. The speed of the Feedwater Pump continues to increase until permeate flow rate is achieved. Brine discharge valve, ERD booster and feed water pump speed are adjusted until the specified ERD parameter values and permeate flow rate and recovery of 42% are achieved.

i. The treated water, seawater supply and treated water pumps are designed to operate in 1.6 mgd increments.

j. Each SWRO unit has a low TDS permeate discharge and a high TDS permeate discharge. The high TDS permeate discharge can be up to 40% of the overall permeate production in the base case. The flow split is controlled by adjusting the VFD speed for the BWRO feed water pumps until the desired permeate production is a achieved. There are numerous interlocks on the number of units operating and minimum flow rates per unit.

k. Need approximately 15 minutes to start a large seawater RO unit, so the degree of overlap between the seawater RO units and the seawater supply wells or raw water supply pumps will need to be closely timed.

l. Low TDS permeate from the SWRO units is combined with the permeate from the 2nd Pass BWRO units to produce an average blended permeate with less than 0.5 ppm of boron and 60 ppm of chlorides. Available residual pressure from the SWRO Units is used to push the blended permeate (9.6 mgd at design capacity) through the UV disinfection system to post treatment stabilization area. The permeate is either discharged to the Calcite contactor tanks or dosed with lime. If the calcite contactors are used then the blended permeate flow is split using a passive hydraulic flow splitting. After passing though the calcite bed the flow is discharged from the calcite tanks and flows by gravity to the Treated Water tanks after final pH trim with CO2 and 50% caustic soda.

m. Brine from the 1st pass RO is discharged directly to the discharge force main at a pressure of 15 psi and flow directly to the junction box at the Monterey Regional WPF. Brine can be discharged to the Brine EQ basin for 5 hours when the plant is producing 9.6 mgd of treated water.

n. Brine from the 2ed pass BWRO units can be discharged directly to the Brine discharge force main or returned to the Filtered Water Inlet pipe where it enters the SWRO Building.

o. The raw water sodium hypochlorite feed rate is based on an operator dosage set point and flow paced

p. Sodium Bi-sulfite federate is based on chlorine residual, flow rate and dosage set point

q. Scale inhibitor is based on Filtered Water flow rate and operator set dosage

r. If used the sulfuric acid feed to the SWRO feed water is based on operator dosage setpoint and flow paced

s. Permeate UV dosage is determined by the operator and input into the equipment supplier control system. UV lamp intensity and number of lamps is controlled by the Vender control panel

t. Lime Dosage is based on operator lime dosage setpoint and flowrate

u. CO2 dose and feed rate is determined by operator set pH and flowrate

v. Polyphosphate, ortho-phosphate or phosphoric acid is injected into the treated water pipe based on operator dose setpoint and treated water flowrate

w. Treated water sodium hypochlorite feed rate based on operate setpoint, flowrate, and chlorine residual.

x. The on-site hypochlorite generation is controlled by the vender supplied package system PLC based on hypochlorite tank level. When the hypochlorite level drops below the operators defined set point the generator(s) start and refill the tank.

y. There are control loops for the Brine EQ Basin Pump station and the Backwash reclamation Pump station. These are independent of the SWRO treatment plant control sequence

z. When there is a loss of power, the emergency generators starts and is used to operate the permeate flush pumps and SWRO unit flush valves.

aa. During a normal shutdown of an SWRO unit with power the SWRO unit is flushed with filtered water to remove high concentration of salt from the membrane array and brine piping. After the filtered water flush the operator can initiate a permeate water flow to future purge the unit of water with high dissolved solids.

29.0 PROCESS CONTROL

Table 29-1 identifies sample points, analyzers, and points of chemical addition.

Table 29-1 Sample Points, Analyzers, and Points of Chemical Addition

Process	Chemical	Chemical Addition		Continuous analyzers	
		Continuous	Intermittent	Flow requirements	Disposal
Pretreatment iron removal	Sodium hypochlorite	X		Chlorine residual analyzer	Waste sump
Filtered Water dechlorination	Sodium bi-sulfite	X		• Chlorine residual analyzer • ORP	• Waste sump • NA
Seawater RO Feedwater	Scale Inhibitor	X		No analyzer	
Seawater RO pH adjustment	Sulfuric acid		X	pH	NA
Brackish Water pH adjustment	Sodium hydroxide	X		pH	NA
RO Permeate Stabilization	Lime or Calcite	X		pH Alkalinity	NA Septic
RO Permeate pH adjustment	Carbon dioxide	X		pH	NA
Finished Water Disinfection	Sodium hypochlorite	X		Chlorine residual analyzer	Waste sump
Finished Water corrosion control	Phosphoric acid or orthophosphate	X		No Analyzer	NA

30. INSTRUMENTATION AND CONTROL

The treatment and pumping facilities are operated through a distributed instrumentation and control system (the "DCS"), also termed SCADA, allowing for automated and manual control of the overall system, subsystems, and individual pieces of equipment. Control logic will be distributed throughout the control network and will be designed in a manner to allow sub-systems to operate independently of communications to other PLCs and computers.

KEY REFERENCE DRAWINGS:
I-47 SCADA NETWORK BLOCK DIAGRAM
I-48 PLC COMMUNICATION ARCHITECTURE

The DCS System Architecture is illustrated on the SCADA Network Block Diagram, I-47, and PLC Communication Architecture, I-48. Table 30-1 provides the general design criteria for the SCADA System.

Table 30-1 DCS Basis of Design Standards and Requirements

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
Control System Standards		Distributed Control Concept, where process is controlled by a PLC in that area. The control program is resident in the PLC, while control set	✓	

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
		points can be adjusted through the operator workstations or HMI Operator Interface Terminal (OIT)		
System Configuration		Redundant HMI Servers and workstations so that loss of a single computer does not interrupt operator monitoring or control	✓	
Redundant Database		Two database will be maintained for historical data, alarm history and SQL information	✓	
SCADA Hardware and Software		• 1 iFix Server, unlimited tags, redundancy, developer • 1 iFix Server, unlimited tags, redundancy, runtime • 1 iFix Developer client (MS Office Software includes) • 2 iFix Runtime clients (MS Office Software includes) • 1 Proficy Historian Server, 1000 tags, redundant iFix collectors, calculation collector, OPC collector	✓	GE-Intellution iFIX is listed as HMI Software Manufacturer in Appendix 2, Attachment 4, Typical Equipment Manufacturer (Page B-4)
PLC Hardware and Software		PLC will be Allen-Bradley CompactLogix PLC for a minor process and A-B ControlLogix for a larger process. The software for the proposed PLCs will be RSLogix 5000	✓	
Network Architecture		PLCs are to be interconnected using an Ethernet network. Network connections between buildings will be through Ethernet to fiber converters and fiber optic cables. A self-healing fiber optic ring is	✓	

Parameter	Unit	Design Criteria	Per RFP	Notes/Assumptions
		provided to maintain a high degree of reliability in the control network		
Remote Wells Communication		Communication to the remote wells will be Ethernet TCP/IP via fiber optic (FO) cable. Off-site FO cable installation and PLCs including programming for control of the wells pumps are provided by other. Control strategy for the wells and data (transmitting/receiving) from wells to the treatment plant will be developed by the treatment plant designers.	✓	
Communication with MRWPCA		Digital communication/spread spectrum radio link with MRWPCA will be provided to monitor and control the RO concentrate from the plant discharged to the MRWPCA	✓	
Instrumentation		In the interest of standardization, instruments will be selected to maximize interchangeability across similar process functions within the plant, thus minimizing maintenance requirements and spare parts.	✓	Note that instruments for the packaged systems will be provided by the vendors per their recommendations.
Power Quality Metering and Protective/Monitoring Relays Monitored through SCADA		Power quality meters and monitoring/protection relays are to be interconnected using a separate Ethernet network with Ethernet/Modbus TCP/IP Protocol such that power consumption and electrical parameters are monitored through SCADA	✓	

Table 30-2 lists the governing codes and standards used in the development of the instrumentation and control design.

Table 30-2 Governing Codes and Standards

Governing Codes and Standards
National Electrical code (NEC)
National Fire Protection Association (NFPA)
International Society of Automation (ISA)
American National Standards Institute (ANSI)
National Electrical Manufacturers Association (NEMA)
Underwriters Laboratories, Inc. (UL)
Factory Mutual Global (FMG) where required

30.1 Programmable Logic Controllers (PLCs)

The PLC collects process and equipment status information, manipulates field device by executing programmed control routines, and conveys field conditions to the supervisory HMI level.

As shown on the PLC Communication Architecture Diagram, I-48, each area/process will have a PLC, which controls and monitors the processes in that area. Below is the list of PLC within the Plant.

1. PLC-001, Pre-treatment PLC
2. PLC-100, Water Treatment Plant Main PLC
3. PLC-200, RO Master PLC (Vendor)
4. PLC-300, Chemical/Brine Systems PLC
5. PLC-400, On-site Sodium Hypochlorite Generation and Feed Systems PLC (Vendor)
6. PLC-500, UV System PLC (Vendor)
7. PLC-600, CO2 System PLC (Vendor)
8. PLC-700, Post Treatment System PLC (Vendor)

Table 30-3 provides the general design criteria for the PLCs.

Table 30-3 PLCs Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP	Notes/Assumptions
Process controllers manufacturer/type	Allen Bradley – Logix Series	✓	
PLC Cabinets	Includes compact lighting fixture activated by a door switch. Each PLC has a UPS. PLCs shall be located indoors in a controlled environment with fans and heaters wherever possible. PLCs located outdoors shall	✓	

Parameter	Design Criteria	Per RFP	Notes/Assumptions
	have outdoor rated enclosures (NEMA 4X, SS) with sunshades, thermostatically controlled heaters and cooling.		
Network	PLCs are connected to a self-healing fiber optic ring via 10/100 Ethernet switches. Network connections between buildings will be through Ethernet to fiber converters and fiber optic cables.	✓	
Keypads	No keypads will be used; OITs are used where applicable. Provide a touch-screen type operator interface unit on suitable cabinet.	✓	
Spare Wired Terminals	Minimum of 20% of each I/O type in each cabinet.	✓	
Convenience Receptacles	Fuse ground-fault interrupter type or RVSS as applicable to the installation.	✓	
Separation of Power Cable and Signal Wires	120VAC control cable shall be physically separated from 4-20 ma signals and 24 volt cabling as much as practicable inside control cabinets; provide barriers for compliance with ISA standards. Field wiring into the control panel, including junction boxes, shall be labeled as per the P&ID drawings (not wiring numbers).	✓	
Number of I/O slots	As required plus minimum 20% spare	✓	
3 Wire Control of Motors	Required for all motor driven equipment; consisting of one normally-closed contact for stop and one normally-open contact for start, etc., except for chemical metering pumps.	✓	
Modulating valves	Analog control with full open and full closed feedback or open/closed control with position feedback and full open and full closed feedback.	✓	
Analog and Discrete Inputs/Outputs	• Analog Inputs/Outputs: 4-20 mA; • Discrete inputs: 24 VDC. • Discrete Outputs: Isolated dry relay contacts shall be furnished for all discrete outputs; relays may be integral to the I/O module. Interposing relays shall be	✓	

Parameter	Design Criteria	Per RFP	Notes/Assumptions
	furnished in cases where the I/O module relay contacts do not have adequate electrical ratings.		
I/O modules	High density	✓	
Arc Flash Safety	Instrumentation is to be separated from power in separate enclosures. 480 volt starters shall not be located within instrumentation enclosures.	✓	

30.2 Uninterruptible Power Supply (UPS)

All PLC, computers/workstations, and communication interfaces will be UPS powered, either from central UPS power supply or UPS within the PLC panel. The UPS will provide continuous power during a utility upset or power transfer and will be sized to provide a minimum of 15 minutes ride through time.

Table 30-4 provides the general design criteria for the UPS.

Table 30-4 UPS Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP	Notes/Assumptions
Central UPS power supply	Serves the control room personal computers, printers and server room, switches, routers, firewalls and other network equipment located in the administration building.	✓	
Bypass Switches	UPS includes static bypass switch and a separate maintenance bypass switch	✓	
Transient Voltage Surge Suppression (TVSS)	Provides shielded isolation transformer and TVSS for bypass feed	✓	
IP Communication Module	Provides IP communication module to communicate with the HMI for UPS status and alarms reporting. Minimum reporting includes alarms for overload, over temperature, low battery, load on bypass and load transferred to the maintenance by-pass	✓	
PLCs and analyzers containing programming	Powered from individual UPS units provided with each enclosure, and mounted in the PLC panels as applicable	✓	
AC power source	Normal/standby power system.	✓	
UPS Power Duration	Minimum of 15 minutes of backup power	✓	

30.3 Operator Interface Hardware and Software

Table 30-5 provides the general design criteria for the operator interface hardware and software.

Table 30-5 Operator Interface Hardware and Software Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP	Notes/Assumptions
Human-Machine Interface (HMI) Software	GE-Intellution iFIX	✓	Appendix 2, Attachment 4, Typical Equipment Manufacturer, Page B-4.
LAN Connection	To be provided in all control panels using 8-port DIN rail mounted Ethernet Switch. LAN connections shall be wired to a separate network independent of the SCADA LAN and the Business WAN.	✓	
Local Area Network (LAN)	• 100-base T stackable hub for connecting computers • CAT-6 (within building) • Fiber Optic (between buildings)	✓	

30.4 Modes of Operation

Table 30-6 provides the general design criteria for the modes of operation.

Table 30-6 Modes of Operation Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP	Notes/Assumptions
Process Equipment	Each piece equipped with a local-off-remote selector switch (at the piece of equipment). Additional contact block will be added on the selector switch for remote position feedback to PLC/HMI. If the DCS attempts to control a device from the PLC when it is not in the remote mode, a failure condition will be delineated at the operator interface. Equipment furnished as part of a package system with a local control panel may not require individual LOR selector switches.	✓	
Local-Manual	An operator at a piece of process equipment will turn the device on and off and make adjustments. Required for all equipment.	✓	
Local-Automatic	Controls are hardwired into pieces of equipment by a vendor (such as prepackaged process equipment).	✓	
Remote-Manual	An operator turns items on and off via the operator human machine interface (the “HMI”) connected to the DCS.	✓	
Remote-Automatic	The DCS turns items on and off and performs all control while monitored thru the HMI. Required for equipment as necessary for overall plant coordinated control.	✓	

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30.5 Operator Interface Functions

System integrator shall consult with the Owner for graphics screens and reports development to meet the operator interface functions indicated herein.

Table 30-7 provides the general design criteria for the operator interface functions.

Table 30-7 Operator Interface Functions Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP	Notes/Assumptions
Screens	• List of specific I/O point required on each screen • Follows CAW's standard color conventions for stop, run, open, closed and intermediate conditions • Follow text conventions approved by the Owner • Popup displays that enable operator interface with equipment and set points • Control programs shall include limiting parameters for operator inputs, such as chemical feed dosages to prevent excursions. Only supervisors are to have access to modify those parameters. • Provide a list of all screens to be created by the system integrator. • Provide sample screens to establish the standard for layout and acceptable level of detail	✓	
Reports	• Reports shall be generated to summarize plant operation, electrical consumption, water production, chemical inventory, and regulatory compliance. • The reports shall be accomplished by creating the forms in Microsoft Access (latest release) format and downloading data directly from the system. • When data that is not generated by the system is required on certain forms, the operator shall have the capability to manually enter this information into the report, or overwrite data that the system has downloaded. • Assume that ten reports are required with the ability to update them on a daily, weekly, monthly, quarterly, and annual basis as well as month and year	✓	

Parameter	Design Criteria	Per RFP	Notes/Assumptions
	to date basis.		
Alarms	• An alarm summary table shall be developed and reviewed with CAW during design. • The table shall include specific initial values for all high and low alarm set points. Analog set points are also to be configurable on the graphic displays. • The specific alarm software package that is ultimately selected must have auto dialing capabilities such that alarm conditions can notify on-call personnel without the need for separate auto dialer. • Operators shall not be permitted access to modify alarm set points without special authorization.	✓	
Database	An SQL database package is provided to store process data and act as a server to database users outside the process control system.	✓	

30.6 Factory Acceptance Test ("FAT")

CAW and CDM Smith shall witness a complete FAT of the control system prior to its shipment to the Project Site. The FAT shall be conducted by the system integrator and as per RFP Appendix 4, Section 4.3 TESTING AND COMMISIONING, Item I. INTRUMENTATION AND CONTROL TESTING, and sub-section 1 - Factory Acceptance Test.

Table 30-6 FAT Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP	Notes/Assumptions
PLC/SCADA	Verify the functionality, performance, and stability of the hardware and software	✓	
I/O and PLC Program	• Simulate inputs to assure all I/O are provided, and all inputs, outputs and application software are functioning according to the intent of the plans, specifications, and Basis of Design Report. • Simulates system faults and failures to demonstrate the functionality of the system, including each control loop.	✓	
HMI screens, Reports and Alarms	Demonstrate all graphics, report generation and alarm functions of the system	✓	

30.7 On-Site Testing

Per RFP Appendix 4, Section 4.3 TESTING AND COMMISIONING, Item I. INTRUMENTATION AND CONTROL TESTING, the On-Site Testing consists of the Operational Ready Test (ORT), Functional Demonstration Test (FDT) and Site Acceptance Test (SAT). These tests will be conducted on site and Table below provides the general information on the tests.

Table 30-7 On-Site Testing Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP	Notes/Assumptions
ORT	• Following installation of the process control system components and prior to startup, the entire system shall be certified that it is installed and ready for ORT • Loop tested/checked for proper installation and calibration. The system integrator shall maintain the loop status reports at the Project Site and make them available to the Owner at any time • Submit a record copy of the test results to the Owner upon successful completion of the ORT	✓	
FDT	• The FDT shall be witnessed by the Owner and shall consist of a loop by loop demonstration of the functionality and operability of the control system. • Life field data shall be used to the extent possible • Submit a record copy of the test results to the Owner upon successful completion of the FDT	✓	
SAT	• After completion of the ORT and FDT, the system shall undergo a 30-day SAT under conditions of full plant performance without a single non-field repairable malfunction • Owner shall have full use of the system. Only Owner's staff shall be allowed to operate equipment associated with live plant processes. Plant operations remain the responsibility of the Owner • Any malfunction during the SAT shall be analyzed and corrections made. Any malfunction during the 30 day test which cannot be corrected within 24 hours of the occurrence, or more than two similar failure of any duration, will be considered as a non-field repairable malfunction	✓	

Parameter	Design Criteria	Per RFP	Notes/Assumptions
	• All database, PLC and graphical interface data points must be fully functioning • All reports must be functioning and providing accurate results • No software or hardware modifications shall be made to the system without prior approval • Following successful completion of the 30 day test, and subsequent review and approval of test documentation, the instrumentation and control system shall be considered substantially complete and the warranty period shall commence		

30.8 Training

Table 30-8 provides the general design criteria for staff training.

Table 30-8 Training Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP	Notes/Assumptions
Operator Training	Provided to CAW staff to operate the Design-Build Improvements through the control system. Operating training has the following goals: • Use workstations, touchscreens and keyboards • Retrieve and interpret all standard displays including graphics, overview displays, group displays, trends, point summaries and alarm summaries • Enter data manually • Change control parameters and set point values • Assume manual control of equipment and control it from the HMI • Print reports • Acknowledge alarms • Respond to hardware and software errors • Historical data collection, retrieval, and archival • Capability and configurability of reports, alarm reporting, passwords, and system hardware configuration • Database backup and recovery	✓	
Maintenance training	Provided to CAW staff to maintain the hardware of the control system. As a minimum, maintenance training shall	✓	

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Parameter	Design Criteria	Per RFP	Notes/Assumptions
	include: • Power up and shutdown of all hardware devices • Perform schedule maintenance functions • Setup and use off line diagnostics to determine hardware failures • Use workstations, or keyboard to retrieve and interpret displays which provide online diagnostic information • Remove and replace all removable boards/modules • Maintenance training shall be at least 75% hands-on training		
Administrative training	Provided to CAW staff to make basic security related changes. This training includes: • Log on and log out to the HMI and OIT • Setting and clearing passwords • Configuring access levels for various parameters and set points	✓	

30.9 Calibration Plan

It is expected that a detailed calibration plan is to be developed during the construction phase (testing and commissioning) of the Project.

30.10 Protection of Sensitive Equipment

The guidelines for powering and grounding of sensitive electronic equipment listed in IEEE Standard 1100-1999 provided the basis for criteria in this section. Table 30-9 provides a summary of the design criteria for protecting sensitive equipment.

Table 30-10 Protection of Sensitive Equipment Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP	Notes/Assumptions
TVSS	Provide at point of use for all instrumentation loads that required protection. All analog signaling shall be shielded cable. Provide TVSS for the followings: • TVSS is required for all 4-wire instruments, and placed on the 120 Vac branch circuit and on the 4-20 mA portion of the circuit. TVSS on the 4-20 mA wiring shall be located on the PLC end • TVSS is required for all 2-wire instruments that have signal cable running from outdoor to indoor	✓	

Parameter	Design Criteria	Per RFP	Notes/Assumptions
	locations (or signal wire between buildings). TVSS will be on the field side of the 4-20mA signal.		
Grounding	• Direct connection to the ground grid via a driven rod in addition to the equipment safety ground required by the National Electrical Code (each PLC cabinet). • Daisy chaining of grounds is not acceptable if it is the only grounding source. • A grounding detail showing the interface between the PLC cabinet and the proposed grounding system is required • Instrumentation shields shall be grounded at the PLC end only • Cross reference with electrical grounding specifications for understanding/monitoring quality of system grounding • Provide connections to structure steel and interface them to the grounding system	✓	
Power Supplies	Separate power supplies for analog inputs and PLCs, and digital outputs.	✓	
Conduit Spacing	Between power and signal/control cables as listed in IEEE 518-1982.	✓	
Enclosures	Located away from chemicals and sources of moisture to the extent possible. Where enclosures are located in the vicinity of chemicals, fiberglass NEMA 4X enclosures are provided with non-metallic hinges and latches.	✓	

30.11 Field Devices

Table 30-10 provides a summary of the design criteria for the field instrumentation required.

