West Basin Municipal Water District
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Ocean Water Desalination Program Master Plan (PMP)

Facility Operations & Maintenance Plan (OMP)

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Acronyms Used in the Report

AF	Acre-Foot
CIP	Clean-In-Place
CSDPR	Conceptual System Design and Program Requirements
DB	Design-Build
DBB	Design-Bid-Build
DBO	Design-Build Operate
DBOOT	Design Build Own Operate Transfer
I&C	Instrumentation and Control
IRWMP	Integrated Regional Water Management Plan
JPA	Joint Powers Authority
KV	Kilovolt
MCC	Motor Control Center
MGD	Million Gallons per Day
NCPPP	National Council on Public-Private Partnerships
O&M	Operations and Maintenance
OMP	Operations & Maintenance Plan
OWDPMP	Ocean Water Desalination Program Master Plan
P3	Public Private Partnerships
PPP	Public Private Partnerships
RO	Reverse Osmosis
SCADA	Supervisory Control and Data Acquisition
SWRO	Surface Water Reverse Osmosis

1. Introduction

1.1. Objective

The objective of this Facility Operations and Maintenance Plan (OMP) is to identify operational requirements, resources, staffing, management and other considerations that will be necessary to operate and maintain an ocean water desalination facility in West Basin's service area.   These parameters are optimized based on experiences gained from other desalination projects, as well as current Ocean Water Desalination Demonstration Facility (OWDDF) operation and constraints anticipated at selected sites. Operational and maintenance strategies, as well as their associated costs, are presented in an effort to assist West Basin in planning these activities for a full-scale facility.

2. Operational Parameters

2.1. Operations Overview

Numerous factors, including the treatment capacity, raw water quality, effluent requirements, brine discharge limitations, and preliminary plant design will have an impact on operational requirements for a seawater desalination facility. A review of key parameters and global operational considerations is given in the following sections.

2.2. Plant Description

The proposed West Basin Ocean Water Desalination Facility, designed with reverse osmosis as its core desalination process, may undergo phased expansion to suit demands. The Conceptual System Design and Program Requirements Report (CSPDR, also TM-1) identified two flow scenarios, specifically local and regional cases of 20-MGD and 60-MGD, respectively. These cases were expanded to include a total of four scenarios which are described in **Table 2-1**. These expanded cases were also used as a basis for additional costing assessments included in the Project Costs and Funding Plan (PFP).

Table 2-1: Facility Phasing Scenarios

Scenario No	Identification	Description
Scenario 1	10-MGD Facility	Scenario 1 is a fully built-out 10-MGD facility. No provisions are included for future expansion of the plant
Scenario 2	20-MGD Facility	Scenario 2 is a fully built-out 20-MGD facility. No provisions are included for future expansion of the plant
Scenario 3A	10-MGD Facility (with 40-MGD Backbone)	Scenario 3A is a 10-MGD facility with a 40-MGD backbone for expansion. All facilities are sized for 10-MGD, except for intake screens and piping, product water conveyance piping, and the administration and maintenance buildings, which are sized for the 40-MGD backbone
Scenario 3B	40-MGD Facility	Scenario 3B is a fully built-out 40-MGD facility. No provisions are included for future expansion of the plant
Scenario 4	60-MGD Facility	Scenario 4 is a fully built-out 60-MGD facility. No provisions are included for future expansion of the plant

2.3. Influent Water Quality

As part of this OWDPMP, the proposed West Basin Ocean Water Desalination facility is currently being considered for construction at one of two locations: El Segundo or Redondo Beach. Both locations have different water quality characteristics that may impact monitoring and potential maintenance requirements at the facility. A summary of the influent quality at each site is given in **Table 2-2**. This water quality data is also presented in the CSDPR/TM-1 along with a discussion on viable treatment processes.

Table 2-2: Influent Quality

Parameter	Units	El Segundo			Redondo Beach		
		Ave	Min	Max	Ave	Min	Max
Inorganics							
Ca	mg/L	400	343	506	373	360	400
Mg	mg/L	1,280	1,110	1,620	1,254	1,200	1,400
Na	mg/L	10,800	8,880	13,100	10,833	10,000	13,000
K	mg/L	391	41	478	468	390	580
SiO_2	mg/L	<10	<10	<10	0.78	0.52	1.3
F	mg/L	0.94	0.8	1.1	<0.5	<0.5	<0.5
P	mg/L	0.07	0.02	0.1	NS	NS	NS
As	µg/L	9.9	0.9	57	0.98	0.85	1.1
Sr	µg/L	7,190	6,820	7,660	7.07	7	7.1
Al	µg/L	101	99	110	<0.01	<0.01	<0.01
Se	µg/L	51	0.4	194	<0.1	<0.1	<0.1
Fe	µg/L	283	250	336	<0.05	<0.05	<0.05
NO_3	mg/L as N	<25	NA	NA	NS	NS	NS
NO_2	mg/L as N	<25	NA	NA	NS	NS	NS
NH_4	mg/L	0.03	0.005	0.01	2,200	2,200	2,200
ClO_3	µg/L	<1,000	<1,000	<1,000	<10	<10	<10
Cl	mg/L	18,974	18,000	20,100	20,542	20,000	21,000
SO_4	mg/L	2,531	2,230	2,650	2,713	2,500	2,900
Alkalinity	mg/L as $CaCO_3$	113	99	130	109	37	120
Total Hardness	mg/L as $CaCO_3$	6,200	3,340	7,940	-	-	-
Ca Hardness	mg/L as $CaCO_3$	980	860	1,260	-	-	-
B	mg/L	3.5	2.6	4.2	4.7	4.1	5.3
Br	mg/L	59	45	91	65	59	70
$HClO_4$	µg/L	<200	<200	<200	-	-	-
Cr	µg/L	0.21	0.19	0.55	0.0004	0.0004	0.0004
Hex. Cr	µg/L	1.15	0.01	9.7	<1.5	<1.5	<1.5
Ag	µg/L	<10	<10	<10	<0.05	<0.05	<0.05
Be	µg/L	0.64	0.02	1.4	<0.05	<0.05	<0.05
Cu	µg/L	32	0.1	174	2.3	1.5	3.1
Pb	µg/L	0.17	0.07	0.47	0.07	0.05	0.1
Zn	µg/L	1.04	0.5	3	0.5	0.3	0.7
Th	µg/L	0.02	0.02	0.02	<0.0004	<0.0004	<0.0004
Hg	µg/L	1.65	0.02	4.8	0.0004	0.0004	0.0004
General Physical Parameters							

Parameter	Units	El Segundo			Redondo Beach		
		Ave	Min	Max	Ave	Min	Max
TDS	mg/L	35,000	32,000	38,000	37,917	34,000	41,000
Turbidity	NTU	1.6	0.1	8.3	1.8	0.1	9.7
pH	-	8	7.2	8.4	8.2	6.5	8.4
Temp.	°C	18.1	8.7	25.9	17.8	11.5	24.6
Color	Color Units	3	1	5	< 3	< 3	< 3
UV	abs/cm	0.01	0.01	0.02	-	-	-
TOC	mg/L	1.2	0.3	3.4	0.97	0.3	1.7
Microbial							
E. Coli	MPN/ 100mL	3.5	0	27	9.4	2	41
Fecal Coliform	MPN/ 100mL	<1.1	<1.1	4	3.6	2	11
Total Coliform	MPN/ 100mL	7.6	<2	50	3.4	2	11
Entero-cocci	MPN/ 100mL	12	<2	23	5	2	10
HPC	CFU/mL	20	1	47	9	1	170
Crypto-sporidium	oocysts	<1	<1	<1	-	-	-
F-Specific Phage	PFU/L	ND	ND	ND	-	-	-
Giardia	cysts	ND	ND	ND	-	-	-
Somatic Bacteria	PFU/L	3.9	0	18	-	-	-
Direct Bacterial Count x 10^3	DBC/ mL	995	200	2,000	-	-	-
Organics							
Bromoform	µg/L	1	<0.5	7.2	-	-	-
MEK	µg/L	<5	<5	20	-	-	-
Methylene Chloride	µg/L	<0.5	<0.5	<0.5	-	-	-
MTBE	µg/L	<0.5	<0.5	0.56	<0.002	<0.002	<0.002
Toluene	µg/L	<0.5	<0.5	0.92	<0.0005	<0.0005	<0.0005
Algal Toxins							
Domoic Acid	µg/L	0.3	<0.002	2.57	-	-	-

Monitoring programs, such as the recommended monitoring schedule defined in **Table 7-1**, should be designed to track these compounds, as they may cause membrane fouling and other issues that could impact equipment lifecycles, cleaning frequencies, and require intensive maintenance. Maintenance programs should be designed to ensure that such problems may be addressed in the event that they occur.