Table 30-10 Field Devices Basis of Design Standards and Requirements

Parameter	Design Criteria	Per RFP	Notes/Assumptions
General	Output to be 4-20 mA with HART protocol where possible. Display shall be in engineering units. Mount indicator at height and location for ease of access and clear view. Provide remote indicator when warranted. Provide calibration accessories. All transmitter analog signals are to be input to SCADA for monitoring, trending, and logging.	✓	Instrumentation preferred manufacturers list is provided in Appendix 2, Attachment 4, Typical Equipment Manufacturer (Page B-4)

Parameter	Design Criteria	Per RFP	Notes/Assumptions
Pressure Transmitters:	Microprocessor type; accuracy: 0.075% of span; Provide 3 valve manifold to allow field calibration check.	✓	
Differential Pressure Transmitters	Microprocessor type; accuracy: 0.075% of span; Provide 5 valve manifold to allow field calibration check.	✓	
Flow Meters	Process flowmeters are to be magnetic type. Provide upstream and downstream straight run of pipe to allow high measurement accuracy. Provide grounding rings and ground per manufacturer's recommendation. Provide removable electrodes where coating is possible. Meters shall not be submerged or direct buried. Provide remote indicator as needed. Select appropriate materials of construction.	✓	
Level Transmitters	Provide ultrasonic or radar type to continuously monitor level. Units shall be corrosion resistant with appropriate rated enclosures. Provide local indicator at ground level. Install per manufacturer's recommendations.	✓	
Use of Pressure Transmitters for Level Sensing	A pressure transmitter may be used to sense water level where an ultrasonic or radar transmitter is not appropriate. Provide pressure indicator adjacent to transmitter.	✓	
Level Switches	Level switches, independent of continuous level monitors, are required where overflows could occur. Level switches are to be used to sense and alarm when fluid has entered a sump. RF admittance type, with self-test feature, are preferred in most applications.	✓	
Weight Transmitters	Certain tanks (day tanks) shall be weighed to determine loss¬in-weight over time to calculate/verify chemical feed rate.	✓	
Analytical Instruments	Analytical instruments include conductivity, pH, turbidity, ORP, particle count, and residual chlorine. Final selection of instruments to be made with consultation of Owner. Mount and provide sample supply, and sample conditioning for good operation. Where possible, provide digital output to SCADA for analytical instrument self diagnostic.	✓	

30.12 Control Panels

Table 30-11is a schedule of PLC control panels for the project. The schedule also identifies the CSI Division (Div 11, Div 13, Div 15, Div 16, etc.) that has primary responsibility for each panel. The PLC control panels provided by vendors shall meet the consistent standard of design with common equipment to the extent possible.

Table 30-11. Control Panel Schedule

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Pre-treatment PLC Control Panel	PLC-001	Division 13	✓	
Treatment Plant Main PLC Control Panel	PLC-100	Division 13	✓	
RO Master PLC Control Panel and Remote I/O Panels	PLC-200 RIO-211 RIO-212 RIO-213 RIO-214 RIO-215 RIO-216 RIO-217 RIO-221 RIO-222 RIO-301	Division 11	✓	Vendor Supplied Panels
Chemical/Brine Systems PLC Panel	PLC-300	Division 13	✓	
On-Site Sodium Hypochlorite Generation and Feed Systems PLC Control Panel	PLC-400	Division 11	✓	Vendor Supplied Panels
UV System PLC Control Panel	PLC-500	Division 11	✓	Vendor Supplied Panels
CO2 System PLC Control Panel	PLC-600	Division 11	✓	Vendor Supplied Panels
Post Treatment System PLC Control Panel	PLC-700	Division 11	✓	Vendor Supplied Panels

31.0 PHYSICAL SECURITY, ELECTRONIC SECURITY AND SPECIAL SYSTEMS

The design includes implementation of physical facility protection features to deter, detect, and delay vandals, criminals, saboteurs, and insider threats. The design criteria associated with these security features are summarized in Table 31-1.

Table 31-1. Security and Special Systems Basis of Design Standards and Requirements

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Site Fencing				
Site Fencing Height	ft	6	✓	
Site fencing materials		PVC coated galvanized steel	✓	
Fencing within 50 ft of either side of the main entrance		Architectural grade fencing	✓	

CDM Smith

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
Main Entrance Gate				
Type		Slide	✓	
Equipment		Closed circuit camera, intercom, lighting, and card access	✓	
Actuator		Electronic	✓	
Actuator manufacturer		HY Security	✓	
Site Lighting				
Down cast pole lights			✓	
Site Areas				
Outdoor electric service equipment		Anti-climb security fencing with intrusion detection	✓	
Critical pumping equipment areas located outdoors		Anti-climb security fencing and intrusion detection	✓	
Wastewater clarification and recycling areas		Fenced with intrusion detection	✓	
Concentrate equalization basin		Fenced	✓	
Enterprise Electronic Security System				
Companywide EESS extension to Project Site and the facilities on the site		System includes both an electronic security system and an electronic fire alarm system.	✓	
System designer/supplier/installer		Tyco, Inc.	✓	
Building electronic access		Card readers control access to all buildings.	✓	
Security Cameras		20 IP type cameras located indoor and outdoor	✓	
External Door Security		Some card swipe / some exit only	✓	
External Door Monitoring		Electronically	✓	
External Door Back Boxes		Each external door includes four low voltage cables (3-18/6, and 1-16/4) with back boxes. Final placement of back boxes will be based on the Tyco design and per Tyco design typical details.	✓	
Internal doors bound to secure portion of administration area		Equipped with card swipe entry devices	✓	
Glass Break System		Included for all rooms with glass windows. Devices will be wired per Tyco design typical details.	✓	
Motion Detection System		Assumed 20 motion detectors for CAW to located once room	✓	

Parameter	Units	Design Criteria	Per RFP	Notes/Assumptions
		layouts are complete		
Security Panel and Computer Server Room (SCPS Room)				
Security panels location		Secure room (SCPS Room)	✓	
Room size	ft	10 x 15	✓	
Climate control		Temperature and humidity	✓	
Monitoring device routing		“home runs” to security panel	✓	
Fiber optic cable routing		SCPS Room	✓	
Network routers and equipment location		SCPS Room	✓	
Electronic Fire Alarm System				
System installer		Tyco	✓	
System manufacturer		Edwards	✓	
Number of devices based on fire code			✓	
Telephone and Intercom System				
Telephone and intercom device type		IP based	✓	
Number of telephony locations		Assumed 20	✓	
Other Parameters				
All wiring and cabling is to be run in conduit and protected from tampering.			✓	
Security features are to be incorporated into hatches, vents, and overflows on all water storage tanks.			✓	
Signs are to be placed at 50 ft intervals around the Project Site perimeter; wording to be determined CAW.			✓	
Chemical fill lines are to be locked.			✓	
Vehicle parking is to be away from the building.			✓	

32.0 LANDSCAPING AND IRRIGATION

KEY REFERENCE DRAWINGS:
A-9 LANDSCAPE PLAN

A landscaping and irrigation plan has been developed for the site and is located in the proposal drawing in the Architectural section. The landscaping plan includes an agricultural education garden. All of the plantings are low water use plants for the entire facility. The beds between the buildings are raised to seat height (16 or 18 inches), while the long beds at the street edge are flush with grade. The materials for the raised beds are decorative CMU block and are 12 inches wide with 14 inch wide cap. The entry path and overlook include more refined yet local materials, while the surrounding landscape is simpler and natural in character and is stabilized decomposed granite and driftwood (salvaged) wood walk over bioswale catchment area. The gardens would be planted with strawberry, kale, onion, artichoke and the plantings would be in raised beds. The planting would go in as flats or 4-in pots and be planted in a certified organic top soil/planter mix suitable for crops. The beds are open to grade with some allowance for in-bed drain inlets should compaction limit natural drainage. The bioswale catchment area a shallow basin 18 inches deep filled with sedges (4-inch pots at 12 or 14 inches on center). The sedges follow the flow line. The edges and surrounding landscape is back dune/maritime chaparral and is a combination of open sand with seasonal windflowers and low mounding shrubs such as manzanita. A drip irrigation system is included in the construction estimate.

33.0 SITE DEVELOPMENT

Site layout has a number of design considerations including cost, hydraulic profile, security, aesthetics, considerations for future improvements, and operations.

KEY REFERENCE DRAWINGS:

- C-1 PROPOSED SITE PLAN
- C-2 SOIL BORING PLAN
- C-3 PAVING AND GRADING PLAN
- C-4 YARD PIPING PLAN
- C-5 FUTURE SURFACE WATER INTAKE OPTION
- G-7 HYDRAULIC PROFILE – 9.6 mgd BASE CASE WITH PRESSURE FILTERS

- The RO process is modular and allowance has been made for expansion to 12.8 mgd.
- An area of the site has been identified for potential installation of seawater pretreatment facilities (SHEET C-5).
- Paved roadways are designed to accommodate large loads of liquid treatment chemicals.
- Turning radii are suitable for the size of trucks and trailers.
- The chemical unloading area is sloped allow for drainage to under the delivery vehicles.
- At grade header curbs are provided to allow drainage from the road surface to infiltration areas adjacent to the roads.

A) RO System Performance Computer Projection

HYBRID SPLIT PARTIAL TWO PASS & Permeate THROTTLING(ALL STAGES) WITH Pressure/Work Exchanger

RO program licensed to:							
Calculation created by:	K. Kiefer			Blended flow:		1600000.6	gpd
Project name:	Max TDS 8C 5 Yr			Permeate flow:	1644445.0 0	400000.00	gpd
HP Pump flow:	1153.0	308.6	gpm	Raw water flow:		3915345.2	gpd
Feed pressure:	902.6	156.3	psi	Permeate recovery:	42.0	90.0	%
Feedwater Temperature:		8.0	C(46F)	Total system recovery:		40.9	%
Feed water pH:	8.00	10.00		Element age:		5.0	years
Chem dose, ppm, ppm	19.3	4.0		Flux decline % per year:	5.0	5.0	
				Fouling Factor	0.77	0.77	
				Salt passage increase, %/yr:	7.0	7.0	
Average flux rate:	7.7	11.0	gfd	Feed type:	Seawater - open intake		

Stage	Perm. Flow	Flow/Vessel Feed	Conc	Flux	Beta	Conc.&Throt. Pressures		Element Type	Elem. No.	Array
	gpm	gpm	gpm	gfd		psi	psi			
1-1	585.6	35.8	28.1	9.2	1.03	896.9	10.0	SWC5-LD	228	76x3
1-2	556.3	28.1	20.8	6.6	1.02	888.8	10.0	SWC6-LD	304	76x4
2-1	204.4	34.3	11.6	11.7	1.23	149.5	10.0	ESPA2-LD	63	9x7
2-2	73.3	26.1	7.7	9.4	1.25	142.1	10.0	ESPA2-LD	28	4x7

	Raw water	Adjusted Water	Feed water	Permeate	Concentrate	ERD Reject
Ion	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Ca	500.0	500.0	511.8	0.298	882.0	861.5
Mg	1400.0	1400.0	1433.2	0.834	2469.7	2412.3
Na	11700.0	11700.0	11975.9	34.325	20595.4	20118.4
K	570.0	570.0	583.4	2.107	1002.7	979.5
NH4	0.0	0.0	0.0	0.000	0.0	0.0
Ba	0.160	0.160	0.164	0.000	0.282	0.3
Sr	15.000	15.000	15.355	0.009	26.461	25.8
CO3	26.4	9.9	10.2	0.000	20.2	20.5
HCO3	150.0	161.9	165.4	0.700	272.9	266.3
SO4	2900.0	2909.1	2978.0	1.735	5131.6	5011.9
Cl	21270.0	21270.0	21771.9	52.109	37451.8	36584.1
F	2.0	2.0	2.0	0.010	3.5	3.4
NO3	0.0	0.0	0.0	0.000	0.0	0.0
B	5.40	5.40	5.50	0.532	8.78	8.6
SiO2	30.0	30.0	30.7	0.06	52.9	51.6
CO2	1.11	1.18	1.18	0.89	0.00	1.18
TDS	38569.0	38573.5	39483.6	92.72	67918.1	66344.4
pH	8.30	8.00	8.00	8.31	7.92	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	30%	31%	62%
SrSO4 / Ksp * 100:	57%	58%	115%
BaSO4 / Ksp * 100:	635%	654%	1218%
SiO2 saturation:	27%	30%	52%
Langelier Saturation Index	1.21	0.88	1.25
Stiff & Davis Saturation Index	0.35	0.02	0.31
Ionic strength	0.77	0.78	1.35
Osmotic pressure	384.3 psi	393.4 psi	676.7 psi

H.P. Differential of Pressure/Work Exchanger	14.5	psi	Pressure/Work Exchanger Leakage:	0.7 %
Pressure/Work Exchanger Boost Pressure	28.3	psi	Volumetric Mixing	5.4 %

HYBRID SPLIT PARTIAL TWO PASS & Permeate THROTTLING(ALL STAGES) WITH Pressure/Work Exchanger

RO program licensed to:							
Calculation created by:	K. Kiefer			Blended flow:		1600000.6	gpd
Project name:	Max TDS 8C 5 Yr			Permeate flow:	1644445.0 0	400000.00	gpd
HP Pump flow:	1153.0	308.6	gpm	Raw water flow:		3915345.2	gpd
Feed pressure:	902.6	156.3	psi	Permeate recovery:	42.0	90.0	%
Feedwater Temperature:		8.0	C(46F)	Total system recovery:		40.9	%
Feed water pH:	8.00	10.00		Element age:		5.0	years
Chem dose, ppm, ppm	19.3	4.0		Flux decline % per year:	5.0	5.0	
				Fouling Factor	0.77	0.77	
				Salt passage increase, %/yr:	7.0	7.0	
Average flux rate:	7.7	11.0	gfd	Feed type:	Seawater - open intake		

Stage	Perm. Flow gpm	Flow/Vessel Feed gpm	Conc gpm	Flux gfd	Beta	Conc.&Throt. Pressures psi	psi	Element Type	Elem. No.	Array
1-1	585.6	35.8	28.1	9.2	1.03	896.9	10.0	SWC5-LD	228	76x3
1-2	556.3	28.1	20.8	6.6	1.02	888.8	10.0	SWC6-LD	304	76x4
2-1	204.4	34.3	11.6	11.7	1.23	149.5	10.0	ESPA2-LD	63	9x7
2-2	73.3	26.1	7.7	9.4	1.25	142.1	10.0	ESPA2-LD	28	4x7

Stg	Elem no.	Feed pres psi	Pres drop psi	Perm flow gpm	Perm Flux gfd	Beta	Perm sal TDS	Conc osm pres	Ca	Cumulative Perm Ion levels Mg	Cl	B	SiO2
1-1	1	902.6	2.1	2.9	10.3	1.03	84.5	427.7	0.28	0.78	47	0.40	0.05
1-1	2	900.5	1.9	2.6	9.2	1.03	93.2	463.8	0.31	0.86	52	0.43	0.06
1-1	3	898.6	1.7	2.3	8.1	1.02	102.9	501.0	0.34	0.95	57	0.47	0.06
1-2	1	893.9	1.5	2.4	8.7	1.03	128.5	548.5	0.47	1.31	79	0.70	0.09
1-2	2	892.4	1.3	2.0	7.2	1.02	152.7	594.8	0.52	1.46	89	0.77	0.10
1-2	3	891.1	1.2	1.6	5.9	1.02	177.6	638.5	0.58	1.63	99	0.85	0.11
1-2	4	889.8	1.1	1.3	4.6	1.02	204.6	677.5	0.67	1.88	114	0.98	0.13
2-1	1	156.3	1.6	3.5	12.5	1.10	3.6	5.0	0.00	0.01	2	0.23	0.00
2-1	2	154.7	1.3	3.3	12.0	1.10	3.8	5.6	0.00	0.01	2	0.24	0.00
2-1	3	153.4	1.1	3.3	11.9	1.12	3.9	6.4	0.00	0.01	2	0.26	0.00
2-1	4	152.2	0.9	3.2	11.7	1.14	4.2	7.4	0.00	0.01	2	0.27	0.00
2-1	5	151.3	0.8	3.2	11.5	1.16	4.6	8.7	0.00	0.01	2	0.29	0.00
2-1	6	150.6	0.6	3.1	11.3	1.19	5.1	10.6	0.00	0.01	3	0.31	0.00
2-1	7	150.0	0.4	3.1	11.0	1.24	5.8	13.4	0.00	0.01	3	0.34	0.00
2-2	1	146.5	1.1	2.9	10.5	1.11	6.3	15.2	0.00	0.01	3	0.33	0.00
2-2	2	145.5	0.9	2.8	10.2	1.10	6.8	17.3	0.00	0.01	4	0.35	0.00
2-2	3	144.6	0.7	2.8	9.9	1.14	7.5	20.0	0.01	0.01	4	0.37	0.00
2-2	4	143.9	0.6	2.7	9.6	1.16	8.4	23.6	0.01	0.02	5	0.39	0.00
2-2	5	143.3	0.5	2.5	9.1	1.19	9.5	28.4	0.01	0.02	5	0.42	0.00
2-2	6	142.8	0.3	2.4	8.6	1.22	11.0	35.2	0.01	0.02	6	0.45	0.00
2-2	7	142.5	0.2	2.2	7.8	1.25	13.2	44.9	0.01	0.03	7	0.50	0.00

Stage	NDP psi
1-1	444.3
1-2	297.3
2-1	134.1
2-2	106.9

HYBRID SPLIT PARTIAL TWO PASS & Permeate THROTTLING(ALL STAGES) WITH Pressure/Work Exchanger PASS 1

RO program licensed to:						
Calculation created by:	K. Kiefer					
Project name:	Max TDS 8C 5 Yr			Permeate flow:	1644445.0 0	gpd
HP Pump flow:		2719.0	gpm	Raw water flow:	3870898.4	gpd
Feed pressure:		902.6	psi	Permeate recovery ratio:	42.0	%
Feedwater Temperature:		8.0	C(46F)			
Feed water pH:		8.00		Element age:	5.0	years
Chem dose,ppm (50%)		19.3	H2SO4	Flux decline % per year:	5.0	%
				Fouling Factor:	0.77	
				Salt passage increase, %/yr:	7.0	
Average flux rate:		7.7	gfd	Feed type:	Seawater - open intake	

Stage	Perm. Flow gpm	Flow/Vessel Feed gpm	Flow/Vessel Conc gpm	Flux gfd	Beta	Conc.&Throt. Pressures psi	Conc.&Throt. Pressures psi	Element Type	Elem. No.	Array
1-1	585.6	35.8	28.1	9.2	1.02	896.9	10.0	SWC5-LD	228	76x3
1-2	556.3	28.1	20.8	6.6	1.02	888.8	10.0	SWC6-LD	304	76x4

	Raw water 1		Feed water 1		Permeate 1		Concentrate 1	
Ion	mg/l	CaCO3	mg/l	CaCO3	Back	Front	mg/l	CaCO3
Ca	500.0	1246.9	511.8	1276.4	1.43	0.39	882.0	2199.6
Mg	1400.0	5761.3	1433.2	5897.9	3.99	1.10	2469.7	10163.3
Na	11700.0	25434.8	11975.9	26034.6	159.92	44.24	20595.4	44772.5
K	570.0	730.8	583.4	748.0	9.73	2.69	1002.7	1285.5
NH4	0.0	0.0	0.0	0.0	0.00	0.00	0.0	0.0
Ba	0.160	0.1	0.164	0.1	0.000	0.000	0.282	0.2
Sr	15.000	17.1	15.355	17.5	0.043	0.012	26.461	30.2
CO3	26.4	44.0	10.2	17.0	0.00	0.00	20.2	33.7
HCO3	150.0	123.0	165.4	135.6	1.62	0.90	272.9	223.7
SO4	2900.0	3020.8	2978.0	3102.1	8.30	2.29	5131.6	5345.4
Cl	21270.0	30000.0	21771.9	30707.9	242.35	67.02	37451.8	52823.4
F	2.0	5.3	2.0	5.4	0.05	0.01	3.5	9.2
NO3	0.0	0.0	0.0	0.0	0.00	0.00	0.0	0.0
B	5.40		5.50		2.16	0.54	8.78	
SiO2	30.0		30.7		0.27	0.08	52.9	
CO2	1.11		1.18		1.18	1.18	1.18	
TDS	38569.0		39483.6		431.6	119.29	67918.1	
pH	8.30		8.00		6.82	6.23	7.92	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	30%	31%	62%
SrSO4 / Ksp * 100:	57%	58%	115%
BaSO4 / Ksp * 100:	635%	654%	1218%
SiO2 saturation:	27%	30%	52%
Langelier Saturation Index	1.21	0.88	1.25
Stiff & Davis Saturation Index	0.35	0.02	0.31
Ionic strength	0.77	0.78	1.35
Osmotic pressure	384.3 psi	393.4 psi	676.7 psi

HYBRID SPLIT PARTIAL TWO PASS WITH Pressure/Work Exchanger & Permeate THROTTLING(ALL STAGES) PASS 2

RO program licensed to:					
Calculation created by:	K. Kiefer				
Project name:	Max TDS 8C 5 Yr		Permeate flow:	400000.00	gpd
Feed pressure:	156.3	psi	Permeate recovery ratio:	90.0	%
Feedwater Temperature:	8.0	C(46F)			
Feed water pH:	10.00		Element age:	5.0	years
Chem dose, ppm (100%)	4.0	NaOH	Flux decline % per year:	5.0	%
			Fouling Factor:	0.77	
			Salt passage increase, %/yr:	7.0	
Average flux rate:	11.0	gfd	Feed type:	Seawater - open intake	

Stage	Perm. Flow	Flow/Vessel Feed	Flow/Vessel Conc	Flux	Beta	Conc.&Throt. Pressures		Element Type	Elem. No.	Array
	gpm	gpm	gpm	gfd		psi	psi			
2-1	204.4	34.3	11.6	11.7	1.24	149.5	10.0	ESPA2-LD	63	9x7
2-2	73.3	26.1	7.7	9.4	1.25	142.1	10.0	ESPA2-LD	28	4x7

	Raw water 2		Feed water 2		Permeate 2		Concentrate 2	
Ion	mg/l	CaCO3	mg/l	CaCO3	mg/l	CaCO3	mg/l	CaCO3
Ca	1.4	3.6	1.4	3.6	0.009	0.0	14.2	35.4
Mg	4.0	16.4	4.0	16.4	0.024	0.1	39.7	163.5
Na	159.9	347.7	159.9	347.7	4.591	10.0	1557.9	3386.8
K	9.7	12.5	9.7	12.5	0.348	0.4	94.2	120.8
NH4	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0
Ba	0.000	0.0	0.000	0.0	0.000	0.0	0.005	0.0
Sr	0.043	0.0	0.043	0.0	0.000	0.0	0.426	0.5
CO3	0.0	0.0	0.6	1.0	0.002	0.0	14.5	24.1
HCO3	3.4	2.8	1.9	1.6	0.105	0.1	9.7	7.9
SO4	8.3	8.6	8.3	8.6	0.064	0.1	82.4	85.9
Cl	242.4	341.8	242.4	341.8	7.363	10.4	2357.3	3324.8
F	0.0	0.1	0.0	0.1	0.003	0.0	0.4	1.1
NO3	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0
B	2.16		2.16		0.50		17.13	
SiO2	0.3		0.3		0.003		2.7	
CO2	1.18		0.00		0.00		0.00	
TDS	431.6		430.8		13.01		4190.5	
pH	6.8		10.00		8.72		10.70	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	0%	0%	0%
SrSO4 / Ksp * 100:	0%	0%	0%
BaSO4 / Ksp * 100:	0%	0%	4%
SiO2 saturation:	0%	0%	0%
Langelier Saturation Index	-4.44	-1.29	1.42
Stiff & Davis Saturation Index	-4.51	-1.37	1.23
Ionic strength	0.01	0.01	0.07
Osmotic pressure	4.5 psi	4.5 psi	44.2 psi

HYBRID SPLIT PARTIAL TWO PASS & Permeate THROTTLING(ALL STAGES) WITH Pressure/Work Exchanger

RO program licensed to:							
Calculation created by:	K. Kiefer			Blended flow:		1600000.9	gpd
Project name:	Avg TDS 12C 5Yr			Permeate flow:	1671112.0 0	640000.00	gpd
HP Pump flow:	1171.4	493.8	gpm	Raw water flow:		3932028.2	gpd
Feed pressure:	796.0	210.3	psi	Permeate recovery:	42.5	90.0	%
Feedwater Temperature:		12.0	C(54F)	Total system recovery:		40.7	%
Feed water pH:	8.00	10.00		Element age:		5.0	years
Chem dose, ppm, ppm	0.0	3.9		Flux decline % per year:	5.0	5.0	
				Fouling Factor	0.77	0.77	
				Salt passage increase, %/yr:	7.0	7.0	
Average flux rate:	7.9	17.6	gfd	Feed type:	Seawater - open intake		

Stage	Perm. Flow	Flow/Vessel Feed	Conc	Flux	Beta	Conc.&Throt. Pressures		Element Type	Elem. No.	Array
	gpm	gpm	gpm	gfd		psi	psi			
1-1	618.1	35.9	27.8	9.8	1.03	790.4	10.0	SWC5-LD	228	76x3
1-2	542.4	27.8	20.7	6.4	1.02	782.3	10.0	SWC6-LD	304	76x4
2-1	323.2	54.9	19.0	18.5	1.23	197.1	10.0	ESPA2-LD	63	9x7
2-2	121.3	42.7	12.3	15.6	1.27	185.3	10.0	ESPA2-LD	28	4x7

	Raw water	Adjusted Water	Feed water	Permeate	Concentrate	ERD Reject
Ion	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Ca	405.0	405.0	414.7	0.198	720.8	703.8
Mg	1262.0	1262.0	1292.3	0.609	2246.0	2193.2
Na	10630.0	10630.0	10883.4	25.421	18869.6	18427.7
K	392.0	392.0	401.3	1.219	695.3	679.0
NH4	0.0	0.0	0.0	0.000	0.0	0.0
Ba	0.013	0.013	0.013	0.000	0.023	0.0
Sr	7.810	7.810	7.997	0.004	13.899	13.6
CO3	6.7	7.0	7.3	0.000	15.0	14.6
HCO3	105.0	107.3	109.6	0.397	180.2	176.2
SO4	2667.0	2667.0	2730.9	1.289	4746.2	4634.7
Cl	19101.0	19101.0	19556.6	38.209	33917.6	33123.1
F	1.3	1.3	1.3	0.006	2.3	2.2
NO3	0.0	0.0	0.0	0.000	0.0	0.0
B	4.80	4.80	4.89	0.445	7.71	7.5
SiO2	1.3	1.3	1.3	0.01	2.3	2.3
CO2	0.71	0.73	0.73	0.44	0.00	0.73
TDS	34585.7	34586.5	35411.6	67.80	61416.8	59978.0
pH	8.00	8.00	8.00	8.00	7.92	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	23%	24%	48%
SrSO4 / Ksp * 100:	28%	29%	57%
BaSO4 / Ksp * 100:	52%	53%	101%
SiO2 saturation:	1%	1%	2%
Langelier Saturation Index	0.69	0.71	1.08
Stiff & Davis Saturation Index	-0.17	-0.16	0.13
Ionic strength	0.69	0.70	1.22
Osmotic pressure	350.3 psi	358.7 psi	622.0 psi

H.P. Differential of Pressure/Work Exchanger	14.5	psi	Pressure/Work Exchanger Leakage:	0.7 %
Pressure/Work Exchanger Boost Pressure	28.2	psi	Volumetric Mixing	5.4 %

HYBRID SPLIT PARTIAL TWO PASS & Permeate THROTTLING(ALL STAGES) WITH Pressure/Work Exchanger

RO program licensed to:							
Calculation created by:	K. Kiefer			Blended flow:		1600000.9	gpd
Project name:	Avg TDS 12C 5Yr			Permeate flow:	1671112.0 0	640000.00	gpd
HP Pump flow:	1171.4	493.8	gpm	Raw water flow:		3932028.2	gpd
Feed pressure:	796.0	210.3	psi	Permeate recovery:	42.5	90.0	%
Feedwater Temperature:		12.0	C(54F)	Total system recovery:		40.7	%
Feed water pH:	8.00	10.00		Element age:		5.0	years
Chem dose, ppm, ppm	0.0	3.9		Flux decline % per year:	5.0	5.0	
				Fouling Factor	0.77	0.77	
				Salt passage increase, %/yr:	7.0	7.0	
Average flux rate:	7.9	17.6	gfd	Feed type:	Seawater - open intake		

Stage	Perm. Flow gpm	Flow/Vessel Feed gpm	Flow/Vessel Conc gpm	Flux gfd	Beta	Conc.&Throt. Pressures psi	psi	Element Type	Elem. No.	Array
1-1	618.1	35.9	27.8	9.8	1.03	790.4	10.0	SWC5-LD	228	76x3
1-2	542.4	27.8	20.7	6.4	1.02	782.3	10.0	SWC6-LD	304	76x4
2-1	323.2	54.9	19.0	18.5	1.23	197.1	10.0	ESPA2-LD	63	9x7
2-2	121.3	42.7	12.3	15.6	1.27	185.3	10.0	ESPA2-LD	28	4x7

Stg	Elem no.	Feed pres psi	Pres drop psi	Perm flow gpm	Perm Flux gfd	Beta	Perm sal TDS	Conc osm pres	Ca	Mg	Cl	B	SiO2
									Cumulative Perm Ion levels				
1-1	1	796.0	2.1	3.1	11.0	1.03	85.1	392.0	0.25	0.79	48	0.42	0.00
1-1	2	793.9	1.9	2.7	9.8	1.03	94.5	427.2	0.28	0.88	53	0.46	0.00
1-1	3	792.0	1.7	2.4	8.5	1.03	105.1	463.2	0.31	0.97	59	0.50	0.00
1-2	1	787.3	1.5	2.4	8.7	1.03	133.4	507.4	0.44	1.38	83	0.76	0.00
1-2	2	785.9	1.3	2.0	7.1	1.02	160.1	549.9	0.50	1.54	93	0.84	0.01
1-2	3	784.5	1.2	1.5	5.6	1.02	188.3	588.4	0.56	1.74	105	0.94	0.01
1-2	4	783.4	1.1	1.2	4.3	1.02	218.1	622.4	0.65	2.02	122	1.08	0.01
2-1	1	210.3	3.0	5.5	19.7	1.10	2.3	4.3	0.00	0.00	1	0.16	0.00
2-1	2	207.3	2.6	5.3	19.0	1.10	2.5	4.8	0.00	0.00	1	0.16	0.00
2-1	3	204.7	2.2	5.2	18.7	1.12	2.6	5.5	0.00	0.01	1	0.17	0.00
2-1	4	202.5	1.8	5.1	18.4	1.14	2.7	6.3	0.00	0.01	1	0.19	0.00
2-1	5	200.6	1.5	5.0	18.2	1.16	2.8	7.4	0.00	0.01	1	0.20	0.00
2-1	6	199.2	1.2	5.0	17.9	1.19	3.1	8.9	0.00	0.01	2	0.21	0.00
2-1	7	198.0	0.9	4.9	17.6	1.23	3.5	11.2	0.00	0.01	2	0.23	0.00
2-2	1	194.1	2.1	4.7	16.9	1.11	3.7	12.7	0.00	0.01	2	0.22	0.00
2-2	2	192.0	1.8	4.6	16.5	1.12	4.0	14.4	0.00	0.01	2	0.24	0.00
2-2	3	190.2	1.5	4.5	16.1	1.14	4.4	16.7	0.00	0.01	2	0.25	0.00
2-2	4	188.8	1.2	4.4	15.7	1.16	4.8	19.6	0.00	0.01	3	0.27	0.00
2-2	5	187.6	0.9	4.2	15.2	1.19	5.4	23.7	0.00	0.01	3	0.29	0.00
2-2	6	186.7	0.7	4.1	14.6	1.22	6.2	29.7	0.00	0.01	3	0.31	0.00
2-2	7	186.0	0.5	3.8	13.8	1.28	7.4	38.8	0.00	0.01	4	0.34	0.00

Stage	NDP psi
1-1	374.1
1-2	237.4
2-1	186.2
2-2	156.3

HYBRID SPLIT PARTIAL TWO PASS & Permeate THROTTLING(ALL STAGES) WITH Pressure/Work Exchanger PASS 1

RO program licensed to:					
Calculation created by:	K. Kiefer				
Project name:	Avg TDS 12C 5Yr		Permeate flow:	1671112.0 0	gpd
HP Pump flow:	2730.6	gpm	Raw water flow:	3860913.4	gpd
Feed pressure:	796.0	psi	Permeate recovery ratio:	42.5	%
Feedwater Temperature:	12.0	C(54F)			
Feed water pH:	8.00		Element age:	5.0	years
Chem dose,ppm (50%)	0.0	H2SO4	Flux decline % per year:	5.0	%
			Fouling Factor:	0.77	
			Salt passage increase, %/yr:	7.0	
Average flux rate:	7.9	gfd	Feed type:	Seawater - open intake	

Stage	Perm. Flow gpm	Flow/Vessel Feed gpm	Flow/Vessel Conc gpm	Flux gfd	Beta	Conc.&Throt. Pressures psi	Conc.&Throt. Pressures psi	Element Type	Elem. No.	Array
1-1	618.1	35.9	27.8	9.8	1.03	790.4	10.0	SWC5-LD	228	76x3
1-2	542.4	27.8	20.7	6.4	1.02	782.3	10.0	SWC6-LD	304	76x4

	Raw water 1		Feed water 1		Permeate 1		Concentrate 1	
Ion	mg/l	CaCO3	mg/l	CaCO3	Back	Front	mg/l	CaCO3
Ca	405.0	1010.0	414.7	1034.2	1.08	0.33	720.8	1797.4
Mg	1262.0	5193.4	1292.3	5317.9	3.39	1.01	2246.0	9242.6
Na	10630.0	23108.7	10883.4	23659.5	136.75	40.63	18869.6	41020.8
K	392.0	502.6	401.3	514.5	6.22	1.93	695.3	891.4
NH4	0.0	0.0	0.0	0.0	0.00	0.00	0.0	0.0
Ba	0.013	0.0	0.013	0.0	0.000	0.000	0.023	0.0
Sr	7.810	8.9	7.997	9.1	0.020	0.007	13.899	15.9
CO3	6.7	201.9	7.3	12.1	0.00	0.00	15.0	25.0
HCO3	105.0	86.1	109.6	89.8	1.28	0.63	180.2	147.7
SO4	2667.0	2778.1	2730.9	2844.7	7.16	2.12	4746.2	4943.9
Cl	19101.0	26940.8	19556.6	27583.4	204.74	60.92	33917.6	47838.6
F	1.3	3.4	1.3	3.5	0.03	0.01	2.3	6.1
NO3	0.0	0.0	0.0	0.0	0.00	0.00	0.0	0.0
B	4.80		4.89		1.84	0.52	7.71	
SiO2	1.3		1.3		0.00	0.01	2.3	
CO2	0.71		0.73		0.73	0.73	0.73	
TDS	34585.7		35411.6		363.3	108.12	61416.8	
pH	8.00		8.00		6.78	6.25	7.92	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	23%	24%	48%
SrSO4 / Ksp * 100:	28%	29%	57%
BaSO4 / Ksp * 100:	52%	53%	101%
SiO2 saturation:	1%	1%	2%
Langelier Saturation Index	0.69	0.71	1.08
Stiff & Davis Saturation Index	-0.17	-0.16	0.13
Ionic strength	0.69	0.70	1.22
Osmotic pressure	350.3 psi	358.7 psi	622.0 psi

HYBRID SPLIT PARTIAL TWO PASS WITH Pressure/Work Exchanger & Permeate THROTTLING(ALL STAGES) PASS 2

RO program licensed to:					
Calculation created by:	K. Kiefer				
Project name:	Avg TDS 12C 5Yr		Permeate flow:	640000.00	gpd
Feed pressure:	210.3	psi	Permeate recovery ratio:	90.0	%
Feedwater Temperature:	12.0	C(54F)			
Feed water pH:	10.00		Element age:	5.0	years
Chem dose, ppm (100%)	3.9	NaOH	Flux decline % per year:	5.0	%
			Fouling Factor:	0.77	
			Salt passage increase, %/yr:	7.0	
Average flux rate:	17.6	gfd	Feed type:	Seawater - open intake	

Stage	Perm. Flow	Flow/Vessel Feed	Flow/Vessel Conc	Flux	Beta	Conc.&Throt. Pressures		Element Type	Elem. No.	Array
	gpm	gpm	gpm	gfd		psi	psi			
2-1	323.2	54.9	19.0	18.5	1.23	197.1	10.0	ESPA2-LD	63	9x7
2-2	121.3	42.7	12.3	15.6	1.28	185.3	10.0	ESPA2-LD	28	4x7

	Raw water 2		Feed water 2		Permeate 2		Concentrate 2	
Ion	mg/l	CaCO3	mg/l	CaCO3	mg/l	CaCO3	mg/l	CaCO3
Ca	1.1	2.7	1.1	2.7	0.004	0.0	10.8	26.9
Mg	3.4	13.9	3.4	13.9	0.014	0.1	33.8	138.9
Na	136.8	297.3	136.8	297.3	2.602	5.7	1344.1	2921.9
K	6.2	8.0	6.2	8.0	0.147	0.2	60.9	78.0
NH4	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0
Ba	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0
Sr	0.020	0.0	0.020	0.0	0.000	0.0	0.203	0.2
CO3	0.0	0.0	0.4	0.7	0.001	0.0	9.8	16.4
HCO3	2.0	1.7	1.2	1.0	0.044	0.0	6.0	4.9
SO4	7.2	7.5	7.2	7.5	0.036	0.0	71.3	74.3
Cl	204.7	288.8	204.7	288.8	4.136	5.8	2010.2	2835.3
F	0.0	0.1	0.0	0.1	0.001	0.0	0.3	0.7
NO3	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0
B	1.84		1.84		0.34		15.35	
SiO2	0.0		0.0		0.000		0.0	
CO2	0.73		0.00		0.00		0.00	
TDS	363.3		362.9		7.32		3562.7	
pH	6.8		10.00		8.54		10.69	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	0%	0%	0%
SrSO4 / Ksp * 100:	0%	0%	0%
BaSO4 / Ksp * 100:	0%	0%	0%
SiO2 saturation:	0%	0%	0%
Langelier Saturation Index	-4.73	-1.51	1.21
Stiff & Davis Saturation Index	-4.78	-1.55	1.06
Ionic strength	0.01	0.01	0.06
Osmotic pressure	3.9 psi	3.9 psi	38.2 psi

HYBRID SPLIT PARTIAL TWO PASS & Permeate THROTTLING(ALL STAGES) WITH Pressure/Work Exchanger

RO program licensed to:							
Calculation created by:	K. Kiefer			Blended flow:		1600000.2	gpd
Project name:	MPWSP Avg S			Permeate flow:	1652778.0 0	475000.00	gpd
HP Pump flow:	1161.7	366.5	gpm	Raw water flow:		3888889.4	gpd
Feed pressure:	739.0	130.3	psi	Permeate recovery:	42.5	90.0	%
Feedwater Temperature:		12.0	C(54F)	Total system recovery:		41.1	%
Feed water pH:	8.00	10.00		Element age:		0.0	years
Chem dose, ppm, ppm	0.0	3.5		Flux decline % per year:	5.0	5.0	
				Fouling Factor	1.00	1.00	
				Salt passage increase, %/yr:	7.0	7.0	
Average flux rate:	7.8	13.0	gfd	Feed type:	Seawater - open intake		

Stage	Perm. Flow	Flow/Vessel Feed	Conc	Flux	Beta	Conc.&Throt. Pressures		Element Type	Elem. No.	Array
	gpm	gpm	gpm	gfd		psi	psi			
1-1	656.8	35.5	26.9	10.4	1.03	733.5	10.0	SWC5-LD	228	76x3
1-2	491.0	26.9	20.4	5.8	1.02	725.6	10.0	SWC6-LD	304	76x4
2-1	244.8	40.7	13.5	14.0	1.24	121.7	10.0	ESPA2-LD	63	9x7
2-2	85.0	30.4	9.2	10.9	1.24	113.3	10.0	ESPA2-LD	28	4x7

	Raw water	Adjusted Water	Feed water	Permeate	Concentrate	ERD Reject
Ion	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Ca	405.0	405.0	413.9	0.175	719.5	704.0
Mg	1262.0	1262.0	1289.9	0.544	2242.1	2193.6
Na	10630.0	10630.0	10863.6	22.563	18849.3	18442.0
K	392.0	392.0	400.6	1.048	694.7	679.7
NH4	0.0	0.0	0.0	0.000	0.0	0.0
Ba	0.013	0.013	0.013	0.000	0.023	0.0
Sr	7.810	7.810	7.982	0.003	13.876	13.6
CO3	6.7	7.0	7.2	0.000	15.0	14.6
HCO3	105.0	107.1	109.2	0.341	180.1	176.4
SO4	2667.0	2667.0	2725.9	1.152	4738.2	4635.5
Cl	19101.0	19101.0	19521.1	33.858	33878.5	33146.2
F	1.3	1.3	1.3	0.005	2.3	2.3
NO3	0.0	0.0	0.0	0.000	0.0	0.0
B	4.80	4.80	4.89	0.377	7.89	7.7
SiO2	1.3	1.3	1.3	0.00	2.3	2.3
CO2	0.71	0.72	0.72	0.51	0.00	0.72
TDS	34585.7	34586.3	35346.9	60.07	61343.7	60017.9
pH	8.00	8.00	8.00	7.91	7.92	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	23%	24%	47%
SrSO4 / Ksp * 100:	28%	28%	57%
BaSO4 / Ksp * 100:	52%	53%	100%
SiO2 saturation:	1%	1%	2%
Langelier Saturation Index	0.69	0.70	1.08
Stiff & Davis Saturation Index	-0.17	-0.16	0.13
Ionic strength	0.69	0.70	1.22
Osmotic pressure	350.3 psi	358.0 psi	621.3 psi

H.P. Differential of Pressure/Work Exchanger	14.5	psi	Pressure/Work Exchanger Leakage:	0.9 %
Pressure/Work Exchanger Boost Pressure	27.9	psi	Volumetric Mixing	5 %

HYBRID SPLIT PARTIAL TWO PASS & Permeate THROTTLING(ALL STAGES) WITH Pressure/Work Exchanger

RO program licensed to:								
Calculation created by:	K. Kiefer			Blended flow:		1600000.2	gpd
Project name:	MPWSP Avg S			Permeate flow:	1652778.0 0	475000.00	gpd
HP Pump flow:	1161.7	366.5	gpm	Raw water flow:		3888889.4	gpd
Feed pressure:	739.0	130.3	psi	Permeate recovery:	42.5	90.0	%
Feedwater Temperature:		12.0	C(54F)	Total system recovery:		41.1	%
Feed water pH:	8.00	10.00		Element age:		0.0	years
Chem dose, ppm, ppm	0.0	3.5		Flux decline % per year:	5.0	5.0	
				Fouling Factor	1.00	1.00	
				Salt passage increase, %/yr:	7.0	7.0	
Average flux rate:	7.8	13.0	gfd	Feed type:	Seawater - open intake		

Stage	Perm. Flow gpm	Flow/Vessel Feed gpm	Flow/Vessel Conc gpm	Flux gfd	Beta	Conc.&Throt. Pressures psi	psi	Element Type	Elem. No.	Array
1-1	656.8	35.5	26.9	10.4	1.03	733.5	10.0	SWC5-LD	228	76x3
1-2	491.0	26.9	20.4	5.8	1.02	725.6	10.0	SWC6-LD	304	76x4
2-1	244.8	40.7	13.5	14.0	1.24	121.7	10.0	ESPA2-LD	63	9x7
2-2	85.0	30.4	9.2	10.9	1.24	113.3	10.0	ESPA2-LD	28	4x7

Stg	Elem no.	Feed pres psi	Pres drop psi	Perm flow gpm	Perm Flux gfd	Beta	Perm sal TDS	Conc osm pres	Ca	Mg	Cl	B	SiO2
									Cumulative Perm Ion levels				
1-1	1	739.0	2.1	3.4	12.1	1.04	57.9	395.4	0.17	0.54	33	0.29	0.00
1-1	2	736.9	1.8	2.9	10.4	1.03	65.5	434.1	0.20	0.61	37	0.32	0.00
1-1	3	735.1	1.6	2.4	8.7	1.03	74.3	472.9	0.22	0.69	42	0.36	0.00
1-2	1	730.5	1.4	2.3	8.4	1.03	96.5	518.0	0.32	1.00	60	0.56	0.00
1-2	2	729.1	1.3	1.8	6.6	1.02	117.7	559.4	0.36	1.13	69	0.63	0.00
1-2	3	727.8	1.1	1.3	4.8	1.02	140.8	593.8	0.42	1.30	79	0.71	0.00
1-2	4	726.6	1.1	1.0	3.5	1.02	165.2	622.0	0.49	1.53	92	0.83	0.01
2-1	1	130.3	2.0	4.2	15.2	1.10	2.2	4.0	0.00	0.00	1	0.15	0.00
2-1	2	128.3	1.7	4.0	14.5	1.10	2.3	4.5	0.00	0.00	1	0.15	0.00
2-1	3	126.6	1.4	4.0	14.3	1.12	2.4	5.2	0.00	0.00	1	0.16	0.00
2-1	4	125.2	1.2	3.9	14.0	1.14	2.6	6.0	0.00	0.00	1	0.18	0.00
2-1	5	124.0	1.0	3.8	13.7	1.16	2.7	7.1	0.00	0.01	1	0.19	0.00
2-1	6	123.0	0.7	3.7	13.4	1.19	2.9	8.6	0.00	0.01	2	0.20	0.00
2-1	7	122.3	0.5	3.6	13.1	1.24	3.3	10.9	0.00	0.01	2	0.22	0.00
2-2	1	118.7	1.3	3.4	12.3	1.11	3.5	12.4	0.00	0.01	2	0.22	0.00
2-2	2	117.4	1.1	3.3	11.9	1.10	3.8	14.1	0.00	0.01	2	0.23	0.00
2-2	3	116.3	0.9	3.2	11.5	1.14	4.2	16.3	0.00	0.01	2	0.25	0.00
2-2	4	115.4	0.7	3.1	11.1	1.16	4.6	19.2	0.00	0.01	2	0.26	0.00
2-2	5	114.7	0.6	2.9	10.6	1.18	5.2	23.1	0.00	0.01	3	0.28	0.00
2-2	6	114.1	0.4	2.7	9.9	1.21	6.0	28.6	0.00	0.01	3	0.31	0.00
2-2	7	113.7	0.3	2.5	8.9	1.24	7.1	36.3	0.00	0.01	4	0.34	0.00