2.4. Product Water Quality

A summary of product water quality targets that the desalination facility will be designed to achieve is given in **Table 2-3.** The development of these goals is described in detail in TM-1. These goals will apply to both the Redondo Beach and El Segundo sites, regardless of which site is ultimately chosen for the facility's installation.

Table 2-3: Effluent Goals

Parameter	Units	Effluent Goal
Pathogens		
Cryptosporidium	-	3-log (99.9%) reduction
Giardia	-	3-log (99.9%) reduction
Viruses	-	4-log (99.99%) reduction
Turbidity		
Post-Membrane Filtration (each train)	NTU	< 0.15 for more than 15 min
Disinfectants		
Chloramines	mg/L	2.5 - 3.0
Disinfection Byproducts		
Total trihalomethanes (TTHMs)	mg/L	< 0.040 (50% of MCL)
Haloacetic Acids (HAA5)	mg/L	< 0.030 (50% of MCL)
Chlorite	mg/L	< 0.8 (80% of MCL)
Bromate	mg/L	< 0.008 mg/L (80% of MCL)
Other Regulated Water Quality Categories		
Inorganic contaminants	-	Primary MCLs
Organic contaminants	-	Primary MCLs
Radionuclides	-	Primary MCLs
Secondary standards		
pH	-	8.2 - 8.5
Chloride	mg/L	< 100
Total Dissolved Solids	mg/L	250
Other Secondary Parameters	-	MCLs
Unregulated Parameters		
$CaCO_3$ Precipitation Potential	mg/L	> 0 (minimum), 4 – 10 (target)
Langelier Saturation Index	-	> 0 (minimum), > 0.2 (target)
Boron	mg/L	< 0.5
Bromide	mg/L	< 0.3

2.5. Waste Stream Management

Discharges from the West Basin Ocean Water Desalination Plant operations will likely consist of a combination of four major liquid streams as follows:

- Concentrate from the SWRO process
- Backwash water from granular media filters
- Backwash water from low pressure membranes MF/UF
- Neutralized waste from the membrane filtration and SWRO CIP process

Limits for the discharge of these waste streams will be a factor of source, discharge location and duration. The source, or makeup of the waste stream, is derived from the raw water quality and unit processes implemented. West Basin's currently preferred unit process are identified in the CSDPR. The treatment trains will be confirmed or refined

based on the results of the current testing at the Demonstration Facility. The monitoring program being implemented at the Demonstration facility is currently establishing a basis for these waste stream qualities. The discharge location currently proposed for the concentrate, MF/UF and filter backwash are ocean discharge. Discharge limits will likely be similar to requirements of the existing discharge permit for the demonstration project.

The concentrate production is continuous with the operation of the SWRO system. Discharge from the facility will be controlled from a storage and pumping facility. At this facility, the flow and water quality limits will need to be monitored and maintained.

Establishing permitting requirements for these discharges, including defined limits is described in the Project Permitting plan (PPP). However, one of the requirements of the OMP is to define ongoing permit compliance requirements. Establishing a monitoring program for waste stream discharge permit compliance is integral to this effort.

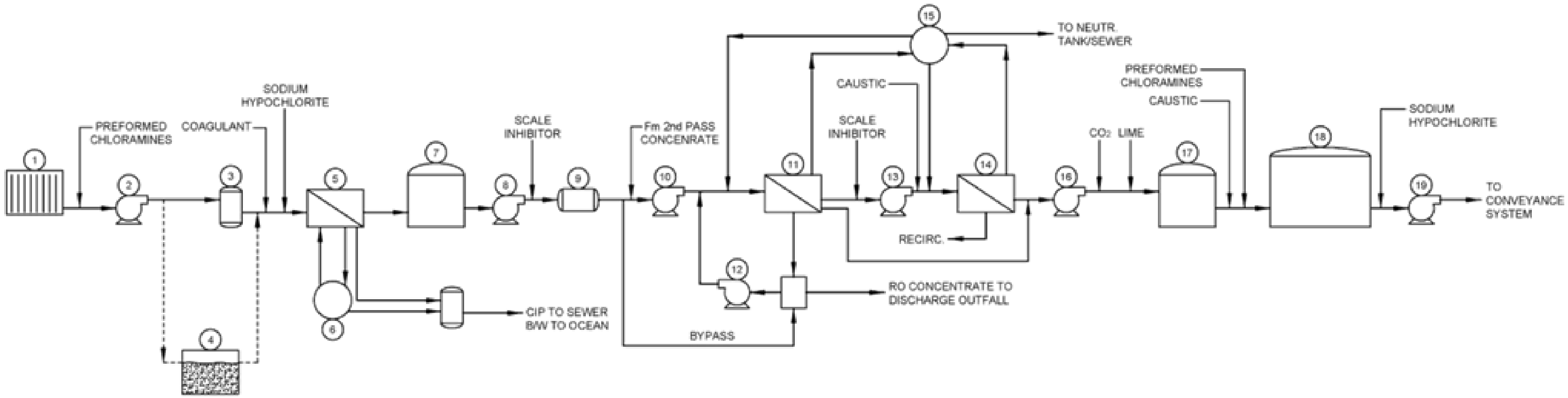
2.6. Treatment Process Overview

Based on the nature of the raw water quality, effluent goals, and pilot results, the proposed West Basin Ocean Water Desalination plant will be designed to include several core component processes. These processes are summarized as follows:

- Intake
- Pretreatment
  - Screening
  - Coagulation
  - Granular Media Filtration
  - Low pressure membranes MF/UF
  - Cartridge filters
- Reverse osmosis (single or two-pass process)
- Energy Recovery
- Post-treatment
  - Stabilization and corrosion control
  - Disinfection
- Residuals handling and disposal
- Concentrate Discharge/Diffuser System

Loading rates associated with these treatment processes can be found in the CSDPR. A process flow diagram is included as **Figure 2-1**.

Figure 2-1: Process Flow Diagram (PFD)



PROCESS/ EQUIPMENT NO.	DESCRIPTION	COMMENTS	UNIT CAPACITY	
			20-MGD	60-MGD
1	SCREENS	WEDGE WIRE SCREENS	45.1 MGD	135.3 MGD
2	RAW WATER PUMP STATION	RAW WATER PUMPS	45.1 MGD	135.3 MGD
3	STRAINERS	DISK FILTERS	44.2 MGD	132.6 MGD
4	HIGH RATE GRANULAR MEDIA FILTRATION	HIGH RATE GMF (ALTERNATIVE TO DISK FILTERS)	44.2 MGD	132.6 MGD
5	MF/UF	MF/UF	42.0 MGD	126.0 MGD
6	MF/UF CIP SYSTEM	CIP SYST. AND DISCH. NEUTRALIZATION TANK		
7	MF/UF FILTRATE STORAGE	FILTRATE TANK	0.6 MG	1.8 MG
8	MF/UF FILTRATE BOOSTER P.S.	BOOSTER PUMPS	42.0 MGD	126.0 MG
9	CARTRIDGE FILTERS	CARTRIDGE FILTERS	42.0 MGD	126.0 MGD
10	RO FEED P.S. - 1ST PASS	RO FEED PUMPS	42.0 MGD	126.0 MGD

PROCESS/ EQUIPMENT NO.	DESCRIPTION	COMMENTS	UNIT CAPACITY	
			20-MGD	60-MGD
11	RO SYSTEM - 1ST PASS	RO SYSTEM - 1ST PASS	21.0 MGD	63.0 MGD
12	ENERGY RECOVERY	PRESSURE EXCHANGE ENERGY RECOVERY	-	-
13	RO FEED P.S. - 2ND PASS	RO FEED PUMPS	10.3 MGD	30.9 MGD
14	RO SYSTEM - 2ND PASS	RO SYSTEM - 2ND PASS	9.3 MGD	27.9 MGD
15	RO CIP	CIP SYSTEM	-	-
16	POST-TREATMENT P.S.	BOOSTER PUMPS	20 MGD	60 MGD
17	POST-TREATMENT	LIME CONTACT TANK	20 MGD	60 MGD
18	CLEARWELL	PRODUCT WATER STORAGE	5 MG	15 MG
19	PRODUCT WATER P.S.	PRODUCT WATER PUMPS	30 MGD	60 MGD

NOTES:
1. 2ND RO SIZING BASED ON 50% OF 1ST PASS RO.