Stage	NDP psi
1-1	312.0
1-2	174.9
2-1	108.8
2-2	84.0

HYBRID SPLIT PARTIAL TWO PASS & Permeate THROTTLING(ALL STAGES) WITH Pressure/Work Exchanger PASS 1

RO program licensed to:						
Calculation created by:	K. Kiefer					
Project name:	MPWSP Avg S			Permeate flow:	1652778.0 0	gpd
HP Pump flow:		2700.6	gpm	Raw water flow:	3836108.8	gpd
Feed pressure:		739.0	psi	Permeate recovery ratio:	42.5	%
Feedwater Temperature:		12.0	C(54F)			
Feed water pH:		8.00		Element age:	0.0	years
Chem dose,ppm (50%)		0.0	H2SO4	Flux decline % per year:	5.0	%
				Fouling Factor:	1.00	
				Salt passage increase, %/yr:	7.0	
Average flux rate:		7.8	gfd	Feed type:	Seawater - open intake	

Stage	Perm. Flow gpm	Flow/Vessel Feed gpm	Flow/Vessel Conc gpm	Flux gfd	Beta	Conc.&Throt. Pressures psi	psi	Element Type	Elem. No.	Array
1-1	656.8	35.5	26.9	10.4	1.03	733.5	10.0	SWC5-LD	228	76x3
1-2	491.0	26.9	20.4	5.8	1.02	725.6	10.0	SWC6-LD	304	76x4

	Raw water 1		Feed water 1		Permeate 1		Concentrate 1	
Ion	mg/l	CaCO3	mg/l	CaCO3	Back	Front	mg/l	CaCO3
Ca	405.0	1010.0	413.9	1032.3	1.01	0.25	719.5	1794.4
Mg	1262.0	5193.4	1289.9	5308.1	3.16	0.77	2242.1	9226.9
Na	10630.0	23108.7	10863.6	23616.6	127.44	31.04	18849.3	40976.7
K	392.0	502.6	400.6	513.6	5.87	1.43	694.7	890.6
NH4	0.0	0.0	0.0	0.0	0.00	0.00	0.0	0.0
Ba	0.013	0.0	0.013	0.0	0.000	0.000	0.023	0.0
Sr	7.810	8.9	7.982	9.1	0.020	0.005	13.876	15.8
CO3	6.7	201.9	7.2	12.0	0.00	0.00	15.0	24.9
HCO3	105.0	86.1	109.2	89.5	0.97	0.47	180.1	147.6
SO4	2667.0	2778.1	2725.9	2839.5	6.67	1.62	4738.2	4935.6
Cl	19101.0	26940.8	19521.1	27533.2	190.88	46.48	33878.5	47783.5
F	1.3	3.4	1.3	3.5	0.03	0.01	2.3	6.1
NO3	0.0	0.0	0.0	0.0	0.00	0.00	0.0	0.0
B	4.80		4.89		1.76	0.39	7.89	
SiO2	1.3		1.3		0.01	0.00	2.3	
CO2	0.71		0.72		0.72	0.72	0.72	
TDS	34585.7		35346.9		338.8	82.47	61343.7	
pH	8.00		8.00		6.75	6.12	7.92	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	23%	24%	47%
SrSO4 / Ksp * 100:	28%	28%	57%
BaSO4 / Ksp * 100:	52%	53%	100%
SiO2 saturation:	1%	1%	2%
Langelier Saturation Index	0.69	0.70	1.08
Stiff & Davis Saturation Index	-0.17	-0.16	0.13
Ionic strength	0.69	0.70	1.22
Osmotic pressure	350.3 psi	358.0 psi	621.3 psi

HYBRID SPLIT PARTIAL TWO PASS WITH Pressure/Work Exchanger & Permeate THROTTLING(ALL STAGES) PASS 2

RO program licensed to:					
Calculation created by:	K. Kiefer				
Project name:	MPWSP Avg S		Permeate flow:	475000.00	gpd
Feed pressure:	130.3	psi	Permeate recovery ratio:	90.0	%
Feedwater Temperature:	12.0	C(54F)			
Feed water pH:	10.00		Element age:	0.0	years
Chem dose, ppm (100%)	3.5	NaOH	Flux decline % per year:	5.0	%
			Fouling Factor:	1.00	
			Salt passage increase, %/yr:	7.0	
Average flux rate:	13.0	gfd	Feed type:	Seawater - open intake	

Stage	Perm. Flow	Flow/Vessel Feed	Flow/Vessel Conc	Flux	Beta	Conc.&Throt. Pressures		Element Type	Elem. No.	Array
	gpm	gpm	gpm	gfd		psi	psi			
2-1	244.8	40.7	13.5	14.0	1.24	121.7	10.0	ESPA2-LD	63	9x7
2-2	85.0	30.4	9.2	10.9	1.24	113.3	10.0	ESPA2-LD	28	4x7

	Raw water 2		Feed water 2		Permeate 2		Concentrate 2	
Ion	mg/l	CaCO3	mg/l	CaCO3	mg/l	CaCO3	mg/l	CaCO3
Ca	1.0	2.5	1.0	2.5	0.004	0.0	10.1	25.2
Mg	3.2	13.0	3.2	13.0	0.013	0.1	31.5	129.4
Na	127.4	277.0	127.4	277.0	2.488	5.4	1252.0	2721.8
K	5.9	7.5	5.9	7.5	0.143	0.2	57.4	73.6
NH4	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0
Ba	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0
Sr	0.020	0.0	0.020	0.0	0.000	0.0	0.195	0.2
CO3	0.0	0.0	0.4	0.6	0.001	0.0	8.8	14.7
HCO3	1.9	1.6	1.1	0.9	0.041	0.0	5.4	4.4
SO4	6.7	6.9	6.7	6.9	0.035	0.0	66.4	69.2
Cl	190.9	269.2	190.9	269.2	3.957	5.6	1873.2	2642.0
F	0.0	0.1	0.0	0.1	0.001	0.0	0.2	0.7
NO3	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0
B	1.76		1.76		0.34		14.54	
SiO2	0.0		0.0		0.000		0.1	
CO2	0.72		0.00		0.00		0.00	
TDS	338.8		338.3		7.02		3319.9	
pH	6.8		10.00		8.55		10.69	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	0%	0%	0%
SrSO4 / Ksp * 100:	0%	0%	0%
BaSO4 / Ksp * 100:	0%	0%	0%
SiO2 saturation:	0%	0%	0%
Langelier Saturation Index	-4.80	-1.58	1.14
Stiff & Davis Saturation Index	-4.85	-1.63	1.00
Ionic strength	0.01	0.01	0.06
Osmotic pressure	3.6 psi	3.6 psi	35.6 psi

HYBRID SPLIT PARTIAL TWO PASS & Permeate THROTTLING(ALL STAGES) WITH Pressure/Work Exchanger

RO program licensed to:							
Calculation created by:	K. Kiefer			Blended flow:		1600000.9	gpd
Project name:	Max TDS 20C 5Yr			Permeate flow:	1671112.0 0	640000.00	gpd
HP Pump flow:	1174.9	493.8	gpm	Raw water flow:		3978838.1	gpd
Feed pressure:	815.9	178.7	psi	Permeate recovery:	42.0	90.0	%
Feedwater Temperature:		20.0	C(68F)	Total system recovery:		40.2	%
Feed water pH:	8.30	10.00		Element age:		5.0	years
Chem dose, ppm, ppm	0.0	5.3		Flux decline % per year:	5.0	5.0	
				Fouling Factor	0.77	0.77	
				Salt passage increase, %/yr:	7.0	7.0	
Average flux rate:	7.9	17.6	gfd	Feed type:	Seawater - open intake		

Stage	Perm. Flow gpm	Flow/Vessel Feed gpm	Conc gpm	Flux gfd	Beta	Conc.&Throt. Pressures psi	psi	Element Type	Elem. No.	Array
1-1	687.3	36.4	27.3	10.9	1.03	810.3	10.0	SWC5-LD	228	76x3
1-2	473.2	27.3	21.1	5.6	1.02	802.3	10.0	SWC6-LD	304	76x4
2-1	335.3	54.9	17.6	19.2	1.24	165.8	10.0	ESPA2-LD	63	9x7
2-2	109.2	39.6	12.3	14.0	1.21	155.0	10.0	ESPA2-LD	28	4x7

	Raw water	Adjusted Water	Feed water	Permeate	Concentrate	ERD Reject
Ion	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Ca	500.0	500.0	511.6	0.302	881.2	861.2
Mg	1400.0	1400.0	1432.4	0.846	2467.5	2411.4
Na	11700.0	11700.0	11968.8	36.199	20546.7	20082.0
K	570.0	570.0	583.1	2.247	999.9	977.3
NH4	0.0	0.0	0.0	0.000	0.0	0.0
Ba	0.160	0.160	0.164	0.000	0.282	0.3
Sr	15.000	15.000	15.348	0.009	26.437	25.8
CO3	28.4	29.6	30.4	0.001	57.1	55.4
HCO3	150.0	153.2	156.3	0.680	255.4	249.9
SO4	2900.0	2900.0	2967.2	1.761	5110.9	4994.7
Cl	21270.0	21270.0	21759.2	55.132	37370.4	36524.7
F	2.0	2.0	2.0	0.011	3.5	3.4
NO3	0.0	0.0	0.0	0.000	0.0	0.0
B	5.40	5.40	5.49	0.618	8.42	8.3
SiO2	30.0	30.0	30.7	0.06	52.8	51.6
CO2	0.41	0.42	0.42	0.25	0.00	0.42
TDS	38569.0	38575.4	39462.7	97.86	67780.4	66246.1
pH	8.30	8.30	8.30	8.65	8.20	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	26%	27%	54%
SrSO4 / Ksp * 100:	49%	51%	100%
BaSO4 / Ksp * 100:	635%	651%	1213%
SiO2 saturation:	21%	22%	38%
Langelier Saturation Index	1.47	1.51	1.86
Stiff & Davis Saturation Index	0.54	0.57	0.86
Ionic strength	0.77	0.78	1.35
Osmotic pressure	400.7 psi	410.0 psi	704.0 psi

H.P. Differential of Pressure/Work Exchanger	14.5	psi	Pressure/Work Exchanger Leakage:	0.9 %
Pressure/Work Exchanger Boost Pressure	28.2	psi	Volumetric Mixing	5.3 %

HYBRID SPLIT PARTIAL TWO PASS & Permeate THROTTLING(ALL STAGES) WITH Pressure/Work Exchanger

RO program licensed to:							
Calculation created by:	K. Kiefer			Blended flow:		1600000.9	gpd
Project name:	Max TDS 20C 5Yr			Permeate flow:	1671112.0 0	640000.00	gpd
HP Pump flow:	1174.9	493.8	gpm	Raw water flow:		3978838.1	gpd
Feed pressure:	815.9	178.7	psi	Permeate recovery:	42.0	90.0	%
Feedwater Temperature:		20.0	C(68F)	Total system recovery:		40.2	%
Feed water pH:	8.30	10.00		Element age:		5.0	years
Chem dose, ppm, ppm	0.0	5.3		Flux decline % per year:	5.0	5.0	
				Fouling Factor	0.77	0.77	
				Salt passage increase, %/yr:	7.0	7.0	
Average flux rate:	7.9	17.6	gfd	Feed type:	Seawater - open intake		

Stage	Perm. Flow gpm	Flow/Vessel Feed gpm	Flow/Vessel Conc gpm	Flux gfd	Beta	Conc.&Throt. Pressures psi	psi	Element Type	Elem. No.	Array
1-1	687.3	36.4	27.3	10.9	1.03	810.3	10.0	SWC5-LD	228	76x3
1-2	473.2	27.3	21.1	5.6	1.02	802.3	10.0	SWC6-LD	304	76x4
2-1	335.3	54.9	17.6	19.2	1.24	165.8	10.0	ESPA2-LD	63	9x7
2-2	109.2	39.6	12.3	14.0	1.21	155.0	10.0	ESPA2-LD	28	4x7

Stg	Elem no.	Feed pres psi	Pres drop psi	Perm flow gpm	Perm Flux gfd	Beta	Perm sal TDS	Conc osm pres	Ca	Cumulative Perm Ion levels Mg	Cl	B	SiO2
1-1	1	815.9	2.1	3.6	12.9	1.04	115.3	454.7	0.38	1.07	65	0.49	0.07
1-1	2	813.8	1.9	3.0	10.8	1.03	132.1	500.4	0.44	1.22	74	0.55	0.08
1-1	3	811.9	1.7	2.4	8.8	1.03	151.3	545.0	0.50	1.39	85	0.61	0.09
1-2	1	807.3	1.4	2.3	8.4	1.03	198.6	595.8	0.73	2.03	123	0.97	0.14
1-2	2	805.8	1.3	1.7	6.2	1.03	245.9	639.1	0.84	2.36	143	1.11	0.16
1-2	3	804.5	1.2	1.3	4.5	1.02	295.3	675.0	0.97	2.72	165	1.25	0.18
1-2	4	803.3	1.1	0.9	3.3	1.02	347.1	702.9	1.14	3.20	194	1.45	0.22
2-1	1	178.7	3.0	5.9	21.3	1.11	4.1	7.5	0.00	0.01	2	0.28	0.00
2-1	2	175.7	2.6	5.6	20.1	1.10	4.5	8.4	0.00	0.01	2	0.30	0.00
2-1	3	173.1	2.1	5.5	19.6	1.13	5.0	9.6	0.00	0.01	3	0.32	0.00
2-1	4	171.0	1.8	5.3	19.2	1.15	5.5	11.2	0.00	0.01	3	0.34	0.00
2-1	5	169.2	1.4	5.2	18.7	1.17	6.2	13.3	0.00	0.01	3	0.36	0.00
2-1	6	167.8	1.1	5.1	18.2	1.20	7.0	16.2	0.00	0.01	4	0.39	0.00
2-1	7	166.7	0.8	4.9	17.6	1.25	8.2	20.7	0.01	0.02	4	0.43	0.00
2-2	1	162.9	1.9	4.6	16.5	1.12	9.0	23.6	0.01	0.02	5	0.41	0.00
2-2	2	161.1	1.6	4.4	15.8	1.10	10.0	27.0	0.01	0.02	5	0.44	0.00
2-2	3	159.5	1.3	4.2	15.1	1.14	11.2	31.3	0.01	0.02	6	0.47	0.00
2-2	4	158.2	1.0	4.0	14.3	1.16	12.7	36.8	0.01	0.03	7	0.50	0.00
2-2	5	157.2	0.8	3.7	13.3	1.18	14.6	44.0	0.01	0.03	8	0.54	0.00
2-2	6	156.4	0.6	3.4	12.1	1.20	17.3	53.5	0.01	0.04	9	0.58	0.00
2-2	7	155.7	0.5	2.9	10.6	1.22	21.1	65.9	0.02	0.04	11	0.63	0.01

Stage	NDP psi
1-1	328.2
1-2	178.2
2-1	148.7
2-2	107.4

HYBRID SPLIT PARTIAL TWO PASS & Permeate THROTTLING(ALL STAGES) WITH Pressure/Work Exchanger PASS 1

RO program licensed to:					
Calculation created by:	K. Kiefer				
Project name:	Max TDS 20C 5Yr		Permeate flow:	1671112.0 0	gpd
HP Pump flow:	2763.1	gpm	Raw water flow:	3907723.2	gpd
Feed pressure:	815.9	psi	Permeate recovery ratio:	42.0	%
Feedwater Temperature:	20.0	C(68F)			
Feed water pH:	8.30		Element age:	5.0	years
Chem dose,ppm (50%)	0.0	H2SO4	Flux decline % per year:	5.0	%
			Fouling Factor:	0.77	
			Salt passage increase, %/yr:	7.0	
Average flux rate:	7.9	gfd	Feed type:	Seawater - open intake	

Stage	Perm. Flow gpm	Flow/Vessel Feed gpm	Flow/Vessel Conc gpm	Flux gfd	Beta	Conc.&Throt. Pressures psi	Conc.&Throt. Pressures psi	Element Type	Elem. No.	Array
1-1	687.3	36.4	27.3	10.9	1.03	810.3	10.0	SWC5-LD	228	76x3
1-2	473.2	27.3	21.1	5.6	1.02	802.3	10.0	SWC6-LD	304	76x4

	Raw water 1		Feed water 1		Permeate 1		Concentrate 1	
Ion	mg/l	CaCO3	mg/l	CaCO3	Back	Front	mg/l	CaCO3
Ca	500.0	1246.9	511.6	1275.8	2.01	0.49	881.2	2197.6
Mg	1400.0	5761.3	1432.4	5894.8	5.63	1.38	2467.5	10154.3
Na	11700.0	25434.8	11968.8	26019.1	225.19	55.45	20546.7	44666.7
K	570.0	730.8	583.1	747.5	13.70	3.38	999.9	1281.9
NH4	0.0	0.0	0.0	0.0	0.00	0.00	0.0	0.0
Ba	0.160	0.1	0.164	0.1	0.001	0.000	0.282	0.2
Sr	15.000	17.1	15.348	17.5	0.060	0.015	26.437	30.2
CO3	28.4	853.4	30.4	50.7	0.00	0.00	57.1	95.1
HCO3	150.0	123.0	156.3	128.1	2.57	1.09	255.4	209.4
SO4	2900.0	3020.8	2967.2	3090.8	11.66	2.87	5110.9	5323.8
Cl	21270.0	30000.0	21759.2	30690.0	341.31	84.02	37370.4	52708.6
F	2.0	5.3	2.0	5.4	0.06	0.02	3.5	9.2
NO3	0.0	0.0	0.0	0.0	0.00	0.00	0.0	0.0
B	5.40		5.49		2.58	0.61	8.42	
SiO2	30.0		30.7		0.38	0.09	52.8	
CO2	0.41		0.42		0.42	0.42	0.42	
TDS	38569.0		39462.7		607.0	149.42	67780.4	
pH	8.30		8.30		7.28	6.65	8.20	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	26%	27%	54%
SrSO4 / Ksp * 100:	49%	51%	100%
BaSO4 / Ksp * 100:	635%	651%	1213%
SiO2 saturation:	21%	22%	38%
Langelier Saturation Index	1.47	1.51	1.86
Stiff & Davis Saturation Index	0.54	0.57	0.86
Ionic strength	0.77	0.78	1.35
Osmotic pressure	400.7 psi	410.0 psi	704.0 psi

HYBRID SPLIT PARTIAL TWO PASS WITH Pressure/Work Exchanger & Permeate THROTTLING(ALL STAGES) PASS 2

RO program licensed to:					
Calculation created by:	K. Kiefer				
Project name:	Max TDS 20C 5Yr		Permeate flow:	640000.00	gpd
Feed pressure:	178.7	psi	Permeate recovery ratio:	90.0	%
Feedwater Temperature:	20.0	C(68F)			
Feed water pH:	10.00		Element age:	5.0	years
Chem dose, ppm (100%)	5.3	NaOH	Flux decline % per year:	5.0	%
			Fouling Factor:	0.77	
			Salt passage increase, %/yr:	7.0	
Average flux rate:	17.6	gfd	Feed type:	Seawater - open intake	

Stage	Perm. Flow	Flow/Vessel Feed	Flow/Vessel Conc	Flux	Beta	Conc.&Throt. Pressures		Element Type	Elem. No.	Array
	gpm	gpm	gpm	gfd		psi	psi			
2-1	335.3	54.9	17.6	19.2	1.25	165.8	10.0	ESPA2-LD	63	9x7
2-2	109.2	39.6	12.3	14.0	1.22	155.0	10.0	ESPA2-LD	28	4x7

	Raw water 2		Feed water 2		Permeate 2		Concentrate 2	
Ion	mg/l	CaCO3	mg/l	CaCO3	mg/l	CaCO3	mg/l	CaCO3
Ca	2.0	5.0	2.0	5.0	0.014	0.0	20.0	49.8
Mg	5.6	23.2	5.6	23.2	0.039	0.2	55.9	230.2
Na	225.2	489.6	225.2	489.6	7.318	15.9	2186.1	4752.3
K	13.7	17.6	13.7	17.6	0.554	0.7	132.0	169.3
NH4	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0
Ba	0.001	0.0	0.001	0.0	0.000	0.0	0.006	0.0
Sr	0.060	0.1	0.060	0.1	0.000	0.0	0.599	0.7
CO3	0.0	0.1	0.5	0.8	0.002	0.0	10.4	17.3
HCO3	4.4	3.6	1.2	1.0	0.072	0.1	5.4	4.5
SO4	11.7	12.1	11.7	12.1	0.102	0.1	115.7	120.5
Cl	341.3	481.4	341.3	481.4	11.794	16.6	3307.0	4664.3
F	0.1	0.2	0.1	0.2	0.004	0.0	0.6	1.6
NO3	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0
B	2.58		2.58		0.63		20.14	
SiO2	0.4		0.4		0.005		3.8	
CO2	0.42		0.00		0.00		0.00	
TDS	607.0		604.3		20.54		5857.6	
pH	7.3		10.00		8.79		10.67	

	Raw water	Feed water	Concentrate
CaSO4 / Ksp * 100:	0%	0%	0%
SrSO4 / Ksp * 100:	0%	0%	0%
BaSO4 / Ksp * 100:	0%	0%	6%
SiO2 saturation:	0%	0%	0%
Langelier Saturation Index	-3.46	-1.06	1.62
Stiff & Davis Saturation Index	-3.44	-1.04	1.39
Ionic strength	0.01	0.01	0.10
Osmotic pressure	6.7 psi	6.7 psi	64.5 psi

HYBRID SPLIT PARTIAL TWO PASS & Permeate THROTTLING(ALL STAGES) WITH Pressure/Work Exchanger

RO program licensed to:							
Calculation created by:	K. Kiefer			Blended flow:		1600000.9	gpd
Project name:	Max TDS 20C 5Yr			Permeate flow:	1671112.0 0	640000.00	gpd
HP Pump flow:	1174.9	493.8	gpm	Raw water flow:		3978838.1	gpd
Feed pressure:	815.9	178.7	psi	Permeate recovery:	42.0	90.0	%
Feedwater Temperature:		20.0	C(68F)	Total system recovery:		40.2	%
Feed water pH:	8.30	10.00		Element age:		5.0	years
Chem dose, ppm, ppm	0.0	5.3		Flux decline % per year:	5.0	5.0	
				Fouling Factor	0.77	0.77	
				Salt passage increase, %/yr:	7.0	7.0	
Average flux rate:	7.9	17.6	gfd	Feed type:	Seawater - open intake		

****
**** THE FOLLOWING PARAMETERS EXCEED RECOMMENDED DESIGN LIMITS: ***
****

Concentrate Langelier Saturation Index too high (1.86)

The following are recommended general guidelines for designing a reverse osmosis system using Hydranautics membrane elements. Please consult Hydranautics for specific recommendations for operation beyond the specified guidelines.