2.7. Operational Parameters

The proposed West Basin Ocean Water Desalination Facility will require oversight of particular operational parameters to ensure that the treatment process occurs efficiently and equipment integrity is maintained. In addition, attention to these parameters will help to ensure that that the product water quality goals are met. Typical operational parameters, objectives, and goals are outlined in **Table 2-4**:

Table 2-4: Operational Parameters

Parameter	Objective	Goal
Chemical consumption, water production, and operating hours	Confirm that dosing is uniform and pumps are calibrated	Sustain performance of chemical systems to sustain performance of treatment plant.
Pressure loss across each membrane array	Ensure that maximum pressure differentials are not exceeded	Optimize membrane filtration system by modifying flux and CIP regime as required.
Salt passage, flow rate, pressure drop	Determine if membranes are fouling, and if so, how they are fouling. Determine if membranes are damaged.	Optimize RO and CIP processes by modifying pretreatment, and RO recovery, flux and CIP regime as required.
Normalized permeate flow	Confirm that flow is consistent, chemical cleaning occurs when needed	Optimize membrane processes by modifying pretreatment, RO operating parameters such as recovery and flux, and CIP procedures
Record-keeping of water quality	Ensure compliance with specifications	Meet requirements in **Table 7-1**
Permeate pressure, pH, chemical consumption, flux, temperature	Maintain membrane integrity during short-term shutdown events (if required)	Asset management
Permeate pressure, pH, chemical consumption, flux, temperature	Maintain membrane integrity during long-term shutdown events (if required)	Asset management
Foulant type such as sediment, algal blooms, or biogrowth	Determine membrane cleaning strategy required and assess pretreatment system perfomance	Fine tune the CIP process to better restore membrane performance and extend membrane run time.
Flow rate of cleaning solution, temperature, pH, pressure drop, frequency and duration	Remove foulants without damaging membranes	Fine tune the CIP process to better restore membrane performance and extend membrane run time.
Cartridge filter pressure drop increase	Determine source of fouling. Ensure leaks and other malfunctions are mitigated; replacement schedule is regular	Sustain performance of cartridge filtration system by optimizing change-out frequency. May include modifying pretreatment chemical conditioning.

The intent is to develop thorough and rigorous procedures for facility operations and identify clearly in the O&M manual. Following procedures as outlined in the O&M manual and consulting with the plant provider when needed will ensure that the treatment system operates as efficiently as possible.

3. Required Labor and Staffing

3.1. Overview

Appropriate personnel will be required in order to ensure that the facilities are properly operated and maintained, and that all permitted conditions are properly monitored and maintained. Staffing considerations for the proposed West Basin Ocean Water Desalination Facility are described in the following sections.

3.2. Labor / Staffing Plan

3.2.1. Labor Requirements

The staff required to operate a water treatment facility and the certifications they will need will depend on the type of treatment operated and the size of the population the facility will serve. Since the unit processes are being verified in the ongoing Demonstration Plant Operation Study and there are several scenarios for facility capacity/supply values still being considered by West Basin, an additional assessment of staffing requirements will be necessary once these components are defined. For a reverse osmosis ocean water desalination process, the Chief Operator and Shift Operators will need to be certified through the state of California Department of Public Health (CDPH). Distribution operators must also be certified to an appropriate level based on the population size the treatment plant will serve. Laboratory Technicians used to analyze the finished water quality will need to be duly certified per CDPH requirements as well. Based on the conceptual design considered for West Basin's Ocean Water Desalination Facility, an initial assessment of the staffing certification requirements is provided in **Tables 3-1 and 3-2**.

The quantity of personnel required to operate a seawater desalination facility will largely depend on the size and complexity of the facility. A larger staff will certainly be required as the plant undergoes expansion activities. Personnel may be sourced depending on the nature of the work to be done by particular plant roles. "Core" staff members, such as plant managers and operations supervisors, should be dedicated to the desalination facility. "Specialty" staff members, such as electricians and mechanics, may be full-time personnel located on site or outsourced. "Preventative maintenance" personnel are those whose assistance is typically helpful to the efficient operation of a facility, but which might not be required 100 percent of the time.

Initial recommended staffing levels for West Basin's Ocean Water Desalination Facility, at varied plant capacities are provided in the following tables:

Table 3-1: Facility Staffing Roles and Certification Requirements – 10/20 MGD

Staff Role	Staff Type	Certifications	Quantity 10 MGD / 20 MGD
Plant Management and Administration			
Plant Manager	Core	T5	1/1
Secretary	Core	-	1/1
Cleaning Staff	Core	-	1/1
Maintenance			
Maintenance Manager	Core	-	1/1
Instrumentation Engineer/ Automation Technician	Specialty	-	1/1
Electrician	Specialty	-	1/1
Mechanic	Core	-	1/1
Operations			
Lead Operator	Core	T5	1/1
Shift Operator	Core	T4	4/8
Lab Supervisor	Core	-	1/1
Distribution System Operators	Core	D3, D4	2 – 4 (Depends on scenario selected)

Table 3-2: Facility Staffing Roles and Certification Requirements – 40/60 MGD

Staff Role	Staff Type	Certifications	Quantity 40 MGD / 60 MGD
Plant Management and Administration			
Plant Manager	Core	T5	1/1
Secretary	Core	-	1/1
Cleaning Staff	Core	-	1/1
Maintenance			
Maintenance Manager	Core	-	1/1
Instrumentation Engineer/ Automation Technician	Specialty	-	1/1
Electrician	Specialty	-	1/1
Lead Mechanic	Core	-	1/1
Assistant Mechanic	Preventative Maintenance	-	1/1

Staff Role	Staff Type	Certifications	Quantity 40 MGD / 60 MGD
Operations			
Lead Operator	Core	T5	2/2
Shift Operator	Core	T4	12/16
Assistant Operator	Preventative Maintenance	T3	3/3
Lab Supervisor	Core	-	1/1
Lab Technician	Core	-	1/1
Distribution System Operator	Core	D3, D5	2 – 4 (Depends on scenario selected)

It is important to note that certain staff members may take on additional roles as required to maintain plant operations. For example, plant operators may also serve as maintenance staff for the treatment equipment, should it require immediate upkeep that will otherwise detrimentally affect other operation-specific tasks. These efficiencies are considered in the above staffing level assessment but can potentially be further optimized.

Staffing for both the 10/20 and 40/60 MGD facilities can be expanded or reduced depending on the staff experience with operating similar facilities and degree of automation for which the facility is ultimately designed. In the tables above, it is assumed that the facility is automated on a basic level, such that all major treatment equipment, chemical dosing and cleaning systems, and monitoring equipment are automated. Reducing this automation such that the facility is increasingly operated manually will likely require additional staff to ensure that equipment operates safely and efficiently; increasing automation may enable staff to share responsibilities, assistants to be required less frequently, and some plant services to be outsourced.

Overall, it will be necessary to ensure that a baseline operations and maintenance staff, as recommended in **Tables 3-1 and 3-2**, is present or obtainable at all times in order to ensure that problems that may arise are immediately addressed, plant availability is maximized, and that treatment and distribution occurs as efficiently as possible.

3.2.2. Asset Maintenance and Management Program

A Maintenance and Management System (MMS) is desirable to protect the significant values associated with an Ocean Water Desalination system and to assist with sustaining operations. An MMS provides the following capabilities for improved work and asset management:

- An inventory of assets arranged in a local hierarchy for ease in identifying assets.
- Recording asset characteristics over time, including criticality and condition of the highest value assets.
- Advance planning, defining and scheduling of preventive maintenance tasks.
- Recording, issuing and tracking work orders for preventive and corrective maintenance.
- Tracking an inventory of spare parts and supplies, and providing functions for receiving, issuing and re-ordering inventory items.
- Capturing labor and equipment costs, and all associated costs with assets to support long-term repair/replacement decisions.
- Proving a basis for developing regular maintenance reports to aid in optimizing maintenance functions.

It is recommended that an MMS, or a computerized MMS, be developed for West Basin's Ocean Water Desalination program to protect this valuable asset and improve its sustainable operations.

3.3. Work Schedule

Based on the conceptual design details developed in the CSDPR, preliminary work schedules have been developed. These scheduled will need to be re-assessed based on the facility sizing scenario and unit processes selected.

Table 3-3: Work Schedule – 10/20 MGD

Staff	Schedule														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
	Sat	Sun	M	T	W	Th	F	Sat	Sun	M	T	W	Th	F	
Plant Manager			8	8	8	8	8			8	8	8	8	8	80
Lead Operator	12	12			12	12				12	12			12	84
Operator A	12	12			12	12				12	12			12	84
Operator B	12	12			12	12				12	12			12	84
Operator C			12	12			12	12	12			12	12		84
Operator D			12	12			12	12	12			12	12		84
Mechanic			12	12			12	12	12			12	12		84
Lab Supervisor			8	8	8	8	8			8	8	8	8	8	80

Table 3-4: Work Schedule – 40/60 MGD

Staff	Schedule														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
	Sat	Sun	M	T	W	Th	F	Sat	Sun	M	T	W	Th	F	
Plant Manager			8	8	8	8	8			8	8	8	8	8	80
Lead Operator			8	8	8	8	8			8	8	8	8	8	80
Shift Operator A	12	12			12	12				12	12			12	84
Shift Operator B	12	12			12	12				12	12			12	84
Shift Operator C			12	12			12	12	12			12	12		84
Shift Operator D			12	12			12	12	12			12	12		84
Assistant Operator A	12	12			12	12				12	12			12	84
Assistant Operator B	12	12			12	12				12	12			12	84
Assistant Operator C			12	12			12	12	12			12	12		84
Lead Mechanic			8	8	8	8	8			8	8	8	8	8	80
Assistant Mechanic			12	12			12	12	12			12	12		84

Staff	Schedule														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
	Sat	Sun	M	T	W	Th	F	Sat	Sun	M	T	W	Th	F	
Lab Supervisor			8	8	8	8	8			8	8	8	8	8	80
Lab Technician			8	8	8	8	8			8	8	8	8	8	80

The work schedules described **Table 3-3 and Table 3-4** are baseline options that are recommended based on the plant capacities and treatment processes preferred in the CSDPR. After the desalination facility is commissioned and is in operations for a period of up to 1 year, optimization efforts should be underway and these work schedules can be modified to streamline operations while satisfying plant operational requirements.

4. Conveyance System Requirements

4.1. Overview

New conveyance infrastructure is required to carry flows from the desalination plant site to the existing distribution system. The majority of West Basin's service area is supplied from the MWD West Basin and West Coast Feeders through several turnouts. The West Basin (WB) Feeder is aligned along Manhattan Beach Boulevard with nine local turnouts. The West Coast (WC) Feeder is aligned along El Segundo Boulevard with three local turnouts. Both feeders are fed by the MWD Sepulveda Feeder, which is aligned along Van Ness Avenue. The size of the conveyance system depends on the plant capacity and site being evaluated. **Table 4-1** is a summary of estimated pipe sizes and lengths for each of the alternatives includes in the CSDPR (TM-1). The alignments, alternatives and sizing discussion, and turnouts locations are identified in TM-1.

Table 4-1: Conveyance Infrastructure Summary

Scenario No	Plant Capacity	Tie-Ins	El Segundo	Redondo Beach
1	10-MGD	Tie-in to WB turnouts 3, 4, and 5.	4.0 miles of 24” pipe	3.3 miles of 24” pipe
2	20-MGD	Tie-in to WB Feeder and WC Turnouts, Connect Downstream of Turnouts.	2.8 miles of 36” pipe 2.3 miles of 24” pipe 1.8 miles of 16” pipe 0.5 miles of 12” pipe	3.0 miles of 36” pipe 2.0 miles of 30” pipe 0.3 miles of 24” pipe 1.2 miles of 18” pipe 0.5 miles of 16” pipe 0.5 miles of 12” pipe
3A, 3B	10/40-MGD & 40-MGD	Tie-in to WB and WC Feeders.	3.8 miles of 36” pipe 1.3 miles of 24” pipe	3.0 miles of 42” pipe 2.0 miles of 30” pipe 0.3 miles of 24” pipe
4	60-MGD	Tie-in to Sepulveda Feeder.	8.1 miles of 54” pipe	8.9 miles of 54” pipe

The labor/staffing requirements for the conveyance system will be minor compared to the desalination plant due to the relative simplicity of the equipment utilized in the conveyance system. Within many municipalities, the distribution network may be outsourced and the responsibility of maintenance and up keep placed on the outsourcing company.

The following sections describe support facilities and services that must be considered for successful daily operation of the conveyance system.

4.2. Operational Resources

In-house resources (staff and assets) and contracted services (laboratories, contractors, and other resources) that will provide materials and services integral to the efficient operation of the conveyance system are listed in **Table 4-2**. The columns titled "Plant" and "Conveyance" designate whether resources may be shared with the desalination facility or best utilized as a separate service. The table also explains the role/responsibility of the resource/asset.

Table 4-2: Operational Resources

Resource/Asset	Plant	Conveyance	Role/Responsibility
In-House			
Operations Staff	X	X	Inspections, testing, flow monitoring, valve exercising
Maintenance Staff	X	X	Minor repairs, leak repair, general up keep, housekeeping
Instrumentation/Electrical Staff	X	X	Equipment testing, monitoring, calibration services
Laboratory Staff	X	X	Collection of samples, testing and in-house reporting services
Utility Trucks	X	X	Fitted with small crane/hoist for assisting with equipment repairs
Contracted Services (As Needed)			
Certified Laboratories	X	X	Collection of samples, testing and regulatory reporting services
Corrosion Specialists	X	X	Inspections, testing, monitoring of active/passive cathodic protection
Eletrical/Civil/Mechanical Contractors	X	X	Electrical gear, pipe, valves, meters, and ancillary equipment repair and replacement, including paving, traffic control, and landscaping subcontractors
SCADA Support Contractors	X	X	Testing, repair, and programming of related SCADA systems

4.3. Support Facilities

The conveyance system support facilities will largely utilize existing ones, due to the ability for these resources to be shared with those used at the desalination facility. These facilities include the laboratory, maintenance shop, storage areas, and other resources that will be mutually beneficial and available to both the desalination plant and the conveyance system. A breakdown of these support facilities and other considerations are given in Section 6.2.

5. Operations Options

5.1. Overview

There are several options with respect to operating an ocean water desalination facility. These options include owner provided operations personnel, contract operations included in a project delivery model (i.e., Design-Build-Operate), or contract operations provided separately to the Owner after project implementation. Applicability of these alternatives to an Owner vary depending on several factors including an Owners existing staffing structure, and the size, complexity, and location of the project. The following sections discuss these alternatives as they relate to West Basin.

5.2. Owner Operations

In this alternative, West Basin would provide the O&M staffing required for their ocean Water Desalination Facility. This model has not been used by West Basin extensively in the past, and for a facility of the complexity of a desalination facility, this alternative can be a significant challenge. One challenge is in identifying lead, or supervisor level staff with the required experience. Another is in training and maintaining the required quantity of staff level personnel in a timely period. This method is often used where the owner has a significant O&M staff already employed, and can readily grow from their existing O&M staffing model. Since this is not the case for West Basin, this alternative would carry the largest risks.

5.3. Design Build Operate

The Design-Build Operate method is often used on projects where the long term operation of the facility is an important component of the project's life cycle cost. DBO helps to ensure that operation factors are considered during design and construction. In the Design-Build Operate method, the Owner's Representatives are retained and the DBO Team is procured. DBO Team Procurement typically follows the format below.

- Owner prepares RFP for retaining an "Owner's Representative" and retains Project Team (Engineering, Technical, Permitting, Legal, & Management/Financial).
- "Owner's Representative" prepares Project Description/Construction Impacts Report, Preliminary Engineering (10-30%) and DB Bid Package, and Preliminary Opinion of Project Cost.
- Owner prepares DBO RFQ which describes the DBO Team's scope for the project.

- DBO Teams submit Statement of Qualifications (SOQ) to Owner providing justification for their abilities to complete the required scope.
- Owner reviews SOQs and short lists DBO Teams.
- Following pre-qualification, DBO Teams submit bids on the project and include Contract Documents prepared to a level required for adequate cost estimation of work and bid development.
- Owner reviews DBO Team bids and technical proposals and makes final selection.

DBO Contractor Procurement typically has a longer duration compared to Design Engineer Procurement and about the same as DB Contractor Procurement. However, the DBB approach also typically involves a longer design period, a longer contractor bidding and selection period, and a longer construction period.

5.4. Contract Operations Procurement

Contract O&M, when properly implemented, is used to provide greater accountability for operations and to transfer operations risks to the private sector. Fixed pricing and technical expertise are major benefits to using Contract O&M. A Contractor with a proven track record is essential for achieving the maximum benefit from a Contract O&M. As such, the procurement process should be similar to that used for procuring other professional services like those above. Specifically, Contract O&M procurement should include a RFP with a process for submitting and evaluating qualifications and selections should not be based solely on bid price.