Feed and Concentrate flow rate limits

Element diameter	Maximum feed flow rate	Minimum concentrate rate
8.0 inches	75 gpm (283.9 lpm)	12 gpm (45.4 lpm)
8.0 inches(Full Fit)	75 gpm (283.9 lpm)	30 gpm (113.6 lpm)

Concentrate polarization factor (beta) should not exceed 1.2 for standard elements

Saturation limits for sparingly soluble salts in concentrate

Soluble salt	Saturation
BaSO4	6000%
CaSO4	230%
SrSO4	800%
SiO2	100%

Langelier Saturation Index for concentrate should not exceed 1.8

The above saturation limits only apply when using effective scale inhibitor.
Without scale inhibitor, concentrate saturation should not exceed 100%.

B) Preliminary Valve Schedule

Notes: The instrumentation isolation ball valves are not included in the Valve List

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
1	I-4	BFV-001-00	BUTTERFLY VALVE	RW	16"	HDPE	Bypass to Concentrate Basin	Manual		
2	I-4	BPV-002-00	ACK PRESSURE REGULATING VALV	SHC	1 1/2"	PVC	Sodium Hypochlorite to Raw Water Intake			
3	I-4	BV-007-00	BALL VALVE	DR	1/2"	PVC	Sodium Hypochlorite to Raw Water Intake Drain Line	Manual		
4	I-4	BV-006-00	BALL VALVE	SHC	1 1/2"	PVC	Sodium Hypochlorite to Raw Water Intake	Manual		
5	I-4	BCV-002-00	BALL CHECK VALVE	SHC	1 1/2"	PVC	Sodium Hypochlorite to Raw Water Intake	Manual		
6	I-4	BPV-003-00	ACK PRESSURE REGULATING VALV	FeCL3	1/2"	PVC	Future Ferric Chloride to Raw Water Intake			Future
7	I-4	BV-009-00	BALL VALVE	DR	1/2"	PVC	Future Ferric Chloride to Raw Water Intake Drain Line	Manual		Future
8	I-4	BV-008-00	BALL VALVE	FeCL3	1/2"	PVC	Future Ferric Chloride to Raw Water Intake	Manual		Future
9	I-4	BCV-003-00	BALL CHECK VALVE	FeCL3	1/2"	PVC	Future Ferric Chloride to Raw Water Intake	Manual		Future
10	I-4	BFP-001-00	BACKFLOW PREVENTOR	PW	1 1/2"	PVC	Plant Water to Eyewash Station			
11	I-4	BV-005-00	BALL VALVE	PW	1 1/2"	PVC	Plant Water to Eyewash Station	Manual		
12	I-5	ARV-101-00	AIR RELEASE VALVE	V	6"	PVC	Filter No. 1			
13	I-5	ARV-103-00	AIR RELEASE VALVE	V	6"	PVC	Filter No. 3			
14	I-5	ARV-105-00	AIR RELEASE VALVE	V	6"	PVC	Filter No. 5			
15	I-5	ARV-107-00	AIR RELEASE VALVE	V	6"	PVC	Filter No. 7			
16	I-5	ARV-109-00	AIR RELEASE VALVE	V	6"	PVC	Filter No. 9			
17	I-5	BFV-101-01	BUTTERFLY VALVE	RW	12"	FRB	Raw Water Inlet to Filter No. 1	Pneumatic	Double Acting	
18	I-5	BFV-101-02	BUTTERFLY VALVE	BWW	24"	FRP	Backwash Waste Discharge from Filter No. 1	Pneumatic	Double Acting	
19	I-5	BFV-101-03	BUTTERFLY VALVE	BWS	24"	FRP	Backwash Supply to Filter No. 1	Pneumatic	Double Acting	
20	I-5	BFV-101-04	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 1 Effluent	Pneumatic	Double Acting	
21	I-5	BFV-101-06	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 1 Effluent	Electric	Open/Close	
22	I-5	BFV-101-07	BUTTERFLY VALVE	V	6"	PVC	Filter No. 1	Manual		
23	I-5	BFV-101-08	BUTTERFLY VALVE	FW	18"	FRP	Filter No. 1 Effluent	Manual		
24	I-5	BFV-101-09	BUTTERFLY VALVE	FTW	12"	HDPE	Filter No. 1 Effluent to Backwash Reclamation Basin	Manual		
25	I-5	BFV-103-01	BUTTERFLY VALVE	RW	12"	FRB	Raw Water Inlet to Filter No. 3	Pneumatic	Double Acting	
26	I-5	BFV-103-02	BUTTERFLY VALVE	BWW	24"	FRP	Backwash Waste Discharge from Filter No. 3	Pneumatic	Double Acting	

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
27	I-5	BFV-103-03	BUTTERFLY VALVE	BWS	24"	FRP	Backwash Supply to Filter No. 3	Pneumatic	Double Acting	
28	I-5	BFV-103-04	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 3 Effluent	Pneumatic	Double Acting	
29	I-5	BFV-103-06	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 3 Effluent	Electric	Open/Close	
30	I-5	BFV-103-07	BUTTERFLY VALVE	V	6"	PVC	Filter No. 3	Manual		
31	I-5	BFV-103-08	BUTTERFLY VALVE	FW	18"	FRP	Filter No. 3 Effluent	Manual		
32	I-5	BFV-103-09	BUTTERFLY VALVE	FTW	12"	HDPE	Filter No. 3 Effluent to Backwash Reclamation Basin	Manual		
33	I-5	BFV-105-01	BUTTERFLY VALVE	RW	12"	FRB	Raw Water Inlet to Filter No. 5	Pneumatic	Double Acting	
34	I-5	BFV-105-02	BUTTERFLY VALVE	BWW	24"	FRP	Backwash Waste Discharge from Filter No. 5	Pneumatic	Double Acting	
35	I-5	BFV-105-03	BUTTERFLY VALVE	BWS	24"	FRP	Backwash Supply to Filter No. 5	Pneumatic	Double Acting	
36	I-5	BFV-105-04	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 5 Effluent	Pneumatic	Double Acting	
37	I-5	BFV-105-06	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 5 Effluent	Electric	Open/Close	
38	I-5	BFV-105-07	BUTTERFLY VALVE	V	6"	PVC	Filter No. 5	Manual		
39	I-5	BFV-105-08	BUTTERFLY VALVE	FW	18"	FRP	Filter No. 5 Effluent	Manual		
40	I-5	BFV-105-09	BUTTERFLY VALVE	FTW	12"	HDPE	Filter No. 5 Effluent to Backwash Reclamation Basin	Manual		
41	I-5	BFV-107-01	BUTTERFLY VALVE	RW	12"	FRB	Raw Water Inlet to Filter No. 7	Pneumatic	Double Acting	
42	I-5	BFV-107-02	BUTTERFLY VALVE	BWW	24"	FRP	Backwash Waste Discharge from Filter No. 7	Pneumatic	Double Acting	
43	I-5	BFV-107-03	BUTTERFLY VALVE	BWS	24"	FRP	Backwash Supply to Filter No. 7	Pneumatic	Double Acting	
44	I-5	BFV-107-04	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 7 Effluent	Pneumatic	Double Acting	
45	I-5	BFV-107-06	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 7 Effluent	Electric	Open/Close	
46	I-5	BFV-107-07	BUTTERFLY VALVE	V	6"	PVC	Filter No. 7	Manual		
47	I-5	BFV-107-08	BUTTERFLY VALVE	FW	18"	FRP	Filter No. 7 Effluent	Manual		
48	I-5	BFV-107-09	BUTTERFLY VALVE	FTW	12"	HDPE	Filter No. 7 Effluent to Backwash Reclamation Basin	Manual		
49	I-5	BFV-109-01	BUTTERFLY VALVE	RW	12"	FRB	Raw Water Inlet to Filter No. 9	Pneumatic	Double Acting	
50	I-5	BFV-109-02	BUTTERFLY VALVE	BWW	24"	FRP	Backwash Waste Discharge from Filter No. 9	Pneumatic	Double Acting	
51	I-5	BFV-109-03	BUTTERFLY VALVE	BWS	24"	FRP	Backwash Supply to Filter No. 9	Pneumatic	Double Acting	
52	I-5	BFV-109-04	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 9 Effluent	Pneumatic	Double Acting	
53	I-5	BFV-109-06	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 9 Effluent	Electric	Open/Close	

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
54	I-5	BFV-109-07	BUTTERFLY VALVE	V	6"	PVC	Filter No. 9	Manual		
55	I-5	BFV-109-08	BUTTERFLY VALVE	FW	18"	FRP	Filter No. 9 Effluent	Manual		
56	I-5	BFV-109-09	BUTTERFLY VALVE	FTW	12"	HDPE	Filter No. 9 Effluent to Backwash Reclamation Basin	Manual		
57	I-5	BV-101-02	BALL VALVE	V	6"	PVC	Filter No. 1	Manual		
58	I-5	BV-103-02	BALL VALVE	V	6"	PVC	Filter No. 3	Manual		
59	I-5	BV-105-02	BALL VALVE	V	6"	PVC	Filter No. 5	Manual		
60	I-5	BV-107-02	BALL VALVE	V	6"	PVC	Filter No. 7	Manual		
61	I-5	BV-109-02	BALL VALVE	V	6"	PVC	Filter No. 9	Manual		
62	I-6	ARV-102-00	AIR RELEASE VALVE	V	6"	PVC	Filter No. 2			
63	I-6	ARV-104-00	AIR RELEASE VALVE	V	6"	PVC	Filter No. 4			
64	I-6	ARV-106-00	AIR RELEASE VALVE	V	6"	PVC	Filter No. 6			
65	I-6	ARV-108-00	AIR RELEASE VALVE	V	6"	PVC	Filter No. 8			
66	I-6	ARV-110-00	AIR RELEASE VALVE	V	6"	PVC	Filter No. 10			
67	I-6	BFV-102-01	BUTTERFLY VALVE	RW	12"	FRB	Raw Water Inlet to Filter No. 2	Pneumatic	Double Acting	
68	I-6	BFV-102-02	BUTTERFLY VALVE	BWW	24"	FRP	Backwash Waste Discharge from Filter No. 2	Pneumatic	Double Acting	
69	I-6	BFV-102-03	BUTTERFLY VALVE	BWS	24"	FRP	Backwash Supply to Filter No. 2	Pneumatic	Double Acting	
70	I-6	BFV-102-04	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 2 Effluent	Pneumatic	Double Acting	
71	I-6	BFV-102-06	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 2 Effluent	Electric	Open/Close	
72	I-6	BFV-102-07	BUTTERFLY VALVE	V	6"	PVC	Filter No. 2	Manual		
73	I-6	BFV-102-08	BUTTERFLY VALVE	FW	18"	FRP	Filter No. 2 Effluent	Manual		
74	I-6	BFV-102-09	BUTTERFLY VALVE	FTW	12"	HDPE	Filter No. 2 Effluent to Backwash Reclamation Basin	Manual		
75	I-6	BFV-104-01	BUTTERFLY VALVE	RW	12"	FRB	Raw Water Inlet to Filter No. 4	Pneumatic	Double Acting	
76	I-6	BFV-104-02	BUTTERFLY VALVE	BWW	24"	FRP	Backwash Waste Discharge from Filter No. 4	Pneumatic	Double Acting	
77	I-6	BFV-104-03	BUTTERFLY VALVE	BWS	24"	FRP	Backwash Supply to Filter No. 4	Pneumatic	Double Acting	
78	I-6	BFV-104-04	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 4 Effluent	Pneumatic	Double Acting	
79	I-6	BFV-104-06	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 4 Effluent	Electric	Open/Close	
80	I-6	BFV-104-07	BUTTERFLY VALVE	V	6"	PVC	Filter No. 4	Manual		

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
81	I-6	BFV-104-08	BUTTERFLY VALVE	FW	18"	FRP	Filter No. 4 Effluent	Manual		
82	I-6	BFV-104-09	BUTTERFLY VALVE	FTW	12"	HDPE	Filter No. 4 Effluent to Backwash Reclamation Basin	Manual		
83	I-6	BFV-106-01	BUTTERFLY VALVE	RW	12"	FRB	Raw Water Inlet to Filter No. 6	Pneumatic	Double Acting	
84	I-6	BFV-106-02	BUTTERFLY VALVE	BWW	24"	FRP	Backwash Waste Discharge from Filter No. 6	Pneumatic	Double Acting	
85	I-6	BFV-106-03	BUTTERFLY VALVE	BWS	24"	FRP	Backwash Supply to Filter No. 6	Pneumatic	Double Acting	
86	I-6	BFV-106-04	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 6 Effluent	Pneumatic	Double Acting	
87	I-6	BFV-106-06	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 6 Effluent	Electric	Open/Close	
88	I-6	BFV-106-07	BUTTERFLY VALVE	V	6"	PVC	Filter No. 6	Manual		
89	I-6	BFV-106-08	BUTTERFLY VALVE	FW	18"	FRP	Filter No. 6 Effluent	Manual		
90	I-6	BFV-106-09	BUTTERFLY VALVE	FTW	12"	HDPE	Filter No. 6 Effluent to Backwash Reclamation Basin	Manual		
91	I-6	BFV-108-01	BUTTERFLY VALVE	RW	12"	FRB	Raw Water Inlet to Filter No. 8	Pneumatic	Double Acting	
92	I-6	BFV-108-02	BUTTERFLY VALVE	BWW	24"	FRP	Backwash Waste Discharge from Filter No. 8	Pneumatic	Double Acting	
93	I-6	BFV-108-03	BUTTERFLY VALVE	BWS	24"	FRP	Backwash Supply to Filter No. 8	Pneumatic	Double Acting	
94	I-6	BFV-108-04	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 8 Effluent	Pneumatic	Double Acting	
95	I-6	BFV-108-06	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 8 Effluent	Electric	Open/Close	
96	I-6	BFV-108-07	BUTTERFLY VALVE	V	6"	PVC	Filter No. 8	Manual		
97	I-6	BFV-108-08	BUTTERFLY VALVE	FW	18"	FRP	Filter No. 8 Effluent	Manual		
98	I-6	BFV-108-09	BUTTERFLY VALVE	FTW	12"	HDPE	Filter No. 8 Effluent to Backwash Reclamation Basin	Manual		
99	I-6	BFV-110-01	BUTTERFLY VALVE	RW	12"	FRB	Raw Water Inlet to Filter No. 10	Pneumatic	Double Acting	
100	I-6	BFV-110-02	BUTTERFLY VALVE	BWW	24"	FRP	Backwash Waste Discharge from Filter No. 10	Pneumatic	Double Acting	
101	I-6	BFV-110-03	BUTTERFLY VALVE	BWS	24"	FRP	Backwash Supply to Filter No. 10	Pneumatic	Double Acting	
102	I-6	BFV-110-04	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 10 Effluent	Pneumatic	Double Acting	
103	I-6	BFV-110-06	BUTTERFLY VALVE	FW	12"	FRP	Filter No. 10 Effluent	Electric	Open/Close	
104	I-6	BFV-110-07	BUTTERFLY VALVE	V	6"	PVC	Filter No. 10	Manual		
105	I-6	BFV-110-08	BUTTERFLY VALVE	FW	18"	FRP	Filter No. 10 Effluent	Manual		
106	I-6	BFV-110-09	BUTTERFLY VALVE	FTW	12"	HDPE	Filter No. 10 Effluent to Backwash Reclamation Basin	Manual		
107	I-6	BV-102-02	BALL VALVE	V	6"	PVC	Filter No. 2	Manual		

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
108	I-6	BV-104-02	BALL VALVE	V	6"	PVC	Filter No. 4	Manual		
109	I-6	BV-106-02	BALL VALVE	V	6"	PVC	Filter No. 6	Manual		
110	I-6	BV-108-02	BALL VALVE	V	6"	PVC	Filter No. 8	Manual		
111	I-6	BV-110-02	BALL VALVE	V	6"	PVC	Filter No. 10	Manual		
112	I-7	BV-212-00	BALL VALVE	FW	1/2"	PVC	Sample Line upstream of SBS Injection	Manual		
113	I-7	BV-214-00	BALL VALVE	FW	1/2"	PVC	Sample Line downstream of SBS Injection	Manual		
114	I-7	BPV-200-00	ACK PRESSURE REGULATING VALV	SBS	1/2"	PVC	Sodium Bisulfite to Static Mixer at Filtered Water Tanks			
115	I-7	BV-200-01	BALL VALVE	DR	1/2"	PVC	Sodium Bisulfite to Static Mixer at Filtered Water Tanks	Manual		
116	I-7	BV-200-02	BALL VALVE	SBS	1/2"	PVC	Sodium Bisulfite to Static Mixer at Filtered Water Tanks	Manual		
117	I-7	BCV-200-00	BALL CHECK VALVE	SBS	1/2"	PVC	Sodium Bisulfite to Static Mixer at Filtered Water Tanks	Manual		
118	I-7	BFV-201-00	BUTTERFLY VALVE	FW	30"	FRP	Filtered Water Tank No. 1 Inlet	Manual		
119	I-7	BFV-221-00	BUTTERFLY VALVE	FW	36"	HDPE(DR 26)	Filtered Water Tank No. 1 to Filtered Water Pump Station	Manual		
120	I-7	BFV-211-00	BUTTERFLY VALVE	DR	6"	HDPE	Filtered Water Tank No. 1 Drain to Salinas Sump	Manual		
121	I-7	BFV-201-01	BUTTERFLY VALVE	BWS	30"	HDPE(DR 26)	Filtered Water Tank No. 1 to Backwash Supply Pump	Manual		
122	I-7	BFV-202-00	BUTTERFLY VALVE	FW	30"	FRP	Filtered Water Tank No. 2 Inlet	Manual		
123	I-7	BFV-222-00	BUTTERFLY VALVE	FW	36"	HDPE(DR 26)	Filtered Water Tank No. 2 to Filtered Water Pump Station	Manual		
124	I-7	BFV-212-00	BUTTERFLY VALVE	DR	6"	HDPE	Filtered Water Tank No. 2 Drain to Salinas Sump	Manual		
125	I-7	BFV-202-01	BUTTERFLY VALVE	BWS	30"	HDPE(DR 26)	Filtered Water Tank No. 2 to Backwash Supply Pump	Manual		
126	I-7	BFV-202-02	BUTTERFLY VALVE	DR	6"	HDPE	Filtered Water Tanks Common Drain to Salinas Sump	Manual		
127	I-8	BFV-311-00	BUTTERFLY VALVE	FW	12"	FRP	Filtered Water Pump No. 1 Suction	Manual		
128	I-8	CV-312-00	CHECK VALVE	FW	14"	FRP	Filtered Water Pump No. 1 Discharge	Manual		
129	I-8	BFV-313-00	BUTTERFLY VALVE	FW	14"	FRP	Filtered Water Pump No. 1 Discharge	Manual		
130	I-8	BFV-321-00	BUTTERFLY VALVE	FW	12"	FRP	Filtered Water Pump No. 2 Suction	Manual		
131	I-8	CV-322-00	CHECK VALVE	FW	14"	FRP	Filtered Water Pump No. 2 Discharge	Manual		
132	I-8	BFV-323-00	BUTTERFLY VALVE	FW	14"	FRP	Filtered Water Pump No. 2 Discharge	Manual		
133	I-8	BFV-331-00	BUTTERFLY VALVE	FW	14"	FRP	Filtered Water Pump No. 3 Suction	Manual		
134	I-8	CV-332-00	CHECK VALVE	FW	20"	FRP	Filtered Water Pump No. 3 Discharge	Manual		

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
135	I-8	BFV-333-00	BUTTERFLY VALVE	FW	20"	FRP	Filtered Water Pump No. 3 Discharge	Manual		
136	I-8	BFV-341-00	BUTTERFLY VALVE	FW	14"	FRP	Filtered Water Pump No. 4 Suction	Manual		
137	I-8	CV-342-00	CHECK VALVE	FW	20"	FRP	Filtered Water Pump No. 4 Discharge	Manual		
138	I-8	BFV-343-00	BUTTERFLY VALVE	FW	20"	FRP	Filtered Water Pump No. 4 Discharge	Manual		
139	I-8	ARV-340-00	AIR RELEASE VALVE	V	3"	FRP	Filtered Water Pumps Discharge			
140	I-9	BV-400-01	BALL VALVE	FW	1/2"	PVC	Sample Line upstream of Chemical Injection	Manual		
141	I-9	BV-400-02	BALL VALVE	FW	1/2"	PVC	Sample Line downstream of Chemical Injection	Manual		
142	I-9	BPV-402-00	ACK PRESSURE REGULATING VALV	ASC	1/2"	PVC	Antiscalant to Static Mixer at Cartridge Filters			
143	I-9	BV-404-00	BALL VALVE	DR	1/4"	PVC	Antiscalant to Static Mixer at Cartridge Filters	Manual		
144	I-9	BV-403-00	BALL VALVE	ASC	1/2"	PVC	Antiscalant to Static Mixer at Cartridge Filters	Manual		
145	I-9	BCV-402-00	BALL CHECK VALVE	ASC	1/2"	PVC	Antiscalant to Static Mixer at Cartridge Filters	Manual		
146	I-9	BPV-403-00	ACK PRESSURE REGULATING VALV	SA	1/2"	PVC	Sulfuric Acid to Static Mixer at Cartridge Filters			
147	I-9	BV-406-00	BALL VALVE	DR	1/4"	PVC	Sulfuric Acid to Static Mixer at Cartridge Filters	Manual		
148	I-9	BV-405-00	BALL VALVE	SA	1/2"	PVC	Sulfuric Acid to Static Mixer at Cartridge Filters	Manual		
149	I-9	BCV-403-00	BALL CHECK VALVE	SA	1/2"	PVC	Sulfuric Acid to Static Mixer at Cartridge Filters	Manual		
150	I-9	PRV-401-00	PRESSURE RELIEF VALVE	V	1/2"	FRP	Cartridge Filter No. 1 Inlet			
151	I-9	BFV-401-01	BUTTERFLY VALVE	ROF	12"	FRP	Cartridge Filter No. 1 Inlet	Manual		
152	I-9	BFV-401-02	BUTTERFLY VALVE	ROF	12"	FRP	Cartridge Filter No. 1 Outlet	Manual		
153	I-9	BV-401-04	BALL VALVE	DR	2"	PVC	Cartridge Filter No. 1 Drain	Manual		
154	I-9	BV-401-05	BALL VALVE	DR	2"	PVC	Cartridge Filter No. 1 Drain	Manual		
155	I-9	BV-401-06	BALL VALVE	V	1/2"	PVC	Cartridge Filter No. 1 Vent	Manual		
156	I-9	BV-401-07	BALL VALVE	V	1/2"	PVC	Cartridge Filter No. 1 Vent	Manual		
157	I-9	BFV-402-01	BUTTERFLY VALVE	ROF	12"	FRP	Cartridge Filter No. 2 Inlet	Manual		
158	I-9	BFV-402-02	BUTTERFLY VALVE	ROF	12"	FRP	Cartridge Filter No. 2 Outlet	Manual		
159	I-9	BV-402-04	BALL VALVE	DR	2"	PVC	Cartridge Filter No. 2 Drain	Manual		
160	I-9	BV-402-05	BALL VALVE	DR	2"	PVC	Cartridge Filter No. 2 Drain	Manual		
161	I-9	BV-402-06	BALL VALVE	V	1/2"	PVC	Cartridge Filter No. 2 Vent	Manual		