Contract O&M can take on a variety of forms due to the length of the contract period and the scope of services describing how facilities are to be operated and maintained and the criteria against which the Contractor’s performance will be measured. Typically Contract O&M will measure performance based on guaranteeing a certain effluent or product water quality and quantity at guaranteed cost and energy consumption (which can put the Owner at risk if influent quality is uncontrolled) or by requiring a certain level of staffing and for providing appropriate maintenance materials.

6. Required Support Facilities

6.1. Overview

The support facilities required to ensure effective operation and maintenance of the seawater desalination facility will be similar to those required for the conveyance system. These facilities are described in the following sections.

6.2. Support Facilities

Support facilities considered for the desalination plant will be separate from, but similar to those required for the conveyance system. These facilities are described in **Table 6-1**.

Table 6-1: Support Facilities

Resource	Desalination Plant	Conveyance System
Laboratory	X	X
Maintenance Shop	X	X
Control Room	X	X
Lunch Room	X	X
Vehicle Storage Garage	X	X
Spare Parts Storage Rooms	X	X
Locker Rooms	X	X
Rest Rooms	X	X
Records Storage	X	X
Janitor Closet	X	X
Conference Room	X	X
Offices for Plant Manager, Operations Manager, and the Lab Manager	X	X
Meeting Area	X	
Research and Development Area	X	
Tour Facilities	X	

The footprint required for each of these facilities will depend on the size of the desalination and conveyance systems. A preliminary estimation of the footprint requirements for many of the items listed in **Table 6-1** are summarized in **Table 6-2** for 20-MGD and **Table 6-3** for 60-MGD. **Figures 6-1 through 6-4** highlight support

facilities on the site plans for 20-MGD and 60-MGD. For estimating purposes, footprint requirements for the other plant capacities are interpolated or extrapolated from this data.

Table 6-2: Footprint Requirements: Administration Building/Education Center / 20 MGD

Area	Description	Size	Qty	Dimensions USF	Unit USF	Total USF
1	**Maintenance, Operations, Lab**					
1.1	Reception / Waiting Area	Small - 2 people	1	10' x 15'	150	**150**
1.2	Conference Room	Medium - 10 people	1	15' x 20'	300	**300**
1.3	Kitchen / Break Area	Large - 12 people	1	15' x 20'	300	**300**
1.4	Computer / Server Room	Medium	1	10' x 12'	120	**120**
1.5	Bottled Water Storage Room	Small	1	10' x 12'	120	**120**
1.6	Private Offices	Standard	6	10' x 15'	150	**900**
1.7	Office Cubicles	Medium	12	8' x 6'	48	**576**
1.8	Restrooms / Lockers	Medium	2	10' x 20'	200	**400**
1.9	Control Room	Large	1	30' x 30'	900	**900**
1.10	Maintenance Room	Large	1	20' x 50'	1000	**1000**
1.11	Parts Storage Room	Large	1	15' x 20'	300	**300**
1.12	Laboratory	3 x 300sf/person	1	30' x 30'	900	**900**
	Total Square Feet					**5966**
	x Circulation Factor					35%
	Total Required Square Feet (RSF)					**8100**
2	**Administration, NRG Offices**					
2.1	Reception / Waiting Area	Large - 5 people	1	20' x 20'	400	**400**
2.2	Reception / Waiting Area	Small - 2 people	1	10' x 15 '	150	**150**
2.3	Conference Room	Large - 14 people	1	15' x 30'	450	**450**
2.4	Conference Room	Small - 6 people	2	15' x 15'	225	**450**
2.5	Kitchen / Break Area	Large - 12 people	1	15' x 20'	300	**300**
2.6	Kitchen / Break Area	Small - 6 people	1	10' x 12'	120	**120**
2.7	Computer / Server Room	Medium	1	10' x 12'	120	**120**
2.8	Bottled Water Storage Room	Small	1	10' x 12'	120	**120**
2.9	Private Offices	Standard	20	10' x 15'	150	**3000**
2.10	Office Cubicles	Medium	40	8' x 6'	48	**1920**
2.11	Restrooms / Lockers	Large	2	15' x 30'	450	**900**
	Total Square Feet					**7930**
	x Circulation Factor					35%
	Total Required Square Feet (RSF)					**10700**
3	**Education Center**					
3.1	Reception / Waiting Area	Large - 5 people	1	20' x 20'	400	**400**
3.2	Restrooms / Lockers	Medium	2	10' x 20'	200	**400**
3.3	Kitchen / Break Area	Large - 12 people	1	15' x 20'	300	**300**
3.4	Auditorium	Large - 100 people	1	50' x 50'	2500	**2500**
	Total Square Feet					**3600**
	x Circulation Factor					35%
	Total Required Square Feet (RSF)					**4900**

Table 6-3: Footprint Requirements: Administration Building/Education Center / 60 MGD

Area	Description	Size	Qty	Dimensions USF	Unit USF	Total USF
1	**Maintenance, Operations, Lab**					
1.1	Reception / Waiting Area	Large - 12 people	1	15' x 20'	300	**300**
1.2	Conference Room	Large - 14 people	1	15' x 30'	450	**450**
1.3	Conference Room	Small - 6 people	1	15' x 15'	225	**225**
1.4	Kitchen / Break Area	Large - 12 people	1	15' x 20'	300	**300**
1.5	Computer / Server Room	Medium	1	10' x 12'	120	**120**
1.6	Bottled Water Storage Room	Small	1	10' x 12'	120	**120**
1.7	Private Offices	Standard	16	10' x 15'	150	**2400**
1.8	Office Cubicles	Medium	32	8' x 6'	48	**1536**
1.9	Restrooms / Lockers	Large	2	15' x 30'	450	**900**
1.10	Control Room	Large	1	30' x 30'	900	**900**
1.11	Maintenance Room	Large	1	20' x 50'	1000	**1000**
1.12	Parts Storage Room	Large	1	15' x 20'	300	**300**
1.13	Laboratory	9 x 300sf/person	1	30' x 60'	1800	**1800**
	Total Square Feet					**10351**
	x Circulation Factor					35%
	Total Required Square Feet (RSF)					**14000**
2	**Administration, NRG Offices**					
2.1	Reception / Waiting Area	Large - 5 people	1	20' x 20'	400	**400**
2.2	Reception / Waiting Area	Small - 2 people	1	10' x 15 '	150	**150**
2.3	Conference Room	Large - 14 people	1	15' x 30'	450	**450**
2.4	Conference Room	Small - 6 people	2	15' x 15'	225	**450**
2.5	Kitchen / Break Area	Large - 12 people	1	15' x 20'	300	**300**
2.6	Kitchen / Break Area	Small - 6 people	1	10' x 12'	120	**120**
2.7	Computer / Server Room	Medium	1	10' x 12'	120	**120**
2.8	Bottled Water Storage Room	Small	1	10' x 12'	120	**120**
2.9	Private Offices	Standard	20	10' x 15'	150	**3000**
2.10	Office Cubicles	Medium	40	8' x 6'	48	**1920**
2.11	Restrooms / Lockers	Large	2	15' x 30'	450	**900**
	Total Square Feet					**7930**
	x Circulation Factor					35%
	Total Required Square Feet (RSF)					**10700**
3	**Education Center**					
3.1	Reception / Waiting Area	Large - 5 people	1	20' x 20'	400	**400**
3.2	Restrooms / Lockers	Medium	2	10' x 20'	200	**400**
3.3	Kitchen / Break Area	Large - 12 people	1	15' x 20'	300	**300**
3.4	Auditorium	Large - 100 people	1	50' x 50'	2500	**2500**
	Total Square Feet					**3600**
	x Circulation Factor					35%
	Total Required Square Feet (RSF)					**4900**

Figure 6-1: NRG Preliminary Site Layout – 20 MGD Support Facilities

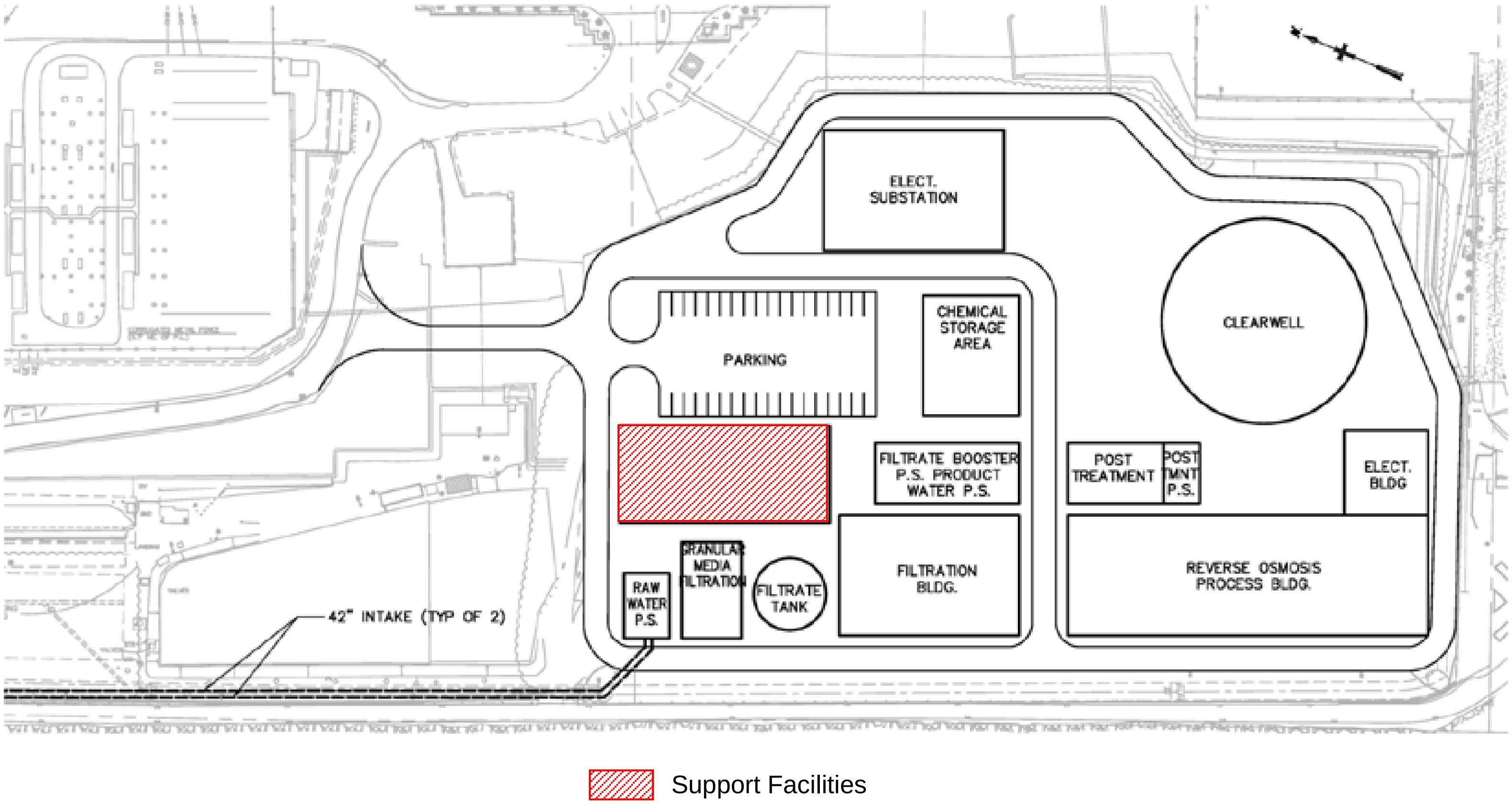


Figure 6-2: AES Preliminary Site Layout – 20 MGD Support Facilities

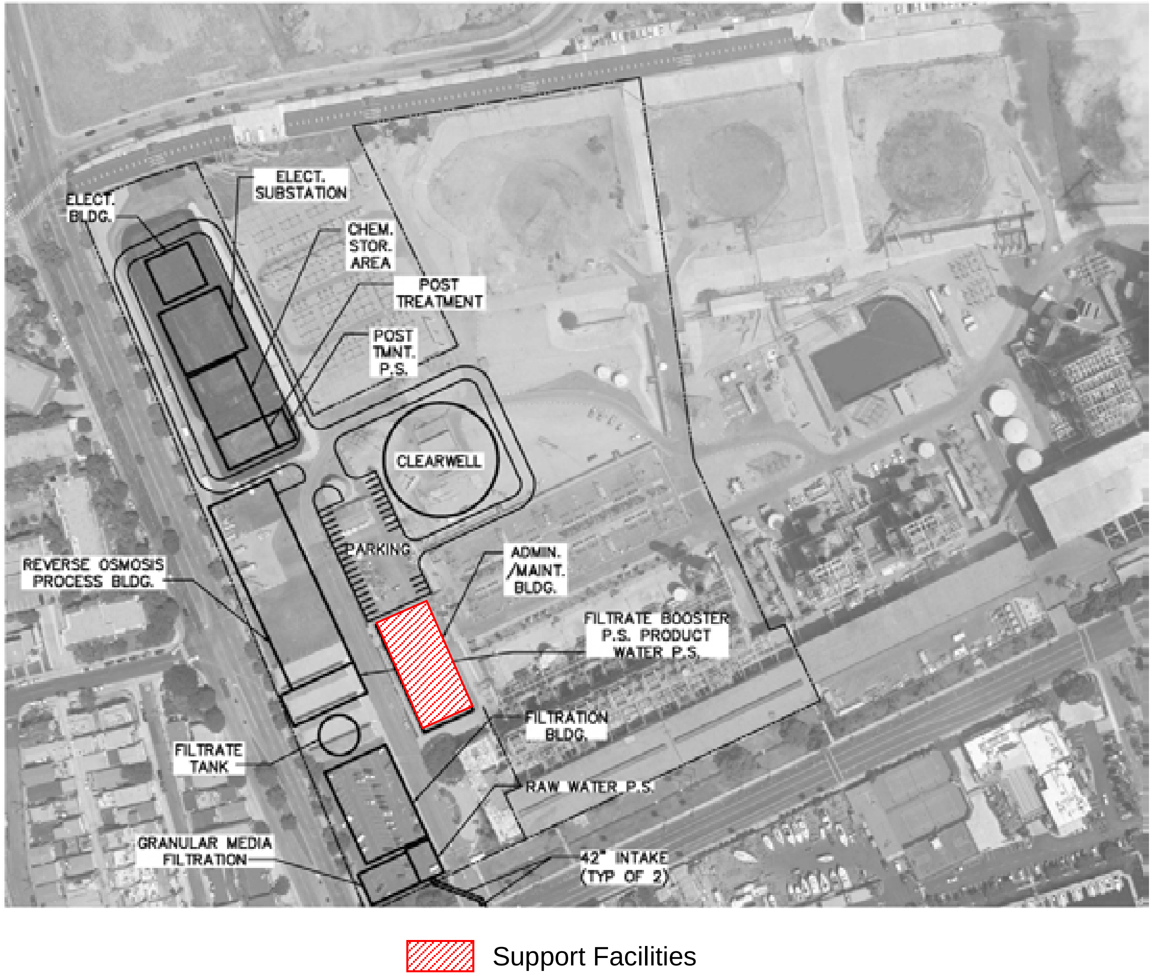


Figure 6-3: NRG Preliminary Site Layout – 60 MGD Support Facilities

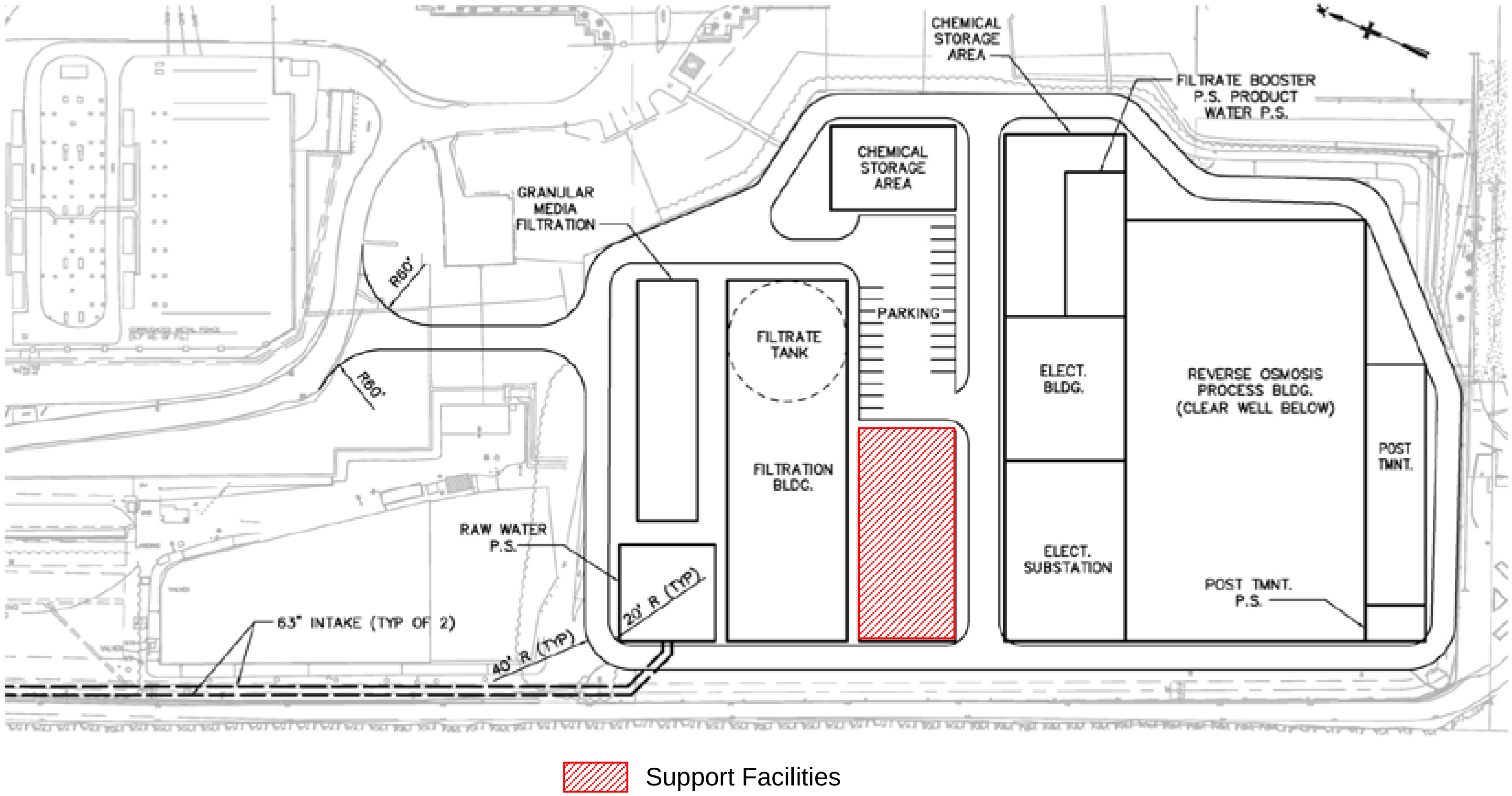
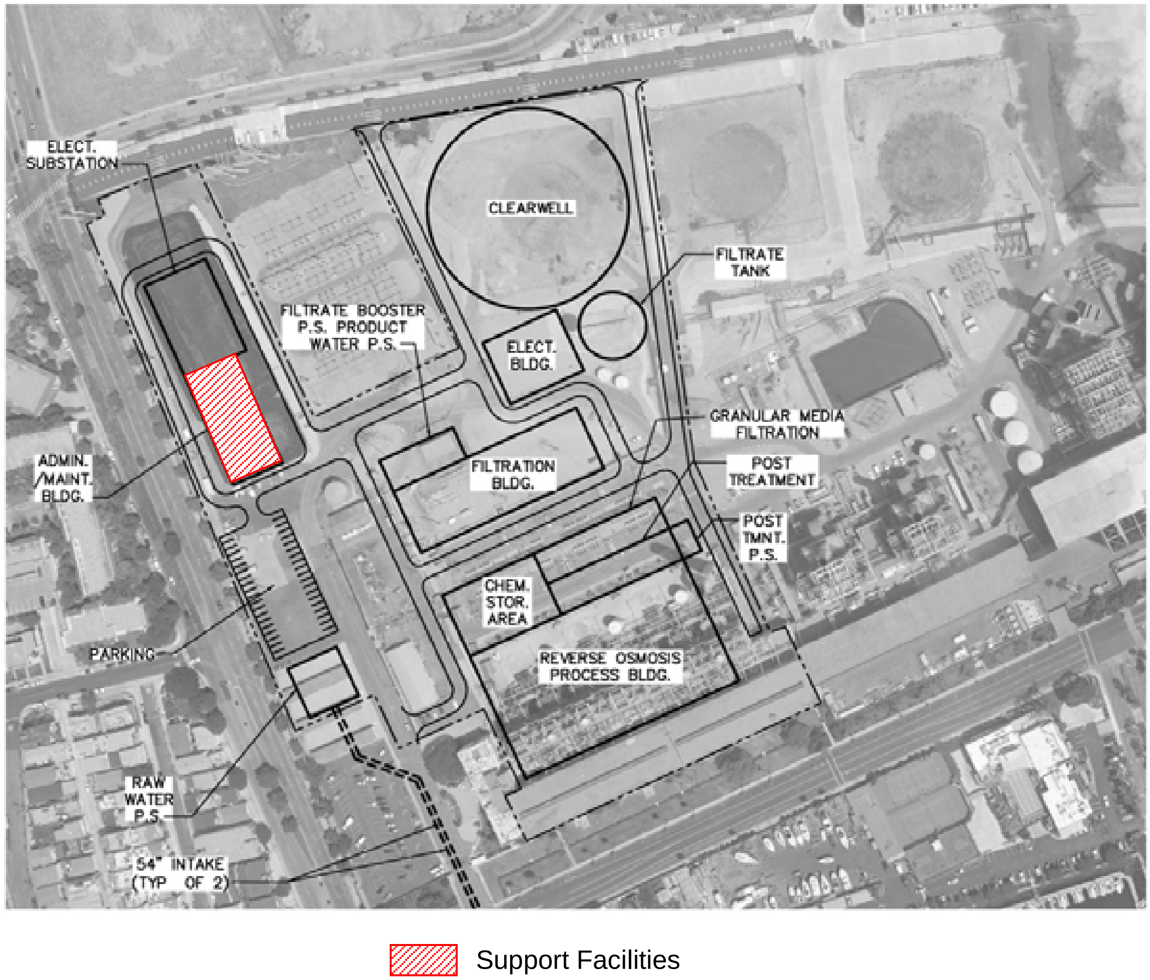


Figure 6-4: AES Preliminary Site Layout – 60 MGD Support Facilities



7. Environmental Compliance Requirements

7.1. Overview

A regular monitoring schedule of key processes throughout the treatment system must be maintained in order to assure process efficiency and that environmental targets are being met. The following section outlines typical reporting requirements and the facilities needed to appropriately monitor water quality.

7.2. Reporting Requirements

A recommended monitoring schedule that may be required by CDPH for a seawater reverse osmosis desalination facility is given in **Table 7-1**.

Table 7-1: Example Regulatory Monitoring Schedule

Parameter	Treatment Area								
	Raw Ocean Water	Pre-screen Product Water	Filtration Product Water	1st Pass RO Permeate	RO Brine Conc.	2nd Pass RO Permeate	Post-treat Product Water	Product Water	Ocean Water Discharge
Temp.	Cont.	-	-	Cont.	Cont.	Cont.	Cont.	Cont.	-
pH	Cont.	-	-	Cont.	Monthly	Cont.	Cont.	Cont.	Quarterly