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
162	I-9	BV-402-07	BALL VALVE	V	1/2"	PVC	Cartridge Filter No. 2 Vent	Manual		
163	I-9	PRV-403-00	PRESSURE RELIEF VALVE	V	1/2"	FRP	Cartridge Filter No. 3 Inlet			
164	I-9	BFV-403-01	BUTTERFLY VALVE	ROF	12"	FRP	Cartridge Filter No. 3 Inlet	Manual		
165	I-9	BFV-403-02	BUTTERFLY VALVE	ROF	12"	FRP	Cartridge Filter No. 3 Outlet	Manual		
166	I-9	BV-403-04	BALL VALVE	DR	2"	PVC	Cartridge Filter No. 3 Drain	Manual		
167	I-9	BV-403-05	BALL VALVE	DR	2"	PVC	Cartridge Filter No. 3 Drain	Manual		
168	I-9	BV-403-06	BALL VALVE	V	1/2"	PVC	Cartridge Filter No. 3 Vent	Manual		
169	I-9	BV-403-07	BALL VALVE	V	1/2"	PVC	Cartridge Filter No. 3 Vent	Manual		
170	I-9	BFV-404-01	BUTTERFLY VALVE	ROF	12"	FRP	Cartridge Filter No. 4 Inlet	Manual		
171	I-9	BFV-404-02	BUTTERFLY VALVE	ROF	12"	FRP	Cartridge Filter No. 4 Outlet	Manual		
172	I-9	BV-404-04	BALL VALVE	DR	2"	PVC	Cartridge Filter No. 4 Drain	Manual		
173	I-9	BV-404-05	BALL VALVE	DR	2"	PVC	Cartridge Filter No. 4 Drain	Manual		
174	I-9	BV-404-06	BALL VALVE	V	1/2"	PVC	Cartridge Filter No. 4 Vent	Manual		
175	I-9	BV-404-07	BALL VALVE	V	1/2"	PVC	Cartridge Filter No. 4 Vent	Manual		
176	I-9	PRV-405-00	PRESSURE RELIEF VALVE	V	1/2"	FRP	Cartridge Filter No. 5 Inlet			
177	I-9	BFV-405-01	BUTTERFLY VALVE	ROF	12"	FRP	Cartridge Filter No. 5 Inlet	Manual		
178	I-9	BFV-405-02	BUTTERFLY VALVE	ROF	12"	FRP	Cartridge Filter No. 5 Outlet	Manual		
179	I-9	BV-405-04	BALL VALVE	DR	2"	PVC	Cartridge Filter No. 5 Drain	Manual		
180	I-9	BV-405-05	BALL VALVE	DR	2"	PVC	Cartridge Filter No. 5 Drain	Manual		
181	I-9	BV-405-06	BALL VALVE	V	1/2"	PVC	Cartridge Filter No. 5 Vent	Manual		
182	I-9	BV-405-07	BALL VALVE	V	1/2"	PVC	Cartridge Filter No. 5 Vent	Manual		
183	I-9	BFV-406-01	BUTTERFLY VALVE	ROF	12"	FRP	Cartridge Filter No. 6 Inlet	Manual		
184	I-9	BFV-406-02	BUTTERFLY VALVE	ROF	12"	FRP	Cartridge Filter No. 6 Outlet	Manual		
185	I-9	BV-406-04	BALL VALVE	DR	2"	PVC	Cartridge Filter No. 6 Drain	Manual		
186	I-9	BV-406-05	BALL VALVE	DR	2"	PVC	Cartridge Filter No. 6 Drain	Manual		
187	I-9	BV-406-06	BALL VALVE	V	1/2"	PVC	Cartridge Filter No. 6 Vent	Manual		
188	I-9	BV-406-07	BALL VALVE	V	1/2"	PVC	Cartridge Filter No. 6 Vent	Manual		

VALVE SCHEDULE

9.6 MGD BASE CASE

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
189	I-9	PRV-407-00	PRESSURE RELIEF VALVE	V	1/2"	FRP	Cartridge Filter No. 7 Inlet			
190	I-9	BFV-407-01	BUTTERFLY VALVE	ROF	12"	FRP	Cartridge Filter No. 7 Inlet	Manual		
191	I-9	BFV-407-02	BUTTERFLY VALVE	ROF	12"	FRP	Cartridge Filter No. 7 Outlet	Manual		
192	I-9	BV-407-04	BALL VALVE	DR	2"	PVC	Cartridge Filter No. 7 Drain	Manual		
193	I-9	BV-407-05	BALL VALVE	DR	2"	PVC	Cartridge Filter No. 7 Drain	Manual		
194	I-9	BV-407-06	BALL VALVE	V	1/2"	PVC	Cartridge Filter No. 7 Vent	Manual		
195	I-9	BV-407-07	BALL VALVE	V	1/2"	PVC	Cartridge Filter No. 7 Vent	Manual		
196	I-9	BV-409-00	BALL VALVE	ROF	1/2"	PVC	Sample Line downstream of Analyzer Panel	Manual		
197	I-9	BFV-400-00	BUTTERFLY VALVE	DR	3"	PVC	BWRO Concentrate to RO Feed Pumps	Electric	Open/Close	
198	I-10	BFV-512-01	BUTTERFLY VALVE	FL	6"	316SS	Permeate Flush to RO Feed Water Pump No. 1	Electric	Open/Close	
199	I-10	CV-512-01	CHECK VALVE	FL	6"	316SS	Permeate Flush to RO Feed Water Pump No. 1	Manual		
200	I-10	BFV-411-00	BUTTERFLY VALVE	ROF	12"	FRP	RO Feed Water Pump No. 1 Suction	Electric	Open/Close	
201	I-10	BFV-540-01	BUTTERFLY VALVE	ERD	10"	FRP	RO Feed to Filtered Water ERD Supply	Electric	Open/Close	RO Vendor Supplied Valve
202	I-10	CV-412-00	CHECK VALVE	ROF	8"	SDSS	RO Feed Water Pump No. 1 Discharge	Manual		RO Vendor Supplied Valve
203	I-10	BFV-512-02	BUTTERFLY VALVE	FL	6"	316SS	Permeate Flush to RO Feed Water Pump No. 2	Electric	Open/Close	
204	I-10	CV-512-02	CHECK VALVE	FL	6"	316SS	Permeate Flush to RO Feed Water Pump No. 2	Manual		
205	I-10	BFV-421-00	BUTTERFLY VALVE	ROF	12"	FRP	RO Feed Water Pump No. 2 Suction	Electric	Open/Close	
206	I-10	BFV-540-02	BUTTERFLY VALVE	ERD	10"	FRP	RO Feed to Filtered Water ERD Supply	Electric	Open/Close	RO Vendor Supplied Valve
207	I-10	CV-422-00	CHECK VALVE	ROF	8"	SDSS	RO Feed Water Pump No. 2 Discharge	Manual		RO Vendor Supplied Valve
208	I-10	BFV-512-03	BUTTERFLY VALVE	FL	6"	316SS	Permeate Flush to RO Feed Water Pump No. 3	Electric	Open/Close	
209	I-10	CV-512-03	CHECK VALVE	FL	6"	316SS	Permeate Flush to RO Feed Water Pump No. 3	Manual		
210	I-10	BFV-431-00	BUTTERFLY VALVE	ROF	12"	FRP	RO Feed Water Pump No. 3 Suction	Electric	Open/Close	
211	I-10	BFV-540-03	BUTTERFLY VALVE	ERD	10"	FRP	RO Feed to Filtered Water ERD Supply	Electric	Open/Close	RO Vendor Supplied Valve
212	I-10	CV-432-00	CHECK VALVE	ROF	8"	SDSS	RO Feed Water Pump No. 3 Discharge	Manual		RO Vendor Supplied Valve
213	I-10	BFV-512-04	BUTTERFLY VALVE	FL	6"	316SS	Permeate Flush to RO Feed Water Pump No. 4	Electric	Open/Close	
214	I-10	CV-512-04	CHECK VALVE	FL	6"	316SS	Permeate Flush to RO Feed Water Pump No. 4	Manual		
215	I-10	BFV-441-00	BUTTERFLY VALVE	ROF	12"	FRP	RO Feed Water Pump No. 4 Suction	Electric	Open/Close	

VALVE SCHEDULE

9.6 MGD BASE CASE

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
216	I-10	BFV-540-04	BUTTERFLY VALVE	ERD	10"	FRP	RO Feed to Filtered Water ERD Supply	Electric	Open/Close	RO Vendor Supplied Valve
217	I-10	CV-442-00	CHECK VALVE	ROF	8"	SDSS	RO Feed Water Pump No. 4 Discharge	Manual		RO Vendor Supplied Valve
218	I-10	BFV-512-05	BUTTERFLY VALVE	FL	6"	316SS	Permeate Flush to RO Feed Water Pump No. 5	Electric	Open/Close	
219	I-10	CV-512-05	CHECK VALVE	FL	6"	316SS	Permeate Flush to RO Feed Water Pump No. 5	Manual		
220	I-10	BFV-451-00	BUTTERFLY VALVE	ROF	12"	FRP	RO Feed Water Pump No. 5 Suction	Electric	Open/Close	
221	I-10	BFV-540-05	BUTTERFLY VALVE	ERD	10"	FRP	RO Feed to Filtered Water ERD Supply	Electric	Open/Close	RO Vendor Supplied Valve
222	I-10	CV-452-00	CHECK VALVE	ROF	8"	SDSS	RO Feed Water Pump No. 5 Discharge	Manual		RO Vendor Supplied Valve
223	I-10	BFV-512-06	BUTTERFLY VALVE	FL	6"	316SS	Permeate Flush to RO Feed Water Pump No. 6	Electric	Open/Close	
224	I-10	CV-512-06	CHECK VALVE	FL	6"	316SS	Permeate Flush to RO Feed Water Pump No. 6	Manual		
225	I-10	BFV-461-00	BUTTERFLY VALVE	ROF	12"	FRP	RO Feed Water Pump No. 6 Suction	Electric	Open/Close	
226	I-10	BFV-540-06	BUTTERFLY VALVE	ERD	10"	FRP	RO Feed to Filtered Water ERD Supply	Electric	Open/Close	RO Vendor Supplied Valve
227	I-10	CV-462-00	CHECK VALVE	ROF	8"	SDSS	RO Feed Water Pump No. 6 Discharge	Manual		RO Vendor Supplied Valve
228	I-10	BFV-512-07	BUTTERFLY VALVE	FL	6"	316SS	Permeate Flush to RO Feed Water Pump No. 7	Electric	Open/Close	
229	I-10	CV-512-07	CHECK VALVE	FL	6"	316SS	Permeate Flush to RO Feed Water Pump No. 7	Manual		
230	I-10	BFV-471-00	BUTTERFLY VALVE	ROF	12"	FRP	RO Feed Water Pump No. 7 Suction	Electric	Open/Close	
231	I-10	BFV-540-07	BUTTERFLY VALVE	ERD	10"	FRP	RO Feed to Filtered Water ERD Supply	Electric	Open/Close	RO Vendor Supplied Valve
232	I-10	CV-472-00	CHECK VALVE	ROF	8"	SDSS	RO Feed Water Pump No. 7 Discharge	Manual		RO Vendor Supplied Valve
233	I-11	BFV-500-01	BUTTERFLY VALVE	ROF	8"	SDSS	RO Feed Water Pump No. 1 to First Pass SWRO Train 1	Manual		RO Vendor Supplied Valve
234	I-11	BFV-511-01	BUTTERFLY VALVE	CIPS	14"	FRP	Cleaning Supply to First Pass SWRO Train 1	Manual		
235	I-11	BFV-531-01	BUTTERFLY VALVE	CIPS	12"	316SS	Cleaning Supply to First Pass SWRO Train 1	Manual		RO Vendor Supplied Valve
236	I-11	BV-531-01	BALL VALVE	DR	2"	316SS	Cleaning Supply to First Pass SWRO Train 1 Drain	Manual		RO Vendor Supplied Valve
237	I-11	BFV-532-01	BUTTERFLY VALVE	CIPS	12"	SDSS	Cleaning Supply to First Pass SWRO Train 1	Manual		RO Vendor Supplied Valve
238	I-11	CV-530-01	CHECK VALVE	ERD	10"	SDSS	ERD Booster Pump No. 1 Discharge	Manual		RO Vendor Supplied Valve
239	I-11	BFV-529-01	BUTTERFLY VALVE	ERD	10"	SDSS	ERD Booster Pump No. 1 Discharge	Manual		RO Vendor Supplied Valve
240	I-11	BFV-530-01	BUTTERFLY VALVE	ERD	10"	SDSS	ERD Booster Pump No. 1 Suction	Manual		RO Vendor Supplied Valve
241	I-11	BFV-525-01	BUTTERFLY VALVE	DR	4"	316SS	Drains from RO Skids	Manual		RO Vendor Supplied Valve
242	I-11	BV-529-01	BALL VALVE	DR	1"	316SS	Drains from RO Skids Drain	Manual		RO Vendor Supplied Valve

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
243	I-11	BFV-527-01	BUTTERFLY VALVE	ROF	4"	SDSS	Drains from RO Skids	Manual		RO Vendor Supplied Valve
244	I-11	ARV-528-01	AIR RELEASE VALVE	V	1/2"	FRP	Filtered Water ERD Supply to Exchanger No. 1			RO Vendor Supplied Valve
245	I-11	ARV-527-01	AIR RELEASE VALVE	V	1/2"	FRP	Filtered Water ERD Supply to Exchanger No. 1			RO Vendor Supplied Valve
246	I-11	ARV-520-01	AIR RELEASE VALVE	V	1/2"	FRP	Exchanger No. 1 to Equalization Basin			RO Vendor Supplied Valve
247	I-11	BV-517-01	BALL VALVE	DR	1"	FRP	Exchanger No. 1 to Equalization Basin Drain	Manual		RO Vendor Supplied Valve
248	I-11	CV-522-01	CHECK VALVE	ROC	10"	FRP	Exchanger No. 1 to Equalization Basin	Manual		RO Vendor Supplied Valve
249	I-11	BFV-523-01	BUTTERFLY VALVE	ROC	10"	FRP	Exchanger No. 1 to Equalization Basin	Electric	Modulate	RO Vendor Supplied Valve
250	I-11	BFV-507-01	BUTTERFLY VALVE	ROP	6"	316SS	First Pass SWRO Train 1 Lower TDS Permeate	Manual		RO Vendor Supplied Valve
251	I-11	CV-507-01	CHECK VALVE	ROP	6"	316SS	First Pass SWRO Train 1 Higher TDS Permeate	Manual		RO Vendor Supplied Valve
252	I-11	BFV-508-01	BUTTERFLY VALVE	ROP	6"	316SS	First Pass SWRO Train 1 Higher TDS Permeate	Manual		RO Vendor Supplied Valve
253	I-11	BFV-509-01	BUTTERFLY VALVE	CIPR	4"	PVC	First Pass SWRO Train 1 to CIP Permeate Return	Manual		RO Vendor Supplied Valve
254	I-11	BV-514-01	BALL VALVE	DR	1"	SDSS	First Pass SWRO Train 1 to Cleaning Return Flush	Electric	Open/Close	RO Vendor Supplied Valve
255	I-11	BV-519-01	BALL VALVE	DR	1"	SDSS	First Pass SWRO Train 1 to Cleaning Return Drain	Manual		RO Vendor Supplied Valve
256	I-11	BFV-513-01	BUTTERFLY VALVE	CIPR	12"	SDSS	First Pass SWRO Train 1 to Cleaning Return	Manual		RO Vendor Supplied Valve
257	I-11	BV-516-01	BALL VALVE	DR	2"	316SS	First Pass SWRO Train 1 to Cleaning Return Drain	Manual		RO Vendor Supplied Valve
258	I-11	BFV-517-01	BUTTERFLY VALVE	CIPR	12"	316SS	First Pass SWRO Train 1 to Cleaning Return	Manual		RO Vendor Supplied Valve
259	I-11	BFV-514-01	BUTTERFLY VALVE	ROC	10"	SDSS	Exchanger No. 1 Energy Recovery System	Manual		RO Vendor Supplied Valve
260	I-11	ARV-516-01	AIR RELEASE VALVE	V	1/2"	SDSS	Exchanger No. 1 Energy Recovery System			RO Vendor Supplied Valve
261	I-12	BFV-500-02	BUTTERFLY VALVE	ROF	8"	SDSS	RO Feed Water Pump No. 2 to First Pass SWRO Train 2	Manual		RO Vendor Supplied Valve
262	I-12	BFV-511-02	BUTTERFLY VALVE	CIPS	14"	FRP	Cleaning Supply to First Pass SWRO Train 2	Manual		
263	I-12	BFV-531-02	BUTTERFLY VALVE	CIPS	12"	316SS	Cleaning Supply to First Pass SWRO Train 2	Manual		RO Vendor Supplied Valve
264	I-12	BV-531-02	BALL VALVE	DR	2"	316SS	Cleaning Supply to First Pass SWRO Train 2 Drain	Manual		RO Vendor Supplied Valve
265	I-12	BFV-532-02	BUTTERFLY VALVE	CIPS	12"	SDSS	Cleaning Supply to First Pass SWRO Train 2	Manual		RO Vendor Supplied Valve
266	I-12	CV-530-02	CHECK VALVE	ERD	10"	SDSS	ERD Booster Pump No. 2 Discharge	Manual		RO Vendor Supplied Valve
267	I-12	BFV-529-02	BUTTERFLY VALVE	ERD	10"	SDSS	ERD Booster Pump No. 2 Discharge	Manual		RO Vendor Supplied Valve
268	I-12	BFV-530-02	BUTTERFLY VALVE	ERD	10"	SDSS	ERD Booster Pump No. 2 Suction	Manual		RO Vendor Supplied Valve
269	I-12	BFV-525-02	BUTTERFLY VALVE	DR	4"	316SS	Drains from RO Skids	Manual		RO Vendor Supplied Valve

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
270	I-12	BV-529-02	BALL VALVE	DR	1"	316SS	Drains from RO Skids Drain	Manual		RO Vendor Supplied Valve
271	I-12	BFV-527-02	BUTTERFLY VALVE	ROF	4"	SDSS	Drains from RO Skids	Manual		RO Vendor Supplied Valve
272	I-12	ARV-528-02	AIR RELEASE VALVE	V	1/2"	FRP	Filtered Water ERD Supply to Exchanger No. 2			RO Vendor Supplied Valve
273	I-12	ARV-527-02	AIR RELEASE VALVE	V	1/2"	FRP	Filtered Water ERD Supply to Exchanger No. 2			RO Vendor Supplied Valve
274	I-12	ARV-520-02	AIR RELEASE VALVE	V	1/2"	FRP	Exchanger No. 2 to Equalization Basin			RO Vendor Supplied Valve
275	I-12	BV-517-02	BALL VALVE	DR	1"	FRP	Exchanger No. 2 to Equalization Basin Drain	Manual		RO Vendor Supplied Valve
276	I-12	CV-522-02	CHECK VALVE	ROC	10"	FRP	Exchanger No. 2 to Equalization Basin	Manual		RO Vendor Supplied Valve
277	I-12	BFV-523-02	BUTTERFLY VALVE	ROC	10"	FRP	Exchanger No. 2 to Equalization Basin	Electric	Modulate	RO Vendor Supplied Valve
278	I-12	BFV-507-02	BUTTERFLY VALVE	ROP	6"	316SS	First Pass SWRO Train 2 Lower TDS Permeate	Manual		RO Vendor Supplied Valve
279	I-12	CV-507-02	CHECK VALVE	ROP	6"	316SS	First Pass SWRO Train 2 Higher TDS Permeate	Manual		RO Vendor Supplied Valve
280	I-12	BFV-508-02	BUTTERFLY VALVE	ROP	6"	316SS	First Pass SWRO Train 2 Higher TDS Permeate	Manual		RO Vendor Supplied Valve
281	I-12	BFV-509-02	BUTTERFLY VALVE	CIPR	4"	PVC	First Pass SWRO Train 2 to CIP Permeate Return	Manual		RO Vendor Supplied Valve
282	I-12	BV-514-02	BALL VALVE	DR	1"	SDSS	First Pass SWRO Train 2 to Cleaning Return Flush	Electric	Open/Close	RO Vendor Supplied Valve
283	I-12	BV-519-02	BALL VALVE	DR	1"	SDSS	First Pass SWRO Train 2 to Cleaning Return Drain	Manual		RO Vendor Supplied Valve
284	I-12	BFV-513-02	BUTTERFLY VALVE	CIPR	12"	SDSS	First Pass SWRO Train 2 to Cleaning Return	Manual		RO Vendor Supplied Valve
285	I-12	BV-516-02	BALL VALVE	DR	2"	316SS	First Pass SWRO Train 2 to Cleaning Return Drain	Manual		RO Vendor Supplied Valve
286	I-12	BFV-517-02	BUTTERFLY VALVE	CIPR	12"	316SS	First Pass SWRO Train 2 to Cleaning Return	Manual		RO Vendor Supplied Valve
287	I-12	BFV-514-02	BUTTERFLY VALVE	ROC	10"	SDSS	Exchanger No. 2 Energy Recovery System	Manual		RO Vendor Supplied Valve
288	I-12	ARV-516-02	AIR RELEASE VALVE	V	1/2"	SDSS	Exchanger No. 2 Energy Recovery System			RO Vendor Supplied Valve
289	I-13	BFV-500-03	BUTTERFLY VALVE	ROF	8"	SDSS	RO Feed Water Pump No. 3 to First Pass SWRO Train 3	Manual		RO Vendor Supplied Valve
290	I-13	BFV-511-03	BUTTERFLY VALVE	CIPS	14"	FRP	Cleaning Supply to First Pass SWRO Train 3	Manual		
291	I-13	BFV-531-03	BUTTERFLY VALVE	CIPS	12"	316SS	Cleaning Supply to First Pass SWRO Train 3	Manual		RO Vendor Supplied Valve
292	I-13	BV-531-03	BALL VALVE	DR	2"	316SS	Cleaning Supply to First Pass SWRO Train 3 Drain	Manual		RO Vendor Supplied Valve
293	I-13	BFV-532-03	BUTTERFLY VALVE	CIPS	12"	SDSS	Cleaning Supply to First Pass SWRO Train 3	Manual		RO Vendor Supplied Valve
294	I-13	CV-530-03	CHECK VALVE	ERD	10"	SDSS	ERD Booster Pump No. 3 Discharge	Manual		RO Vendor Supplied Valve
295	I-13	BFV-529-03	BUTTERFLY VALVE	ERD	10"	SDSS	ERD Booster Pump No. 3 Discharge	Manual		RO Vendor Supplied Valve
296	I-13	BFV-530-03	BUTTERFLY VALVE	ERD	10"	SDSS	ERD Booster Pump No. 3 Suction	Manual		RO Vendor Supplied Valve