SDI	Daily	-	Daily	-	-	-	-	-	-
Conductivity	Cont.	-	Cont.	Cont.	Cont.	Cont.	Cont.	Cont.	-
Turbidity	Cont.	Cont.	Cont.	-	-	-	Daily	Cont.	-
TOC	Weekly	-	-	Weekly	Weekly	Weekly	-	Weekly	-
Barium	Monthly	-	-	Monthly	Monthly	Monthly	-	Weekly	-
Boron	Weekly	-	-	Weekly	Monthly	Weekly	-	Weekly	-
Bromide	Monthly	-	-	Weekly	Monthly	Weekly	-	Weekly	-
Chloride	Weekly	-	-	Weekly	Monthly	Weekly	-	Weekly	-
Alkalinity	Weekly	-	-	Weekly	Monthly	Weekly	-	Weekly	-
Hydrogen Carbonates	Weekly	-	Weekly	Weekly	-	-	-	-	-
Strontium	Monthly	-	-	Monthly	Monthly	Monthly	-	-	-
Sulfates	Weekly	-	-	Weekly	-	-	-	-	-
Calcium	Weekly	-	-	Weekly	Monthly	Weekly	-	-	-
Magnesium	Weekly	-	-	Weekly	Monthly	Weekly	-	-	-
Sodium	Weekly	-	-	Weekly	Monthly	Weekly	-	-	-
Potassium	Weekly	-	-	Weekly	Monthly	Weekly	-	-	-
Total Bacteria	Daily	Monthly	Monthly	Daily	Monthly	Daily	-	Weekly	Daily
TDS	Weekly	-	-	Weekly	Monthly	Weekly	-	Weekly	-
Color	Weekly	-	-	Weekly	-	-	-	Monthly	-
Iron	Annually	-	-	Annually	-	-	-	Weekly	-
Metals	Annually	-	-	Annually	-	-	-	Weekly	-
Total Coliform	Daily	-	-	-	-	-	-	Monthly	-

The schedule outlined above is primarily for plant use, to ensure that the desalination facility is operating efficiently. Preliminary monitoring and reporting requirements for the desalination facility, particularly under circumstances in which the facility undergoes expansion, are discussed in the CSDPR (TM-1).