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
297	I-13	BFV-525-03	BUTTERFLY VALVE	DR	4"	316SS	Drains from RO Skids	Manual		RO Vendor Supplied Valve
298	I-13	BV-529-03	BALL VALVE	DR	1"	316SS	Drains from RO Skids Drain	Manual		RO Vendor Supplied Valve
299	I-13	BFV-527-03	BUTTERFLY VALVE	ROF	4"	SDSS	Drains from RO Skids	Manual		RO Vendor Supplied Valve
300	I-13	ARV-528-03	AIR RELEASE VALVE	V	1/2"	FRP	Filtered Water ERD Supply to Exchanger No. 3			RO Vendor Supplied Valve
301	I-13	ARV-527-03	AIR RELEASE VALVE	V	1/2"	FRP	Filtered Water ERD Supply to Exchanger No. 3			RO Vendor Supplied Valve
302	I-13	ARV-520-03	AIR RELEASE VALVE	V	1/2"	FRP	Exchanger No. 3 to Equalization Basin			RO Vendor Supplied Valve
303	I-13	BV-517-03	BALL VALVE	DR	1"	FRP	Exchanger No. 3 to Equalization Basin Drain	Manual		RO Vendor Supplied Valve
304	I-13	CV-522-03	CHECK VALVE	ROC	10"	FRP	Exchanger No. 3 to Equalization Basin	Manual		RO Vendor Supplied Valve
305	I-13	BFV-523-03	BUTTERFLY VALVE	ROC	10"	FRP	Exchanger No. 3 to Equalization Basin	Electric	Modulate	RO Vendor Supplied Valve
306	I-13	BFV-507-03	BUTTERFLY VALVE	ROP	6"	316SS	First Pass SWRO Train 3 Lower TDS Permeate	Manual		RO Vendor Supplied Valve
307	I-13	CV-507-03	CHECK VALVE	ROP	6"	316SS	First Pass SWRO Train 3 Higher TDS Permeate	Manual		RO Vendor Supplied Valve
308	I-13	BFV-508-03	BUTTERFLY VALVE	ROP	6"	316SS	First Pass SWRO Train 3 Higher TDS Permeate	Manual		RO Vendor Supplied Valve
309	I-13	BFV-509-03	BUTTERFLY VALVE	CIPR	4"	PVC	First Pass SWRO Train 3 to CIP Permeate Return	Manual		RO Vendor Supplied Valve
310	I-13	BV-514-03	BALL VALVE	DR	1"	SDSS	First Pass SWRO Train 3 to Cleaning Return Flush	Electric	Open/Close	RO Vendor Supplied Valve
311	I-13	BV-519-03	BALL VALVE	DR	1"	SDSS	First Pass SWRO Train 3 to Cleaning Return Drain	Manual		RO Vendor Supplied Valve
312	I-13	BFV-513-03	BUTTERFLY VALVE	CIPR	12"	SDSS	First Pass SWRO Train 3 to Cleaning Return	Manual		RO Vendor Supplied Valve
313	I-13	BV-516-03	BALL VALVE	DR	2"	316SS	First Pass SWRO Train 3 to Cleaning Return Drain	Manual		RO Vendor Supplied Valve
314	I-13	BFV-517-03	BUTTERFLY VALVE	CIPR	12"	316SS	First Pass SWRO Train 3 to Cleaning Return	Manual		RO Vendor Supplied Valve
315	I-13	BFV-514-03	BUTTERFLY VALVE	ROC	10"	SDSS	Exchanger No. 3 Energy Recovery System	Manual		RO Vendor Supplied Valve
316	I-13	ARV-516-03	AIR RELEASE VALVE	V	1/2"	SDSS	Exchanger No. 3 Energy Recovery System			RO Vendor Supplied Valve
317	I-14	BFV-500-04	BUTTERFLY VALVE	ROF	8"	SDSS	RO Feed Water Pump No. 4 to First Pass SWRO Train 4	Manual		RO Vendor Supplied Valve
318	I-14	BFV-511-04	BUTTERFLY VALVE	CIPS	14"	FRP	Cleaning Supply to First Pass SWRO Train 4	Manual		
319	I-14	BFV-531-04	BUTTERFLY VALVE	CIPS	12"	316SS	Cleaning Supply to First Pass SWRO Train 4	Manual		RO Vendor Supplied Valve
320	I-14	BV-531-04	BALL VALVE	DR	2"	316SS	Cleaning Supply to First Pass SWRO Train 4 Drain	Manual		RO Vendor Supplied Valve
321	I-14	BFV-532-04	BUTTERFLY VALVE	CIPS	12"	SDSS	Cleaning Supply to First Pass SWRO Train 4	Manual		RO Vendor Supplied Valve
322	I-14	CV-530-04	CHECK VALVE	ERD	10"	SDSS	ERD Booster Pump No. 4 Discharge	Manual		RO Vendor Supplied Valve
323	I-14	BFV-529-04	BUTTERFLY VALVE	ERD	10"	SDSS	ERD Booster Pump No. 4 Discharge	Manual		RO Vendor Supplied Valve

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
324	I-14	BFV-530-04	BUTTERFLY VALVE	ERD	10"	SDSS	ERD Booster Pump No. 4 Suction	Manual		RO Vendor Supplied Valve
325	I-14	BFV-525-04	BUTTERFLY VALVE	DR	4"	316SS	Drains from RO Skids	Manual		RO Vendor Supplied Valve
326	I-14	BV-529-04	BALL VALVE	DR	1"	316SS	Drains from RO Skids Drain	Manual		RO Vendor Supplied Valve
327	I-14	BFV-527-04	BUTTERFLY VALVE	ROF	4"	SDSS	Drains from RO Skids	Manual		RO Vendor Supplied Valve
328	I-14	ARV-528-04	AIR RELEASE VALVE	V	1/2"	FRP	Filtered Water ERD Supply to Exchanger No. 4			RO Vendor Supplied Valve
329	I-14	ARV-527-04	AIR RELEASE VALVE	V	1/2"	FRP	Filtered Water ERD Supply to Exchanger No. 4			RO Vendor Supplied Valve
330	I-14	ARV-520-04	AIR RELEASE VALVE	V	1/2"	FRP	Exchanger No. 4 to Equalization Basin			RO Vendor Supplied Valve
331	I-14	BV-517-04	BALL VALVE	DR	1"	FRP	Exchanger No. 4 to Equalization Basin Drain	Manual		RO Vendor Supplied Valve
332	I-14	CV-522-04	CHECK VALVE	ROC	10"	FRP	Exchanger No. 4 to Equalization Basin	Manual		RO Vendor Supplied Valve
333	I-14	BFV-523-04	BUTTERFLY VALVE	ROC	10"	FRP	Exchanger No. 4 to Equalization Basin	Electric	Modulate	RO Vendor Supplied Valve
334	I-14	BFV-507-04	BUTTERFLY VALVE	ROP	6"	316SS	First Pass SWRO Train 4 Lower TDS Permeate	Manual		RO Vendor Supplied Valve
335	I-14	CV-507-04	CHECK VALVE	ROP	6"	316SS	First Pass SWRO Train 4 Higher TDS Permeate	Manual		RO Vendor Supplied Valve
336	I-14	BFV-508-04	BUTTERFLY VALVE	ROP	6"	316SS	First Pass SWRO Train 4 Higher TDS Permeate	Manual		RO Vendor Supplied Valve
337	I-14	BFV-509-04	BUTTERFLY VALVE	CIPR	4"	PVC	First Pass SWRO Train 4 to CIP Permeate Return	Manual		RO Vendor Supplied Valve
338	I-14	BV-514-04	BALL VALVE	DR	1"	SDSS	First Pass SWRO Train 4 to Cleaning Return Flush	Electric	Open/Close	RO Vendor Supplied Valve
339	I-14	BV-519-04	BALL VALVE	DR	1"	SDSS	First Pass SWRO Train 4 to Cleaning Return Drain	Manual		RO Vendor Supplied Valve
340	I-14	BFV-513-04	BUTTERFLY VALVE	CIPR	12"	SDSS	First Pass SWRO Train 4 to Cleaning Return	Manual		RO Vendor Supplied Valve
341	I-14	BV-516-04	BALL VALVE	DR	2"	316SS	First Pass SWRO Train 4 to Cleaning Return Drain	Manual		RO Vendor Supplied Valve
342	I-14	BFV-517-04	BUTTERFLY VALVE	CIPR	12"	316SS	First Pass SWRO Train 4 to Cleaning Return	Manual		RO Vendor Supplied Valve
343	I-14	BFV-514-04	BUTTERFLY VALVE	ROC	10"	SDSS	Exchanger No. 4 Energy Recovery System	Manual		RO Vendor Supplied Valve
344	I-14	ARV-516-04	AIR RELEASE VALVE	V	1/2"	SDSS	Exchanger No. 4 Energy Recovery System			RO Vendor Supplied Valve
345	I-15	BFV-500-05	BUTTERFLY VALVE	ROF	8"	SDSS	RO Feed Water Pump No. 5 to First Pass SWRO Train 5	Manual		RO Vendor Supplied Valve
346	I-15	BFV-511-05	BUTTERFLY VALVE	CIPS	14"	FRP	Cleaning Supply to First Pass SWRO Train 5	Manual		
347	I-15	BFV-531-05	BUTTERFLY VALVE	CIPS	12"	316SS	Cleaning Supply to First Pass SWRO Train 5	Manual		RO Vendor Supplied Valve
348	I-15	BV-531-05	BALL VALVE	DR	2"	316SS	Cleaning Supply to First Pass SWRO Train 5 Drain	Manual		RO Vendor Supplied Valve
349	I-15	BFV-532-05	BUTTERFLY VALVE	CIPS	12"	SDSS	Cleaning Supply to First Pass SWRO Train 5	Manual		RO Vendor Supplied Valve
350	I-15	CV-530-05	CHECK VALVE	ERD	10"	SDSS	ERD Booster Pump No. 5 Discharge	Manual		RO Vendor Supplied Valve

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
351	I-15	BFV-529-05	BUTTERFLY VALVE	ERD	10"	SDSS	ERD Booster Pump No. 5 Discharge	Manual		RO Vendor Supplied Valve
352	I-15	BFV-530-05	BUTTERFLY VALVE	ERD	10"	SDSS	ERD Booster Pump No. 5 Suction	Manual		RO Vendor Supplied Valve
353	I-15	BFV-525-05	BUTTERFLY VALVE	DR	4"	316SS	Drains from RO Skids	Manual		RO Vendor Supplied Valve
354	I-15	BV-529-05	BALL VALVE	DR	1"	316SS	Drains from RO Skids Drain	Manual		RO Vendor Supplied Valve
355	I-15	BFV-527-05	BUTTERFLY VALVE	ROF	4"	SDSS	Drains from RO Skids	Manual		RO Vendor Supplied Valve
356	I-15	ARV-528-05	AIR RELEASE VALVE	V	1/2"	FRP	Filtered Water ERD Supply to Exchanger No. 5			RO Vendor Supplied Valve
357	I-15	ARV-527-05	AIR RELEASE VALVE	V	1/2"	FRP	Filtered Water ERD Supply to Exchanger No. 5			RO Vendor Supplied Valve
358	I-15	ARV-520-05	AIR RELEASE VALVE	V	1/2"	FRP	Exchanger No. 5 to Equalization Basin			RO Vendor Supplied Valve
359	I-15	BV-517-05	BALL VALVE	DR	1"	FRP	Exchanger No. 5 to Equalization Basin Drain	Manual		RO Vendor Supplied Valve
360	I-15	CV-522-05	CHECK VALVE	ROC	10"	FRP	Exchanger No. 5 to Equalization Basin	Manual		RO Vendor Supplied Valve
361	I-15	BFV-523-05	BUTTERFLY VALVE	ROC	10"	FRP	Exchanger No. 5 to Equalization Basin	Electric	Modulate	RO Vendor Supplied Valve
362	I-15	BFV-507-05	BUTTERFLY VALVE	ROP	6"	316SS	First Pass SWRO Train 5 Lower TDS Permeate	Manual		RO Vendor Supplied Valve
363	I-15	CV-507-05	CHECK VALVE	ROP	6"	316SS	First Pass SWRO Train 5 Higher TDS Permeate	Manual		RO Vendor Supplied Valve
364	I-15	BFV-508-05	BUTTERFLY VALVE	ROP	6"	316SS	First Pass SWRO Train 5 Higher TDS Permeate	Manual		RO Vendor Supplied Valve
365	I-15	BFV-509-05	BUTTERFLY VALVE	CIPR	4"	PVC	First Pass SWRO Train 5 to CIP Permeate Return	Manual		RO Vendor Supplied Valve
366	I-15	BV-514-05	BALL VALVE	DR	1"	SDSS	First Pass SWRO Train 5 to Cleaning Return Flush	Electric	Open/Close	RO Vendor Supplied Valve
367	I-15	BV-519-05	BALL VALVE	DR	1"	SDSS	First Pass SWRO Train 5 to Cleaning Return Drain	Manual		RO Vendor Supplied Valve
368	I-15	BFV-513-05	BUTTERFLY VALVE	CIPR	12"	SDSS	First Pass SWRO Train 5 to Cleaning Return	Manual		RO Vendor Supplied Valve
369	I-15	BV-516-05	BALL VALVE	DR	2"	316SS	First Pass SWRO Train 5 to Cleaning Return Drain	Manual		RO Vendor Supplied Valve
370	I-15	BFV-517-05	BUTTERFLY VALVE	CIPR	12"	316SS	First Pass SWRO Train 5 to Cleaning Return	Manual		RO Vendor Supplied Valve
371	I-15	BFV-514-05	BUTTERFLY VALVE	ROC	10"	SDSS	Exchanger No. 5 Energy Recovery System	Manual		RO Vendor Supplied Valve
372	I-15	ARV-516-05	AIR RELEASE VALVE	V	1/2"	SDSS	Exchanger No. 5 Energy Recovery System			RO Vendor Supplied Valve
373	I-16	BFV-500-06	BUTTERFLY VALVE	ROF	8"	SDSS	RO Feed Water Pump No. 6 to First Pass SWRO Train 6	Manual		RO Vendor Supplied Valve
374	I-16	BFV-511-06	BUTTERFLY VALVE	CIPS	14"	FRP	Cleaning Supply to First Pass SWRO Train 6	Manual		
375	I-16	BFV-531-06	BUTTERFLY VALVE	CIPS	12"	316SS	Cleaning Supply to First Pass SWRO Train 6	Manual		RO Vendor Supplied Valve
376	I-16	BV-531-06	BALL VALVE	DR	2"	316SS	Cleaning Supply to First Pass SWRO Train 6 Drain	Manual		RO Vendor Supplied Valve
377	I-16	BFV-532-06	BUTTERFLY VALVE	CIPS	12"	SDSS	Cleaning Supply to First Pass SWRO Train 6	Manual		RO Vendor Supplied Valve

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
378	I-16	CV-530-06	CHECK VALVE	ERD	10"	SDSS	ERD Booster Pump No. 6 Discharge	Manual		RO Vendor Supplied Valve
379	I-16	BFV-529-06	BUTTERFLY VALVE	ERD	10"	SDSS	ERD Booster Pump No. 6 Discharge	Manual		RO Vendor Supplied Valve
380	I-16	BFV-530-06	BUTTERFLY VALVE	ERD	10"	SDSS	ERD Booster Pump No. 6 Suction	Manual		RO Vendor Supplied Valve
381	I-16	BFV-525-06	BUTTERFLY VALVE	DR	4"	316SS	Drains from RO Skids	Manual		RO Vendor Supplied Valve
382	I-16	BV-529-06	BALL VALVE	DR	1"	316SS	Drains from RO Skids Drain	Manual		RO Vendor Supplied Valve
383	I-16	BFV-527-06	BUTTERFLY VALVE	ROF	4"	SDSS	Drains from RO Skids	Manual		RO Vendor Supplied Valve
384	I-16	ARV-528-06	AIR RELEASE VALVE	V	1/2"	FRP	Filtered Water ERD Supply to Exchanger No. 6			RO Vendor Supplied Valve
385	I-16	ARV-527-06	AIR RELEASE VALVE	V	1/2"	FRP	Filtered Water ERD Supply to Exchanger No. 6			RO Vendor Supplied Valve
386	I-16	ARV-520-06	AIR RELEASE VALVE	V	1/2"	FRP	Exchanger No. 6 to Equalization Basin			RO Vendor Supplied Valve
387	I-16	BV-517-06	BALL VALVE	DR	1"	FRP	Exchanger No. 6 to Equalization Basin Drain	Manual		RO Vendor Supplied Valve
388	I-16	CV-522-06	CHECK VALVE	ROC	10"	FRP	Exchanger No. 6 to Equalization Basin	Manual		RO Vendor Supplied Valve
389	I-16	BFV-523-06	BUTTERFLY VALVE	ROC	10"	FRP	Exchanger No. 6 to Equalization Basin	Electric	Modulate	RO Vendor Supplied Valve
390	I-16	BFV-507-06	BUTTERFLY VALVE	ROP	6"	316SS	First Pass SWRO Train 6 Lower TDS Permeate	Manual		RO Vendor Supplied Valve
391	I-16	CV-507-06	CHECK VALVE	ROP	6"	316SS	First Pass SWRO Train 6 Higher TDS Permeate	Manual		RO Vendor Supplied Valve
392	I-16	BFV-508-06	BUTTERFLY VALVE	ROP	6"	316SS	First Pass SWRO Train 6 Higher TDS Permeate	Manual		RO Vendor Supplied Valve
393	I-16	BFV-509-06	BUTTERFLY VALVE	CIPR	4"	PVC	First Pass SWRO Train 6 to CIP Permeate Return	Manual		RO Vendor Supplied Valve
394	I-16	BV-514-06	BALL VALVE	DR	1"	SDSS	First Pass SWRO Train 6 to Cleaning Return Flush	Electric	Open/Close	RO Vendor Supplied Valve
395	I-16	BV-519-06	BALL VALVE	DR	1"	SDSS	First Pass SWRO Train 6 to Cleaning Return Drain	Manual		RO Vendor Supplied Valve
396	I-16	BFV-513-06	BUTTERFLY VALVE	CIPR	12"	SDSS	First Pass SWRO Train 6 to Cleaning Return	Manual		RO Vendor Supplied Valve
397	I-16	BV-516-06	BALL VALVE	DR	2"	316SS	First Pass SWRO Train 6 to Cleaning Return Drain	Manual		RO Vendor Supplied Valve
398	I-16	BFV-517-06	BUTTERFLY VALVE	CIPR	12"	316SS	First Pass SWRO Train 6 to Cleaning Return	Manual		RO Vendor Supplied Valve
399	I-16	BFV-514-06	BUTTERFLY VALVE	ROC	10"	SDSS	Exchanger No. 6 Energy Recovery System	Manual		RO Vendor Supplied Valve
400	I-16	ARV-516-06	AIR RELEASE VALVE	V	1/2"	SDSS	Exchanger No. 6 Energy Recovery System			RO Vendor Supplied Valve
401	I-17	BFV-500-07	BUTTERFLY VALVE	ROF	8"	SDSS	RO Feed Water Pump No. 7 to First Pass SWRO Train 7	Manual		RO Vendor Supplied Valve
402	I-17	BFV-511-07	BUTTERFLY VALVE	CIPS	14"	FRP	Cleaning Supply to First Pass SWRO Train 7	Manual		
403	I-17	BFV-531-07	BUTTERFLY VALVE	CIPS	12"	316SS	Cleaning Supply to First Pass SWRO Train 7	Manual		RO Vendor Supplied Valve
404	I-17	BV-531-07	BALL VALVE	DR	2"	316SS	Cleaning Supply to First Pass SWRO Train 7 Drain	Manual		RO Vendor Supplied Valve