7.3. Facilities

Depending on the size of the plant and the nature of its operations, it may be necessary to secure laboratory facilities, equipment, and staff with appropriate certification levels to ensure that environmental testing is conducted efficiently and compliance is achieved. For 20 MGD and 60 MGD facilities, an on-site laboratory can be utilized to analyze water quality parameters in order to ensure that daily plant operations are occurring efficiently. However, use of an external laboratory for periodic analyses is recommended to validate the work conducted in the on-site laboratory as well.

Laboratory sampling and testing activities may be shared between multiple types of staff on site. Operators may conduct lab sampling, as needed; otherwise, lab technicians may conduct this sampling activity and analyze them as well. Contract laboratory staff may sample and analyze water samples as needed.

If the desalination facility is highly automated (i.e. utilizes on-line analyzers throughout the desalination process), significant effort may be avoided in monitoring daily operational activities. It will be necessary, however, to ensure that all instrumentation is properly calibrated and functional to ensure that data is gathered accurately. For reporting purposes, particularly for target effluent constituents that must be measured at low levels or whose measurement techniques are complex, is it is recommended that on-site laboratory technicians or an external laboratory are utilized to provide valid data.

8. Operations & Maintenance Budget

8.1. Overview

The budget required to operate and maintain a desalination facility will largely depend on the size of the facility, as it in turn dictates the labor requirements and other costs necessary to manage the plant successfully. The following sections summarize O&M costs for the plant capacity and site alternatives included in the PMP.

8.2. Cost Analysis

Annual operations and maintenance costs are divided among the following categories: Power, Chemicals, Maintenance & Materials, Labor, and Replacement. A summary of the annual O&M costs for each facility size and plant site alternative is provided in **Table 8-1**. For a more detailed breakdown of annual O&M costs (including costing assumptions used for each category), refer to the Project Costs & Funding Plan (PFP) TM of the PMP.

Table 8-1: Annual Operations & Maintenance Costs Summary

Description	Cost [$]									
	10 MGD		20 MGD		10/40 MGD[1]		40 MDG		60 MGD	
	El Segundo	Redondo Beach	El Segundo	Redondo Beach	El Segundo	Redondo Beach	El Segundo	Redondo Beach	El Segundo	Redondo Beach
Power (66 kV)	$3,630,000	$3,615,000	$7,239,000	$7,219,000	$4,038,000	$4,036,000	$16,280,000	$16,200,000	$23,559,000	$23,634,000
Chemicals	$1,496,000	$1,495,000	$3,144,000	$3,144,000	$1,496,000	$1,496,000	$5,967,000	$5,967,000	$8,950,000	$8,950,000
Maintenance & Materials	$570,000	$570,000	$600,000	$600,000	$570,000	$570,000	$715,000	$715,000	$995,000	$995,000
Labor[2]	$1,248,000	$1,248,000	$2,995,200	$2,995,200	$1,248,000	$1,248,000	$4,742,400	$4,742,400	$5,865,600	$5,865,600
Replacement	$1,286,423	$1,283,065	$2,475,126	$2,479,007	$1,325,483	$1,338,835	$4,024,196	$4,029,499	$6,009,298	$6,010,891
Total Annual O&M Cost	**$8,230,423**	**$8,211,065**	**$16,453,326**	**$16,437,207**	**$8,677,483**	**$8,688,835**	**$31,728,596**	**$31,653,899**	**$45,378,898**	**$45,455,491**

1. Annual O&M values are for a 10 MGD facility with a 40 MGD backbone (intake/discharge structures, conveyance piping, etc.) for future expansion.
2. Labor cost is based on whole number FTEs @ $60/hr. This is an assumed burdened labor rate based on experience with similar facilities, which includes direct labor and indirect costs such as benefits, travel, vehicle expenses, office supplies/equipment, delivery/postage, professional fees, promotional/advertising, dues and subscriptions, business insurance, telephone, outside services such as landscaping/miscellaneous, lab/safety supplies, training, etc.

The costs in the **Table 8-1** are reflective of the staffing arrangements discussed in Section 3, including the type and quantity of staff needed for desalination facilities of varying capacity, their certification levels, and work schedules. As the plant design is finalized and operational parameters impacting the facility's lifecycle costs (e.g. chemical type and usage, membrane characteristics) are better defined, these costs may be refined.

Some costs, such as those for labor and chemical supplies, are variable and will increase as plant capacity expands. As the plant design is finalized and a staffing strategy is formulated, it may be possible to optimize operational costs accordingly. The power costs vary for each site and capacity scenario primarily based on the difference in conveyance pumping requirements between each site and pumping scenario. Replacement costs are similar at each site but vary slightly as a result of water quality differences.

Despite the global experience that has been gained in constructing and operating desalination facilities, there is not necessarily a correlation between the size of a plant and anticipated costs. Depending on the desalination technologies that are chosen for construction (i.e., levels of pretreatment required, intake & outfall options, proximity to feed source), regional constraints, conveyance requirements, operating strategies, and other factors, facility costs can vary widely over somewhat narrow capacity ranges. This is illustrated in **Figure 8-1** and **Table 8-2**:

Figure 8-1: Desalination Facility Size vs. Cost

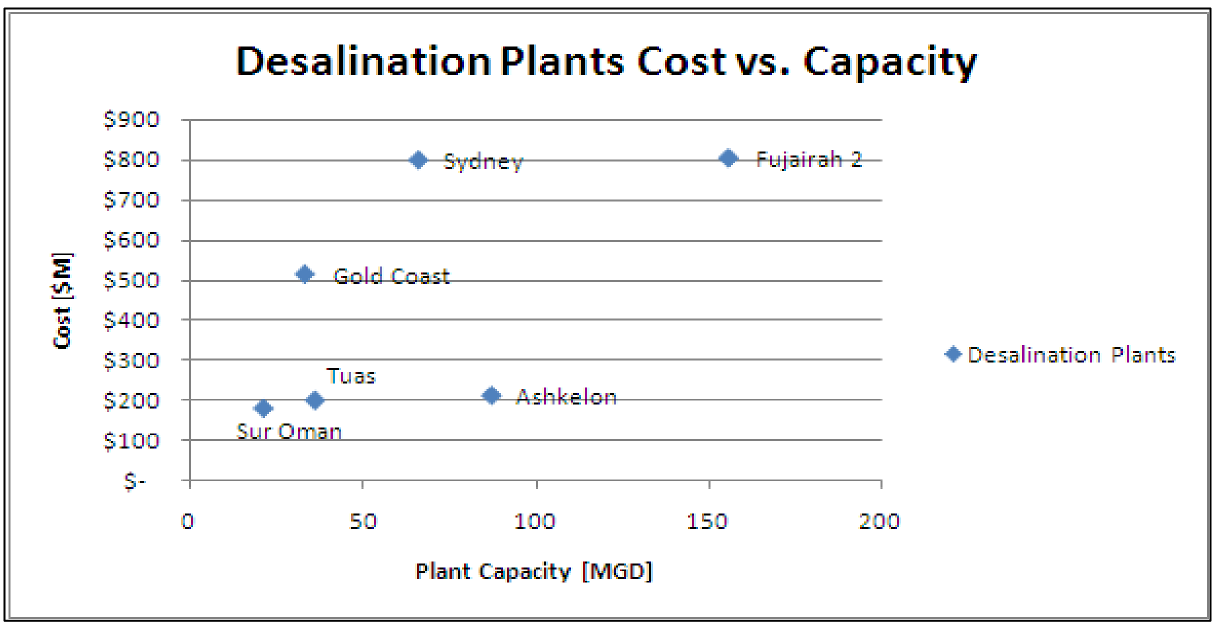


Table 8-2: Example of Desalination Projects

Plant	Location	Technology	Capacity [MGD]	Year	Project Cost [$M]
Ashkelon	Israel	SWRO	87	2005	$212
Sydney	Australia	SWRO	66	2010	$800
Gold Coast	Australia	SWRO	33	2008	$515
Sur Oman	UAE	SWRO	21	2010	$180
Fujairah 2	UAE	SWRO, Thermal	156	2010	$805
Tuas	Singapore	SWRO	36	2006	$200

Consequently, it is important to consider desalination facilities on an individual basis, particularly in terms of their operational and maintenance requirements, to determine an optimal approach that will ensure the effective operation of the plant for the most appropriate costs.