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
405	I-17	BFV-532-07	BUTTERFLY VALVE	CIPS	12"	SDSS	Cleaning Supply to First Pass SWRO Train 7	Manual		RO Vendor Supplied Valve
406	I-17	CV-530-07	CHECK VALVE	ERD	10"	SDSS	ERD Booster Pump No. 7 Discharge	Manual		RO Vendor Supplied Valve
407	I-17	BFV-529-07	BUTTERFLY VALVE	ERD	10"	SDSS	ERD Booster Pump No. 7 Discharge	Manual		RO Vendor Supplied Valve
408	I-17	BFV-530-07	BUTTERFLY VALVE	ERD	10"	SDSS	ERD Booster Pump No. 7 Suction	Manual		RO Vendor Supplied Valve
409	I-17	BFV-525-07	BUTTERFLY VALVE	DR	4"	316SS	Drains from RO Skids	Manual		RO Vendor Supplied Valve
410	I-17	BV-529-07	BALL VALVE	DR	1"	316SS	Drains from RO Skids Drain	Manual		RO Vendor Supplied Valve
411	I-17	BFV-527-07	BUTTERFLY VALVE	ROF	4"	SDSS	Drains from RO Skids	Manual		RO Vendor Supplied Valve
412	I-17	ARV-528-07	AIR RELEASE VALVE	V	1/2"	FRP	Filtered Water ERD Supply to Exchanger No. 7			RO Vendor Supplied Valve
413	I-17	ARV-527-07	AIR RELEASE VALVE	V	1/2"	FRP	Filtered Water ERD Supply to Exchanger No. 7			RO Vendor Supplied Valve
414	I-17	ARV-520-07	AIR RELEASE VALVE	V	1/2"	FRP	Exchanger No. 7 to Equalization Basin			RO Vendor Supplied Valve
415	I-17	BV-517-07	BALL VALVE	DR	1"	FRP	Exchanger No. 7 to Equalization Basin Drain	Manual		RO Vendor Supplied Valve
416	I-17	CV-522-07	CHECK VALVE	ROC	10"	FRP	Exchanger No. 7 to Equalization Basin	Manual		RO Vendor Supplied Valve
417	I-17	BFV-523-07	BUTTERFLY VALVE	ROC	10"	FRP	Exchanger No. 7 to Equalization Basin	Electric	Modulate	RO Vendor Supplied Valve
418	I-17	BFV-507-07	BUTTERFLY VALVE	ROP	6"	316SS	First Pass SWRO Train 7 Lower TDS Permeate	Manual		RO Vendor Supplied Valve
419	I-17	CV-507-07	CHECK VALVE	ROP	6"	316SS	First Pass SWRO Train 7 Higher TDS Permeate	Manual		RO Vendor Supplied Valve
420	I-17	BFV-508-07	BUTTERFLY VALVE	ROP	6"	316SS	First Pass SWRO Train 7 Higher TDS Permeate	Manual		RO Vendor Supplied Valve
421	I-17	BFV-509-07	BUTTERFLY VALVE	CIPR	4"	PVC	First Pass SWRO Train 7 to CIP Permeate Return	Manual		RO Vendor Supplied Valve
422	I-17	BV-514-07	BALL VALVE	DR	1"	SDSS	First Pass SWRO Train 7 to Cleaning Return Flush	Electric	Open/Close	RO Vendor Supplied Valve
423	I-17	BV-519-07	BALL VALVE	DR	1"	SDSS	First Pass SWRO Train 7 to Cleaning Return Drain	Manual		RO Vendor Supplied Valve
424	I-17	BFV-513-07	BUTTERFLY VALVE	CIPR	12"	SDSS	First Pass SWRO Train 7 to Cleaning Return	Manual		RO Vendor Supplied Valve
425	I-17	BV-516-07	BALL VALVE	DR	2"	316SS	First Pass SWRO Train 7 to Cleaning Return Drain	Manual		RO Vendor Supplied Valve
426	I-17	BFV-517-07	BUTTERFLY VALVE	CIPR	12"	316SS	First Pass SWRO Train 7 to Cleaning Return	Manual		RO Vendor Supplied Valve
427	I-17	BFV-514-07	BUTTERFLY VALVE	ROC	10"	SDSS	Exchanger No. 7 Energy Recovery System	Manual		RO Vendor Supplied Valve
428	I-17	ARV-516-07	AIR RELEASE VALVE	V	1/2"	SDSS	Exchanger No. 7 Energy Recovery System			RO Vendor Supplied Valve
429	I-18	BFV-602-01	BUTTERFLY VALVE	CIPS	6"	316SS	Second Pass BWRO Train 1 Stage 1 Inlet	Manual		RO Vendor Supplied Valve
430	I-18	BV-600-01	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 1 Stage 1 Inlet Drain	Manual		RO Vendor Supplied Valve
431	I-18	BFV-603-01	BUTTERFLY VALVE	CIPS	6"	316SS	Second Pass BWRO Train 1 Stage 1 Inlet	Manual		RO Vendor Supplied Valve

VALVE SCHEDULE

9.6 MGD BASE CASE

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
432	I-18	BFV-604-01	BUTTERFLY VALVE	ROP	8"	316SS	Second Pass BWRO Feed Pump No. 1 Suction	Electric	Open/Close	RO Vendor Supplied Valve
433	I-18	CV-601-01	CHECK VALVE	ROP	8"	316SS	Second Pass BWRO Feed Pump No. 1 Discharge	Manual		RO Vendor Supplied Valve
434	I-18	BFV-601-01	BUTTERFLY VALVE	ROP	8"	316SS	Second Pass BWRO Feed Pump No. 1 Discharge	Manual		RO Vendor Supplied Valve
435	I-18	BFV-605-01	BUTTERFLY VALVE	FL	3"	316SS	Permeate Flush to Second Pass BWRO Feed Pump No. 1	Electric	Open/Close	RO Vendor Supplied Valve
436	I-18	CV-605-01	CHECK VALVE	FL	3"	316SS	Permeate Flush to Second Pass BWRO Feed Pump No. 1	Manual		RO Vendor Supplied Valve
437	I-18	BFV-612-01	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 1 Stage 2 Inlet	Manual		RO Vendor Supplied Valve
438	I-18	BFV-614-01	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 1 Stage 2 Inlet	Manual		RO Vendor Supplied Valve
439	I-18	BV-613-01	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 1 Stage 2 Inlet Drain	Manual		RO Vendor Supplied Valve
440	I-18	BFV-613-01	BUTTERFLY VALVE	ROC	8"	316SS	Second Pass BWRO Train 1 Stage 2 Inlet	Manual		RO Vendor Supplied Valve
441	I-18	BFV-610-01	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 1 Stage 1 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
442	I-18	BV-614-01	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 1 Stage 1 Outlet to CIPR Common Header Drain	Manual		RO Vendor Supplied Valve
443	I-18	BFV-615-01	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 1 Stage 1 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
444	I-18	BV-618-01	BALL VALVE	ROC	2 1/2"	2205SS	Second Pass BWRO Train 1 Stage 2 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
445	I-18	BV-619-01	BALL VALVE	DR	1"	2205SS	Second Pass BWRO Train 1 Stage 2 Outlet to CIPR Common Header Drain	Manual		RO Vendor Supplied Valve
446	I-18	BV-620-01	BALL VALVE	ROC	2 1/2"	2205SS	Second Pass BWRO Train 1 Stage 2 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
447	I-18	BV-627-01	BALL VALVE	ROC	2 1/2"	2205SS	Second Pass BWRO Train 1 Stage 2 Outlet to Brine Outfall	Electric	Modulate	RO Vendor Supplied Valve
448	I-18	CV-630-01	CHECK VALVE	ROC	2 1/2"	PVC	Second Pass BWRO Train 1 Stage 2 Outlet to Brine Outfall	Manual		RO Vendor Supplied Valve
449	I-18	BFV-631-01	BUTTERFLY VALVE	ROC	2 1/2"	PVC	Second Pass BWRO Train 1 Stage 2 Outlet to Brine Outfall	Manual		RO Vendor Supplied Valve
450	I-18	BFV-611-01	BUTTERFLY VALVE	CIPR	8"	PVC	Second Pass BWRO Train 1 Stage 2 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
451	I-18	CV-620-01	CHECK VALVE	BWROP	6"	316SS	Second Pass BWRO Train 1 Stage 1 Outlet to UV System	Manual		RO Vendor Supplied Valve
452	I-18	BFV-621-01	BUTTERFLY VALVE	BWROP	6"	316SS	Second Pass BWRO Train 1 Common Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
453	I-18	BV-621-01	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 1 Common Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
454	I-18	BFV-622-01	BUTTERFLY VALVE	DR	3"	PVC	Second Pass BWRO Train 1 Common Outlet to CIP Permeate Return	Manual		RO Vendor Supplied Valve
455	I-18	BFV-623-01	BUTTERFLY VALVE	DR	3"	PVC	Second Pass BWRO Train 1 Common Outlet to CIP Permeate Return	Manual		RO Vendor Supplied Valve
456	I-18	BFV-625-01	BUTTERFLY VALVE	DR	2 1/2"	2205SS	Second Pass BWRO Train 1 Stage 2 Outlet to Process Drain	Manual		RO Vendor Supplied Valve
457	I-18	BV-622-01	BALL VALVE	DR	1"	PVC	Second Pass BWRO Train 1 Stage 2 Outlet to Process Drain	Manual		RO Vendor Supplied Valve
458	I-18	BV-626-01	BALL VALVE	DR	2 1/2"	PVC	Second Pass BWRO Train 1 Stage 2 Outlet to Process Drain	Manual		RO Vendor Supplied Valve

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
459	I-19	BFV-602-02	BUTTERFLY VALVE	CIPS	6"	316SS	Second Pass BWRO Train 2 Stage 1 Inlet	Manual		RO Vendor Supplied Valve
460	I-19	BV-600-02	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 2 Stage 1 Inlet Drain	Manual		RO Vendor Supplied Valve
461	I-19	BFV-603-02	BUTTERFLY VALVE	CIPS	6"	316SS	Second Pass BWRO Train 2 Stage 1 Inlet	Manual		RO Vendor Supplied Valve
462	I-19	BFV-604-02	BUTTERFLY VALVE	ROP	8"	316SS	Second Pass BWRO Feed Pump No. 1 Suction	Electric	Open/Close	RO Vendor Supplied Valve
463	I-19	CV-601-02	CHECK VALVE	ROP	8"	316SS	Second Pass BWRO Feed Pump No. 1 Discharge	Manual		RO Vendor Supplied Valve
464	I-19	BFV-601-02	BUTTERFLY VALVE	ROP	8"	316SS	Second Pass BWRO Feed Pump No. 1 Discharge	Manual		RO Vendor Supplied Valve
465	I-19	BFV-605-02	BUTTERFLY VALVE	FL	3"	316SS	Permeate Flush to Second Pass BWRO Feed Pump No. 1	Electric	Open/Close	RO Vendor Supplied Valve
466	I-19	CV-605-02	CHECK VALVE	FL	3"	316SS	Permeate Flush to Second Pass BWRO Feed Pump No. 1	Manual		RO Vendor Supplied Valve
467	I-19	BFV-612-02	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 2 Stage 2 Inlet	Manual		RO Vendor Supplied Valve
468	I-19	BFV-614-02	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 2 Stage 2 Inlet	Manual		RO Vendor Supplied Valve
469	I-19	BV-613-02	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 2 Stage 2 Inlet Drain	Manual		RO Vendor Supplied Valve
470	I-19	BFV-613-02	BUTTERFLY VALVE	ROC	8"	316SS	Second Pass BWRO Train 2 Stage 2 Inlet	Manual		RO Vendor Supplied Valve
471	I-19	BFV-610-02	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 2 Stage 1 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
472	I-19	BV-614-02	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 2 Stage 1 Outlet to CIPR Common Header Drain	Manual		RO Vendor Supplied Valve
473	I-19	BFV-615-02	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 2 Stage 1 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
474	I-19	BV-618-02	BALL VALVE	ROC	2 1/2"	2205SS	Second Pass BWRO Train 2 Stage 2 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
475	I-19	BV-619-02	BALL VALVE	DR	1"	2205SS	Second Pass BWRO Train 2 Stage 2 Outlet to CIPR Common Header Drain	Manual		RO Vendor Supplied Valve
476	I-19	BV-620-02	BALL VALVE	ROC	2 1/2"	2205SS	Second Pass BWRO Train 2 Stage 2 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
477	I-19	BV-627-02	BALL VALVE	ROC	2 1/2"	2205SS	Second Pass BWRO Train 2 Stage 2 Outlet to Brine Outfall	Electric	Modulate	RO Vendor Supplied Valve
478	I-19	CV-630-02	CHECK VALVE	ROC	2 1/2"	PVC	Second Pass BWRO Train 2 Stage 2 Outlet to Brine Outfall	Manual		RO Vendor Supplied Valve
479	I-19	BFV-631-02	BUTTERFLY VALVE	ROC	2 1/2"	PVC	Second Pass BWRO Train 2 Stage 2 Outlet to Brine Outfall	Manual		RO Vendor Supplied Valve
480	I-19	BFV-611-02	BUTTERFLY VALVE	CIPR	8"	PVC	Second Pass BWRO Train 2 Stage 2 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
481	I-19	CV-620-02	CHECK VALVE	BWROP	6"	316SS	Second Pass BWRO Train 2 Stage 1 Outlet to UV System	Manual		RO Vendor Supplied Valve
482	I-19	BFV-621-02	BUTTERFLY VALVE	BWROP	6"	316SS	Second Pass BWRO Train 2 Common Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
483	I-19	BV-621-02	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 2 Common Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
484	I-19	BFV-622-02	BUTTERFLY VALVE	DR	6"	PVC	Second Pass BWRO Train 2 Common Outlet to CIP Permeate Return	Manual		RO Vendor Supplied Valve
485	I-19	BFV-623-02	BUTTERFLY VALVE	DR	6"	PVC	Second Pass BWRO Train 2 Common Outlet to CIP Permeate Return	Manual		RO Vendor Supplied Valve

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
486	I-19	BFV-625-02	BUTTERFLY VALVE	DR	2 1/2"	2205SS	Second Pass BWRO Train 2 Stage 2 Outlet to Process Drain	Manual		RO Vendor Supplied Valve
487	I-19	BV-622-02	BALL VALVE	DR	1"	PVC	Second Pass BWRO Train 2 Stage 2 Outlet to Process Drain	Manual		RO Vendor Supplied Valve
488	I-19	BV-626-02	BALL VALVE	DR	2 1/2"	PVC	Second Pass BWRO Train 2 Stage 2 Outlet to Process Drain	Manual		RO Vendor Supplied Valve
489	I-20	BFV-602-03	BUTTERFLY VALVE	CIPS	6"	316SS	Second Pass BWRO Train 3 Stage 1 Inlet	Manual		RO Vendor Supplied Valve
490	I-20	BV-600-03	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 3 Stage 1 Inlet Drain	Manual		RO Vendor Supplied Valve
491	I-20	BFV-603-03	BUTTERFLY VALVE	CIPS	6"	316SS	Second Pass BWRO Train 3 Stage 1 Inlet	Manual		RO Vendor Supplied Valve
492	I-20	BFV-604-03	BUTTERFLY VALVE	ROP	8"	316SS	Second Pass BWRO Feed Pump No. 1 Suction	Electric	Open/Close	RO Vendor Supplied Valve
493	I-20	CV-601-03	CHECK VALVE	ROP	8"	316SS	Second Pass BWRO Feed Pump No. 1 Discharge	Manual		RO Vendor Supplied Valve
494	I-20	BFV-601-03	BUTTERFLY VALVE	ROP	8"	316SS	Second Pass BWRO Feed Pump No. 1 Discharge	Manual		RO Vendor Supplied Valve
495	I-20	BFV-605-03	BUTTERFLY VALVE	FL	3"	316SS	Permeate Flush to Second Pass BWRO Feed Pump No. 1	Electric	Open/Close	RO Vendor Supplied Valve
496	I-20	CV-605-03	CHECK VALVE	FL	3"	316SS	Permeate Flush to Second Pass BWRO Feed Pump No. 1	Manual		RO Vendor Supplied Valve
497	I-20	BFV-612-03	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 3 Stage 2 Inlet	Manual		RO Vendor Supplied Valve
498	I-20	BFV-614-03	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 3 Stage 2 Inlet	Manual		RO Vendor Supplied Valve
499	I-20	BV-613-03	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 3 Stage 2 Inlet Drain	Manual		RO Vendor Supplied Valve
500	I-20	BFV-613-03	BUTTERFLY VALVE	ROC	8"	316SS	Second Pass BWRO Train 3 Stage 2 Inlet	Manual		RO Vendor Supplied Valve
501	I-20	BFV-610-03	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 3 Stage 1 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
502	I-20	BV-614-03	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 3 Stage 1 Outlet to CIPR Common Header Drain	Manual		RO Vendor Supplied Valve
503	I-20	BFV-615-03	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 3 Stage 1 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
504	I-20	BV-618-03	BALL VALVE	ROC	2 1/2"	2205SS	Second Pass BWRO Train 3 Stage 2 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
505	I-20	BV-619-03	BALL VALVE	DR	1"	2205SS	Second Pass BWRO Train 3 Stage 2 Outlet to CIPR Common Header Drain	Manual		RO Vendor Supplied Valve
506	I-20	BV-620-03	BALL VALVE	ROC	2 1/2"	2205SS	Second Pass BWRO Train 3 Stage 2 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
507	I-20	BV-627-03	BALL VALVE	ROC	2 1/2"	2205SS	Second Pass BWRO Train 3 Stage 2 Outlet to Brine Outfall	Electric	Modulate	RO Vendor Supplied Valve
508	I-20	CV-630-03	CHECK VALVE	ROC	2 1/2"	PVC	Second Pass BWRO Train 3 Stage 2 Outlet to Brine Outfall	Manual		RO Vendor Supplied Valve
509	I-20	BFV-631-03	BUTTERFLY VALVE	ROC	2 1/2"	PVC	Second Pass BWRO Train 3 Stage 2 Outlet to Brine Outfall	Manual		RO Vendor Supplied Valve
510	I-20	BFV-611-03	BUTTERFLY VALVE	CIPR	8"	PVC	Second Pass BWRO Train 3 Stage 2 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
511	I-20	CV-620-03	CHECK VALVE	BWROP	6"	316SS	Second Pass BWRO Train 3 Stage 1 Outlet to UV System	Manual		RO Vendor Supplied Valve
512	I-20	BFV-621-03	BUTTERFLY VALVE	BWROP	6"	316SS	Second Pass BWRO Train 3 Common Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve

NO.	PID	VALVE TAG	VALVE TYPE	SERVICE	SIZE	PIPE MATERIALS	LOCATION	OPERATOR TYPE	ACTUATOR ACTION	REMARKS
513	I-20	BV-621-03	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 3 Common Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
514	I-20	BFV-622-03	BUTTERFLY VALVE	DR	3"	PVC	Second Pass BWRO Train 3 Common Outlet to CIP Permeate Return	Manual		RO Vendor Supplied Valve
515	I-20	BFV-623-03	BUTTERFLY VALVE	DR	3"	PVC	Second Pass BWRO Train 3 Common Outlet to CIP Permeate Return	Manual		RO Vendor Supplied Valve
516	I-20	BFV-625-03	BUTTERFLY VALVE	DR	2 1/2"	2205SS	Second Pass BWRO Train 3 Stage 2 Outlet to Process Drain	Manual		RO Vendor Supplied Valve
517	I-20	BV-622-03	BALL VALVE	DR	1"	PVC	Second Pass BWRO Train 3 Stage 2 Outlet to Process Drain	Manual		RO Vendor Supplied Valve
518	I-20	BV-626-03	BALL VALVE	DR	2 1/2"	PVC	Second Pass BWRO Train 3 Stage 2 Outlet to Process Drain	Manual		RO Vendor Supplied Valve
519	I-21	BFV-602-04	BUTTERFLY VALVE	CIPS	6"	316SS	Second Pass BWRO Train 4 Stage 1 Inlet	Manual		RO Vendor Supplied Valve
520	I-21	BV-600-04	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 4 Stage 1 Inlet Drain	Manual		RO Vendor Supplied Valve
521	I-21	BFV-603-04	BUTTERFLY VALVE	CIPS	6"	316SS	Second Pass BWRO Train 4 Stage 1 Inlet	Manual		RO Vendor Supplied Valve
522	I-21	BFV-604-04	BUTTERFLY VALVE	ROP	8"	316SS	Second Pass BWRO Feed Pump No. 1 Suction	Electric	Open/Close	RO Vendor Supplied Valve
523	I-21	CV-601-04	CHECK VALVE	ROP	8"	316SS	Second Pass BWRO Feed Pump No. 1 Discharge	Manual		RO Vendor Supplied Valve
524	I-21	BFV-601-04	BUTTERFLY VALVE	ROP	8"	316SS	Second Pass BWRO Feed Pump No. 1 Discharge	Manual		RO Vendor Supplied Valve
525	I-21	BFV-605-04	BUTTERFLY VALVE	FL	3"	316SS	Permeate Flush to Second Pass BWRO Feed Pump No. 1	Electric	Open/Close	RO Vendor Supplied Valve
526	I-21	CV-605-04	CHECK VALVE	FL	3"	316SS	Permeate Flush to Second Pass BWRO Feed Pump No. 1	Manual		RO Vendor Supplied Valve
527	I-21	BFV-612-04	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 4 Stage 2 Inlet	Manual		RO Vendor Supplied Valve
528	I-21	BFV-614-04	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 4 Stage 2 Inlet	Manual		RO Vendor Supplied Valve
529	I-21	BV-613-04	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 4 Stage 2 Inlet Drain	Manual		RO Vendor Supplied Valve
530	I-21	BFV-613-04	BUTTERFLY VALVE	ROC	8"	316SS	Second Pass BWRO Train 4 Stage 2 Inlet	Manual		RO Vendor Supplied Valve
531	I-21	BFV-610-04	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 4 Stage 1 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
532	I-21	BV-614-04	BALL VALVE	DR	1"	316SS	Second Pass BWRO Train 4 Stage 1 Outlet to CIPR Common Header Drain	Manual		RO Vendor Supplied Valve
533	I-21	BFV-615-04	BUTTERFLY VALVE	CIPR	6"	316SS	Second Pass BWRO Train 4 Stage 1 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
534	I-21	BV-618-04	BALL VALVE	ROC	2 1/2"	2205SS	Second Pass BWRO Train 4 Stage 2 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
535	I-21	BV-619-04	BALL VALVE	DR	1"	2205SS	Second Pass BWRO Train 4 Stage 2 Outlet to CIPR Common Header Drain	Manual		RO Vendor Supplied Valve
536	I-21	BV-620-04	BALL VALVE	ROC	2 1/2"	2205SS	Second Pass BWRO Train 4 Stage 2 Outlet to CIPR Common Header	Manual		RO Vendor Supplied Valve
537	I-21	BV-627-04	BALL VALVE	ROC	2 1/2"	2205SS	Second Pass BWRO Train 4 Stage 2 Outlet to Brine Outfall	Electric	Modulate	RO Vendor Supplied Valve
538	I-21	CV-630-04	CHECK VALVE	ROC	2 1/2"	PVC	Second Pass BWRO Train 4 Stage 2 Outlet to Brine Outfall	Manual		RO Vendor Supplied Valve
539	I-21	BFV-631-04	BUTTERFLY VALVE	ROC	2 1/2"	PVC	Second Pass BWRO Train 4 Stage 2 Outlet to Brine Outfall	Manual		RO Vendor Supplied Valve